J. E. D. CLINE

IT'S DOWN TO EARTH

The seven billion people of the Clarke Belt Cities are desperately seeking ways to return to their homes on the ground, after being stranded in Geostationary Earth Orbit by the cutting down of their centrifugally-supported space escallator by which they had temporarily migrated to cities built up there, to live in while the Earth's ecosystem was being cleansed and jump-started back to a long-term viable condition again. Now, how can they get back down?

It's Down To Earth is a science fiction novel in a series by Jim Cline about efforts to rejuvenate the planet by gaining high efficiency electrical lift access to high earth orbital space resources of constant solar energy, total recycling of toxic materials, high level rocket launch facilities, and plenty of room to live; all made possible by building various space access hoop structures electro-dynamically supported by kinetic energy stored circulating within themselves.

It's Down To Earth

Also in this saga series by J. E. D. Cline:
The Novelway Prototype Shop
Building Up
Crisis On First KESTS
The Ark Of 1984's Future
Spacetrains Are For Peacetime
It's Down To Earth
The Torus City Ice Shields Returning Home

Other science fiction by the author:
Masters of the Trading Game
Religion On Another Planet
Past The Town Prison

Also see the author's websites:
www.kestsgeo.com
www.escalatorhi.com

The author's major blog:
www.kestsgeojedc.blogspot.com

Related published technical papers by the author:

Cline, J. E. David, “TreeHouse Haven”, Meditation Magazine, Winter 1990, 28-31

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Cline, James E. D. “Characteristics of Space Escalator Carousels vs. Space Elevators” Space Exploration 2005 Conference Proceedings, SESI, 2005, 355-364.

It's Down To Earth

By James E. D. Cline

Smashwords Edition

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Chapter 1 of "Spacetrains Are for Peacetime" originally written in 1998

Cover graphic insert, from Google Earth

Science fiction books available in paperback by J. E. D. Cline available from http://www.createspace.com

Building Up

The Ark of 1984's Future

It's Down To Earth

The Torus City Ice Shields Returning Home

Building Up

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For my friend Carol, who unceasingly encouraged me to write science fiction, despite my protests that people already thought my innovative technical writings were science fiction.

Foreword

This science fiction novel was initially written in participation with the annual writing activity hosted by NanoWriMo each November; this one written in 2007. The NanoWriMo activity rules are, that one may outline one's upcoming effort, but not one word of prose can be written prior to the start of November 1st; and before the end of November 30th, one must have creatively written at least 50,000 words and have them officially counted on the NanoWrimo.org website. This means one has to creatively write an average of 1,700 words a day for the 30 days of November. Each day's writing appears as a chapter by that number in this book; some are a lot longer than others. The push to write that many words necessarily creatively on the spot each moment, has a curious effect; that of bringing out the creative writer in oneself, so as to get the word count achieved. And surprisingly, I have found I enjoy re-reading my writings thusly made, in contrast to my more deliberate technical writings. This book is published in the hope that others too might find some enjoyment in reading this unfolding story.

The emblem awarded for having passed the 50,000-word finish mark in 2007 is shown below.

This novel is preceded by a scene that is from a prior short story I had written years before, in 1998; and so, for comparison, the first chapter of that story is included in this book as the Prologue.

Background Technology

Scenario

This adventure story plays out in a scenario formed by the planet Earth and its Geostationary Earth Orbit, GEO, that is some 22,300 miles above the earth's equator which, as of the start of this novel, contains a ring of cities; and a transportation structure that links the two, called a “KESTS” which stands for “Kinetic Energy Supported Transportation Structure;” another name for the transportation structure is the more casual one of “Space Escalator Carousel.” Since this structure is intimately involved with the novel's playout, the basic principles of it are described below for those a bit more curious about this technology involved in the adventure.

Why use a Kinetic Energy Supported Transportation Structure (KESTS); and how would it work

The actual energy added to payload by having moved it from the ground up into GEO orbit is only 7.3 kilowatt-hours per pound mass lifted up into orbit there. That is about 73 cents per pound, at a rate of 10 cents per KWh of electrical energy. How to calculate that is described below.

Compare that $0.73 per pound lifted to GEO with the current cost of over $10,000 per pound lifted into GEO needed by conventional rocket launch vehicles, because they have to lift the weight of a huge amount of fuel for the trip and the tankage to hold all that fuel and the big engines to lift all that weight; but out of all that $10,000, only 73 cents of it

actually gets applied to the payload put into GEO; which is the actual purpose of it all.

Lots of new kinds of great things can be done in GEO, as described more a few pages later here, at anywhere near such low transportation cost of 73 cents per pound; along with sufficiently rapid payload throughput capacity to build the huge facilities up there and maintain them.

The KESTS to GEO transportation structure concept appears to have the potential to provide that function.

Considering our conditioning from watching the spectacular launches of the massive rockets now expensively needed to do even a little bit of putting things into GEO conventionally, probably the value of 73 cents of energy per pound seems way too low, for the energy that is given to payload mass put up into GEO from the ground. So, let's take a quick look at it.

First, we know the energy given has to be less than that given to a mass by giving it "escape velocity," the speed with which launched straight up it will never return. That is about 25,000 mph, 1.12e4 m/s. For a pound or 0.454 kg given this velocity, it takes
$E = 0.5MV^{\wedge 2}$ = 2.836e7 Joules of kinetic energy which is equal to 7.878 KWh. At an electrical energy cost of 10 cents per KWh, that is 79 cents of energy given to the one pound mass in accelerating it so fast it will never come back (if there were no atmosphere to punch through, of course) and clearly to go into a lower orbit it receives less energy than that; so this gives us a calculation check limit.

The energy needed to lift between two different altitudes in a gravitational field is
$E = GMm((1/R_0)-(1/R_2))$ Joules, where R_0 is the radius of the lower altitude, 6.378e6 meters at Earth's ground level, and R_1

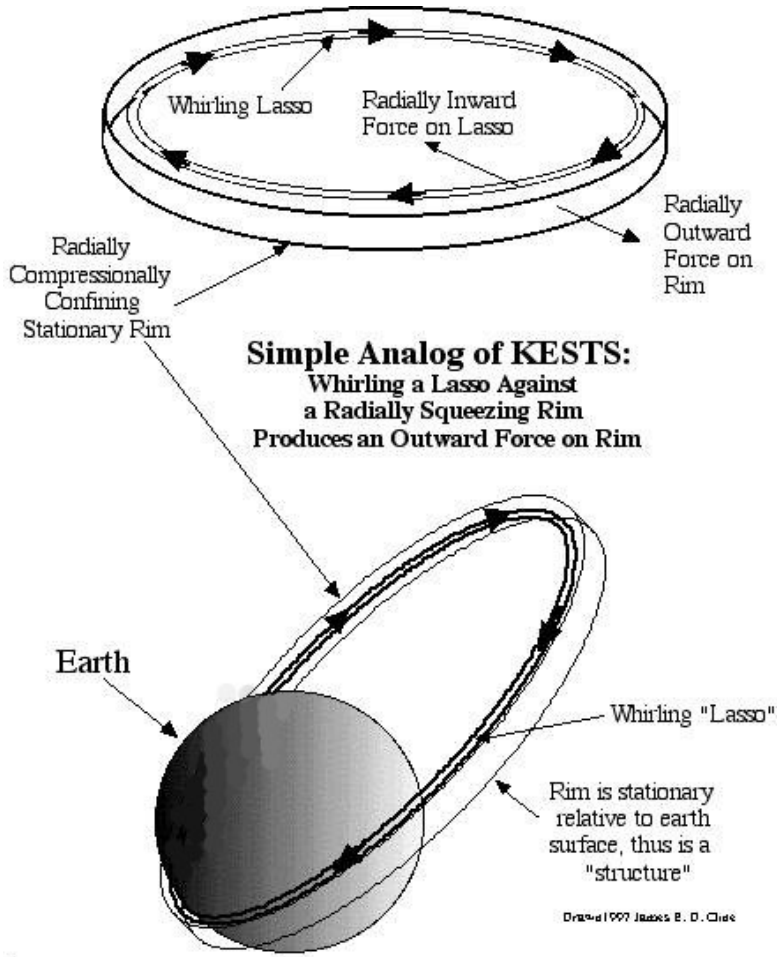
is the radius of Geostationary Earth Orbit 4.23e7 meters. That is 14.76 KWh per Kg or 6.71KWh per pound in the vertical lifting up to GEO altitude; then to give the mass an orbital velocity of 3.07 Km/s at that altitude, again from $E = 0.5MV^{\wedge 2}$ = 2.14e6 Joules = 0.594KWh; adding the two energies together = 7.3KWh per pound mass to move it from the ground up into GEO orbit. At $0.10/KWh, is $0.73 per pound to GEO.

Not to be confused with a KESTS, the more familiar "Space Elevator" is a linear anchored tether structure linking the ground with high earth orbital altitudes, is a different kind of way to do such things; but has its own unique set of characteristics that are not as well suited for the massive construction of facilities in GEO as envisioned here, even if there were a sufficiently strong construction material existing for the tether.

The KESTS bypasses that problem with the anchored tether Space Elevator, by instead supporting the weight of a transportation structure through kinetic energy stored within the structure and expressing as structurally distributed outward centrifugal force in opposition to the inward force of gravitational attraction on the mass of the structure and its live loads.

As used in this novel, the KESTS has a variety of potential forms; each having the common characteristics of being a transportation structure in the form of a hoop or band that eccentrically encircles the planet, which has its weight supported by the rapid rate in which its electric motor hoop armature spins along its path around the planet generating outward centrifugal force that balances the inward force of gravity on the overall structure; and also that payload is lifted between ground and orbit by means of electromagnetically braking against the upward-moving part of the armature mass, dragging the payload up to orbit, and

similarly gently lowering it back to the ground, possibly returning some of its energy back into the system when returning to the ground. This means that the captive spacecraft needs no big rocket engines nor lift heavy fuel for the trips between ground and GEO, enabling great energy efficiency. By conventional rocket launch, it costs about $10,000/lb to GEO, for comparison. Again, the energy actually supplied to payload during the lifting is only 15.7 KWhr/kg, 7.3 KWhr per pound mass, about $0.73 of electricity per pound lifted up from the ground into GEO, when starting from somewhere on the equator. Again, as a reality check, compare with the energy given to mass by accelerating it to Earth's escape velocity of 25,000 miles per hour, as launched from the ground if there were no impeding atmosphere; this is 7.9 KWh per pound, and clearly would be more than is needed to lift merely up into GEO.



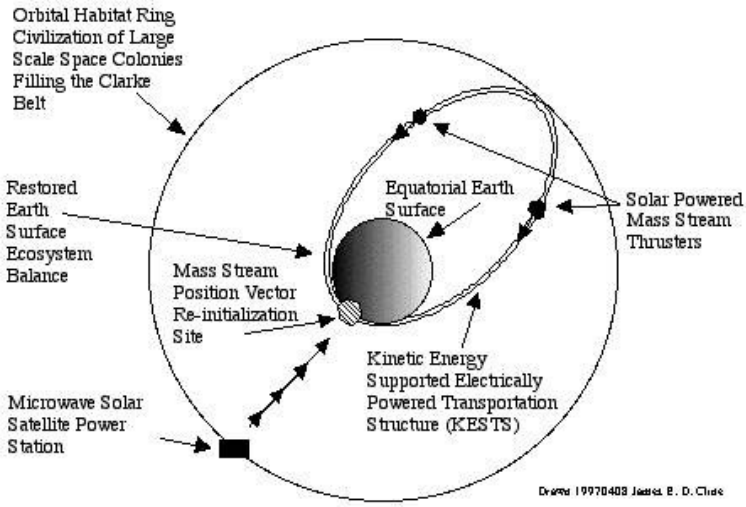
(Graphic from a paper titled “Kinetic Energy Supported Electrically Powered Transportation Structures” which the author wrote, and presented in May 1997 at the Space Studies Institute's space conference at Princeton, NJ; but was unfortunately rejected for publication at the time.)

The preceding diagram shows the outward centrifugal force on a spinning hoop; and then an elongated version spinning around the earth in the equatorial plane along the

approximate path of an Orbital Transfer Trajectory between ground and GEO, the spinning's outward centrifugal force balancing the inward gravitational force on the non-spinning part of the hoop.

A special case of the KESTS is the “Circular KESTS” which spins around the planet in a circular shape, and needs to have access up to it by other means, but once up there, can cruise along at the altitude of the KESTS supported by its above-orbital-velocity constrained path centrifugal force as it goes around the planet. Solid versions of KESTS may be possible too, simpler in design, but of lesser utility than the discontinuous armature mass stream technique mostly used in these descriptions as explored in these fictional adventures.

It is basically a gigantic perimeter synchronous electric motor, built in the general shape of an ellipse that extends around the earth; connecting between the earth surface and GEO. The KESTS internally has high velocity armature mass streams which continuously travel around the ellipse, riding along magnetic levitation tracks at several times orbital velocity, so that their aggregate outward centrifugal force balances the earthward inward force of gravity on the non-moving part of the ellipse; which is attached to the earth surface at the contact point roughly where an Orbital Transfer Trajectory ellipse would graze the Earth's surface, if there were no atmosphere.



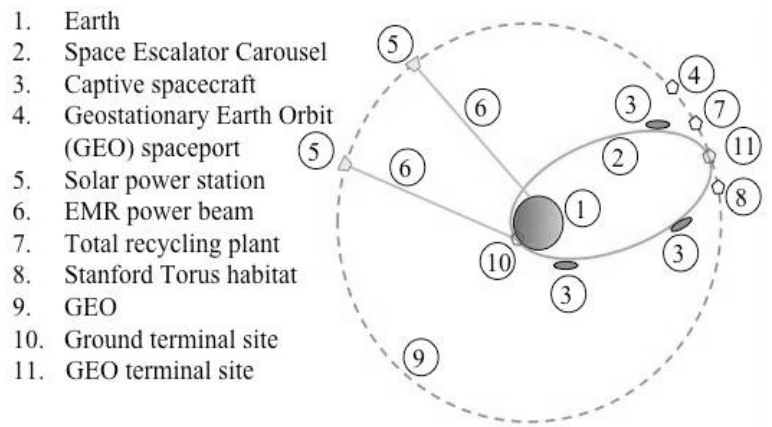
KESTS to an Orbital Habitat Ring Infilling the Clarke Belt

(Graphic from a paper titled “Kinetic Energy Supported Electrically Powered Transportation Structures” which the author presented in May 1997 at the Space Studies Institute's space conference at Princeton, NJ, but it was rejected for publication at the time)

In this novel, the structural attachment to the earth's surface is primarily within a tunnel in Cayembe Peak in the Ecuadorean Andes Mountains on the earth's equator. The earth-stationary part of the KESTS includes the tubing that keeps a hard vacuum environment for the armature segments to flow within while traveling within the earth's atmosphere; and also holds a second type of magnetic levitation track on its outside, along which captive spacecraft are lifted up to space by electrodynamically dragging on the upward-bound armature mass streams until they reach GEO.

Functions of Major Facilities Enabled Built in GEO by Use of KESTS Technology

The following is a diagram showing the KESTS Space Escalator Carousel, showing the Earth in the center, and the Geostationary Earth Orbital ringing it; and some of the major kinds of infrastructure that the KESTS could enable be built and maintained in high earth orbit, as is involved in this novel.



(Graphic from the author's presentation slides used in presenting the technical paper “The Space Escalator Carousel's Unique Potentials” Space Exploration 2005 Conference Proceedings, SESI, 2005, 230-238 at the Space Exploration 2005 conference in Albuquerque, NM in 2005.)

Here is a brief description of four basic kinds of facilities that could be built in GEO if this transportation structure were to be built for rapid and economic delivery of their construction materials and personnel.

Solar Power Satellites have been proposed for the past four decades to provide abundant clean electrical power to all the nations of the earth, but there has been no economical means to lift construction materials to build them up there in space, if limited to conventional, rocket propelled launch vehicle means to reach space. The KESTS would finally enable those Solar Power Satellites to be built and maintained up in high earth orbit, GEO. The electrical energy to run the KESTS itself would be beamed down from a Solar Power Satellite in GEO, to the accelerator site on the ground in the mountain tunnel in Ecuador.

The Total Recycling Plant is a second primary kind of facility that probably could be economically built and operated in GEO as enabled by KESTS transportation. These would be gigantic basic mass spectrometer type devices built in the free-fall hard-vacuum GEO environment, that would use solar energy to totally convert toxic and otherwise environmentally-dangerous industrial byproduct material as well as worn out electronics materials and nuclear wastes, back into their basic elemental states. The incoming waste material would be vaporized into a plasma state by focused solar energy; then using electrostatic fields to be separated into positive and negative ions, and accelerated down a pathway to uniform exit speed as they launch across a magnetic field, and the ion's trajectories are bent according to their unique mass-charge ratio, there to be collected in containers placed out around the magnet at the appropriate angles to where the ions were bent by the magnetic field. When the containers are filled, the materials would be utilized for manufacturing up there in GEO, or be returned down the KESTS for industrial re-use in their now pure form; or perhaps in the case of some dangerous radioactive isotopes, being launched into the Sun.

High Spaceports in GEO would be for conventional rocket facilities. Since GEO, already 91% up out of the Earth's planetary gravitational energy well, they would be extremely energy efficient terminals for spacecraft to travel to and from other destinations in the solar system, including the Moon, Mars, and the moons of the other planets. Starting as cheaply lifted electrically up the KESTS from the ground up into GEO, the spacecraft would have their assembly completed at the spaceports; fueled with fuel brought up the KESTS; and readied for their duties as very large scale manned space exploration expeditions, or for freighting of industrial materials from the Moon and other sources such as asteroids.

The 1 or 2 mile diameter wheel type of city built in space is the last major type of facility involved in this story, much like was envisioned as the 10,000-person space settlement originally designed in 1975 under NASA sponsorship at Stanford, for construction and use in the Earth-Moon Lagrange-5 (L-5) location in space; but adapted here for use in GEO; initial construction from materials brought up the KESTS from the ground, including the water and sawdust for use in making the passive ice shields out of water ice instead of from lunar materials; the water ice would be a benign addition to the earth's atmosphere if and when eons later, the ice shields would be returned to the earth via atmospheric entry.

In the ongoing saga of this novel series, the KESTS was originally built to enable the construction of Solar Power Satellites in GEO to power the earth surface civilization with abundant clean electric power; but by the time KESTS was approved to be built, the whole earth's ecosystem was clearly in collapse mode, so the plan was made to move the earth's population temporarily off-planet into cities built fully around the planet in GEO, while the ecosystem was being jump-started back to long term sustainability. Each city being similar to the wheel-shaped space designs of the mid-1970's which would be nearly self-sustaining cities of 10,000 people each; and would instead be passively shielded by water ice that was reinforced by sawdust, and its outside covered by a thin film of aluminum foil to reflect the sun's energy.

In prior novels of the saga, the scenario has arrived to the point where the Earth had been captured by a group of pirates, who kidnapped a large number of young women as the last of the population headed up the KESTS to their temporary new homes in GEO; then the pirates blocked further access to the ground, while they proclaimed they were now owners of the whole earth.

They were determined to destroy the KESTS, to no longer fear the return of the people to re-claim their land and homes, people that were now stranded up in GEO. And this is the situation as the prologue now opens.

Prologue – Spacetrains Are For Peacetime

The following is the first chapter of the author's short story "Spacetrains Are For Peacetime" written in 1998

Defending KESTS to GEO

As a military man, John Foursight had been against there being efforts to defend the KESTS space rail structure from the beginning. It was known from before it was built that it was much too vulnerable to attacks from saboteurs and hostile groups in wartime; the dispersability of a multitude of free-flying space vehicles was strategically much better than the lumbering space train rail system so immobile and predictable as to position, being attached to the ground. Why keep on defending the spacerail KESTS, why not just abandon it and let the earthsurface pirates knock it down, let the pirates die in their own wastes, then go back and rebuild the KESTS and resume fulfillment of the plan to restore the planet's ecosystem embarked upon so many decades ago. After all, the KESTS spacerail was just an electric motor, and motors could be rebuilt; and in the meantime they could use reaction engines to make up for losses slowing the great ring of structures in GEO. Yet, John was a man of duty, and he would do his duty the very best he could.

Idly he still thought, why should he now be risking his life to defend a mere electric motor? He mentally explored the basics of KESTS as he cruised alongside the great spacerail structure, drifting downward from GEO toward a landing near its ground terminal on the far side of the planet.

Yes, the spacerail KESTS was just a big electric motor with two kinds of coupled armatures, in the shape of an orbital transfer trajectory ellipse between equatorial ground radius

and GEO radius. The electric motor was a fixed structure relative to the planet, and provided the hard vacuum environment for the 20 km/h armature mass stream along their maglev tracks where near the planet in the atmosphere.

Constrained to a path similar to an orbital transfer trajectory, the armature segments were going twice as fast as orbital trajectory, so their excess centrifugal force pressed outward against the stator with an upward force adequate to support external mass equal to their own mass, within the gravitational field. The planet's gravitational field was equivalent to the motor's axle, and the bearings were maglev tracks along which the millions of armature segments continuously slid around the planet on the underside of the immense electric motor's stator. Electrical energy was input to the motor at the ground connection site at the equator, by electromagnetically accelerating the armature segments passing by there as they slid at 20 km/h along the stator's maglev tracks around the planet.

A tremendous amount of energy was kinetically stored in those high velocity armature segments traveling at far above orbital velocity as they whirled around and around the planet inside the motor's stator, their excess velocity providing the outward centrifugal force that balanced most of weight of the motor's stator and its live loads. That same stored kinetic energy was tapped by the vehicles as they slid along different maglev tracks on the outer edge of the motor's stator, the vehicle electrodynamic braking against the upward-bound armature mass streams inside the motor, lifting them up along the outer surface of the gigantic motor all the way from the ground up to the Geostationary Earth Orbit.

The originally emplaced KESTS had been expanded in girth from its hair-diameter starting version, up until it got as big as it is now, able to transport a million people a day with their household possessions, a task it started 35 years ago

and had performed for 20 years, before the pirates attacked at the last weeks of the population's temporary exodus from the ground. An exodus which was to have been temporary for much of the population, until the Earth's ecosystem could be restored to long term viability.

But a bunch of pirates had stopped the process 15 years ago, militarily restricting the Clarke Belt Habitat Ring people to an area they can visit on the ground to about a hundred miles around from the KESTS ground terminal site centered where it tunneled through the Andes mountains in Ecuador. And for the past 5 years the pirates had been attempting to destroy the KESTS link to the ground, claiming the entire planet as theirs alone. And so as both sides of the conflict learned through experience, the attacks on the KESTS were getting increasingly close to success, despite the patrol ships which protected the KESTS. John believed that the KESTS was inadequately defensible; it was a peacetime kind of transportation system, almost indefensible.

Yet here John was, on his fourth cycle of patrolling down the eastward side of the kinetically supported rail track, thoroughly committed to playing out the deadly duel of space-to-space missiles if an attacker suddenly appeared in his sphere of action.

Armed with a guided missile, he would be able to destroy an incoming bombship before it impacted the rail structure, saving the space train but not its live cargo in the vicinity nor John himself. Nor the pilot of that incoming bombship, but then, those pilots knew they were near their end at the moment they launched, one way or the other. He swayed the trajectory a little, adding another component to the randomness that weaved side to side of the rail structure, getting an unpredictable peek at the part of space that was shadowed moments before by the rail structure. His reaction engines kept him close to the structure, but maintained a

trajectory that if dead-sticked somehow, it would not impact the space train rail structure. Down John drifted in his fighter spacecraft, gradually to circle halfway around the planet in the process of losing the 22,300 miles of altitude from his starting point in the Clarke Belt Habitat Ring, now out of sight far above him....

The massive rocket engines suddenly thundered beneath her, and the brief moment of dismay at surely being now on a suicide mission, quickly gave way to the intention that she, Donna Bullguarde, would be the proud one to finally bring down the KESTS, the hated spacerail link between the arrogant Clarke Belt Nation and the great Sovereign Nation of Earthsurface.

She had been taking her turn atop the massive rocket, as usual, to play the simulation games in the pilot seat on her 4 hour shift, as she had taken her turn so many times in the past year. Always before, when the launch sequence got to that point, there were only simulated sounds and instrument readings; they were the same now except that the thunder and shaking was for real this time, no doubt about it as she was pressed down into the acceleration couch beyond any simulation. And so she knew that although the game would be the same as those she had played in this very seat so many times before, this time there would be nothingness for her at the end, and glory with her name added to the list of heros engraved in the hall of honor, maybe even be the one to have a statue made in her image as the one who finally achieved full sovereign separation from those above. She would bring honor to those of the Harem of Bullguarde, honor to the Daughters of Landsworth Breeding Man from whom she was traded to Bullguarde Breeding Man and produced children for him before being put on this assignment years ago. To Donna and Landsworth would be the Glory!

She would play the game with much practiced expertise, game of dodge and subterfuge with the KESTS Patrol Spacecraft which was even now unwittingly on its way down, 21,000 miles above her. She was assured of blotting out that patrol craft and its pilot, along with the million or so of current riders of the KESTS at the moment when she detonated her nuke; and if she could dodge the patrolcraft enough by some miracle, she would also sever the KESTS spacerail bridge and down it would fall. And the planet's surface would forever then belong to the Harems and each's Breeding Men, evermore honoring the name of Donna Bullguarde, greatest bombpilot of all. She smiled grimly and clenched the joystick a little tighter, as her mind began the practiced solutions of the equations that paralleled those of the guidance computer, she then began to sometimes slip in an unpredictable factor into her trajectory, intending to outwit the piloted patrolship and its computer.

John relaxedly again thumbed his randomizer thruster a bit, getting to the other edge of the KESTS spacerail to get a quicker peek beyond that which it had shadowed moments ago. And he instantly froze a second or two while he observed and mentally digested the blip that he saw headed his way. He knew he was good as toast already, for there was no preventing that nuke from torching all life on or near the KESTS now; but he would be able to save the spacerail itself if his skill held out long enough, if he destroyed the intruder before it could ram its nuke into the KESTS bridge structure. All his predecessors had made that sacrifice and had saved the KESTS itself thereby; now his number was up to do it too, his bad luck to draw this patrol shift. He quickly analyzed the probable trajectories and his mental calculations paralleled his patrol spacecraft's computer guidance system, minimizing intercept time to fire his space missile at the upcoming intruder before it could reach the KESTS. John's skill would attempt to gain those two seconds toward

intercept of the incoming piloted bombcraft, mere seconds quicker than the calculable intercept to the KESTS, in the game of dodge and subterfuge now desperately ongoing.

His thoughts flashed back to the warm hug and kiss of his wife 2 years ago, just before she launched in her patrol craft on an also unlucky numbered mission, just as this one has now become. His grief at her loss required many reminders of why this all was happening, and now he again resorted to remembering why this had to be played out to the end.

The KESTS spacerail bridge had been built from the ground up to GEOrbit to save civilization along with the earthsurface ecosystem, a generation ago, first to provide clean electric power and total recycling facilities in GEO, then expanded to move huge amounts of people and their belongings into space in a hurry. Nature had become overburdened by the accumulation of toxic wastes of mankind's civilization, waste material she had no way to recycle herself; and the ecosystem was dying, the weight of mankind's civilization had become much too great to sustain by nature, and mankind was forced to either die off or to take responsibility for its needs for total recycling of its waste products, its needs for abundant clean electrical power, and room to expand its population up where sunlight was always abundant; and the responsibility to restore the Earth's ecosystem back to long term health.

The first small cross-section KESTS was built and emplaced, infilling an Orbital Transfer Trajectory between the equatorial ground and around the Earth to peak at Geostationary Earth Orbit, moving at the same angular velocity as the earth surface; so payload left by the KESTS would stay in space, already with orbital velocity.

The KESTS structure was like a giant perimeter electric motor, driven by electrical power put in where it attached to

the ground; and it enclosed a hard vacuum throughout its internal maglev track system, the motor's armature mass stream traveling faster than orbital transfer velocity just enough to provide the outward centrifugal force component to balance the weight of the motor's earth-motionless stator with its live loads.

The small initial KESTS was used to lift materials to build onto itself until it was big enough to carry a million people a day between the ground to GEO; the electric power needed to energize this enormous transportation system came from one of the first Solar Satellite Power Stations the KESTS had enabled to be built in GEO, its solar-derived electrical energy cleanly beamed down to rectennas located near the KESTS ground terminal armature mass stream electromagnetic accelerators located within the tunnel through the Andes in Ecuador.

From GEO spaceports, expansion of mankind to go to the lunar surface for raw construction materials was easy, since GEO already was 91% up out of Earth's great gravitational energy well. So Earthsurface-like interior space habitats were robotically built from raw materials brought from the Moon, constructed at a rate adequate to provide new fine living space for one million people immigrating each day for 20 years, so as to enable civilization to prosper anew on space resources while the planetary ecosystem was to be lovingly nursed back to balanced health, saving as many species as possible from the moment the decision was made to go this route, to create a planet-wide National Park.

But toward the end of the upward movement of the population, a few tough renegade men began to kidnap women before they could get to the KESTS ground terminal, and created huge harems of them, and formed the Sovereign Nation of Earthsurface. And there became a war zone that eventually balanced into a boundary to define limits to where

the Clarke Belt Nation people could travel to around the KESTS earth terminal, in their conversion work to restore the land to the ideal ecosystem National Park condition, a mere 100 miles radius around the Ecuadorian terminal of the KESTS.

But the vast majority of the nearly vacated planetary earthsurface had been taken over by the Sovereign World guerillas, rejoicing in their windfall possession of a world full of vacated cities and industries, now wealthy beyond their wildest dreams through their piracy. All they had to do now was to sever the KESTS bridge, and the planet would be forever theirs, to pillage and squander as they always had done before the plan to move to the Clarke Belt was approved by the majority of mankind, thinking to save their planet and to save their civilization, so sad to leave their homelands, all of them.

But now ownership of abandoned property was theirs, these militant Sovereign Earthsurfacers, so clever. And the game of Destroy/Protect KESTS evolved to that of the present moment; now it was up to John and his lone patrol craft to once more protect the bridge between the 7 billion person Clarke Belt Nation in GEO, and the home planet it motionlessly ringed 22,300 miles above the equator....

Donna wished that she had a launchable nuke, but there were only a relatively few of the great reaction engine powered launchcraft left over from before KESTS was built, and they had not been intended to be bombers. So she had to contend with the warhead being lashed onboard in the cargo bay, requiring her spacecraft's impact with the KESTS spacerail bridge before detonating it, to bring down the KESTS. Short of that goal if unreachable, she would detonate it anyway, frying the enemy craft, herself, and all life on the relatively unprotected KESTS, usually about a million people traveling

on it at any given time. Hers was the glory of the moment, and in only a few minutes she would know just how big a winner she was.

Donna faked a quick move from around the shadow side of the KESTS relative to the patrol craft, then quickly reversed at the last instant, hoping that would lure the patrol craft to fire its missile but not risk the missile to hit the KESTS.

John took the bait and fired his space missile at the upcoming bombship, but the intruder uncannily dodged back behind the KESTS structure at the last instant; John had missed his chance.

Dismayed only for an instant, he too faked a move around the KESTS, reversed and surprised the upcoming spacecraft. In remembrance of his fallen wife he hit the thrusters full blast and rammed the intruding spacecraft in its cargo bay area, hoping to damage the nuke's firing mechanism before it could be detonated.

Donna elatedly reached for the bomb detonation switch just as she was about to contact the KESTS bridge; but was slammed to the side from an impact from something. A second slam indicated she had collided with the KESTS; she then hit the detonation switch but nothing happened. Checking the viewfinders, she found that her craft was bent around the spacerail bridge, tangled with the patrol ship's wreckage. She closed her helmet's faceplate to conserve air, and began to crawl back to the cargo chamber to inspect the nuke there, and set it off manually if possible.

She was illuminated by the glare of the headlight of a spacetrain which had stopped just short of the wrecked spacecraft tangled around its maglev track structure as she clambered in her spacesuit toward the cargo bay door area. The light also then showed the figure of another spacesuited

figure as it exited from that cargo bay. John had managed to disarm the nuke, and was surprised to be accosted by the attacking pilot who began a free-fall wrestling fist fight right there with him, kicking at him until passing out from lack of air.

He dragged the limp figure from the tangled wreckage, and held it by one arm while he jumped to the spacetrain's airlock door; and soon they were inside, surrounded by a crowd of astonished passengers; opening the faceplate of the attacker, John found the unconscious beautiful face of Donna, former Haremmate of Bullguarde of the Sovereign Nation of Earthsurface.

Three years passed between the events of the Prologue, and the start of this novel....

It's Down To Earth

Chapter 1 Lunar resources

Even at maximum magnification, Donna Bulguarde could not get the telescope to locate any signs of human activity down there in the area of the former Earth surface terminal on Cayembe Peak in Ecuador, 22,300 miles below. She could see the tiny streak across the landscape down there, where even jungle had not grown to cover the remains of the former link between the planet's surface and up here in Geostationary Earth Orbit, the vast Clarke Belt City extension of civilization encircling their former home planet. And now it seemed that maybe all that was left of civilization was up here, she thought with sadness.

“Do you remember back when all you wanted to make happen was that sight you now see down there?” spoke John Foursight, her mate of the past year, casually watching the telescope's display too. “It was just sheer luck that I managed to stop you from achieving that yourself, if you remember.”

Donna too well remembered that. “Well, it does not make any difference, since the KESTS was downed later anyway by another bombpilot from the Harems. The main difference to me is that I feel surprised at how much fun I am having up here with you, living in the place I had thought was despicable, back when I was a HaremMate down there. Amazing how life can have so many interesting variations.”

The unfolding of life events takes many twists and turns. Down there in Ecuador, no life stirred that they could see. Sure, the place was probably still reeking with radioactivity;

but it had been two years since the KESTS was brought down by the bombship, and one would think some signs of re-conquering life would have returned.

She remembered back two years ago, when a drama played out much as it did between she and John, a year before that. The upcoming bombpilot also had spotted the defending fighter spacecraft beginning pursuit of her. But the new bombpilot had learned from Donna's mistake; changing tactics when clearly to be blocked from nuking the KESTS high in space, she veered her spacecraft back down toward the ground, a big head start racing away from the surely baffled defending pilot. But in minutes it became clear what she was up to; she rammed her nuke-carrying bombship into Cayembe Peak in Ecuador, where the ground terminal of the KESTS was located, and her nuke destroyed everything for miles around the terminal, and the KESTS began its fall. The lower parts fell to the ground across part of Ecuador and Brazil to the East, and out across the Pacific Ocean to the West; but most of the KESTS disintegrated as it impacted the atmosphere, from high around most of the Earth.

By the next day it was all over; the KESTS was gone from space, all the people who defended the bit of territory around the KESTS terminal had been fried, along with the remaining pirates ringing the terminal area, part of those who had taken possession of the planet way back. But nothing had come back, not even a small animal had come out of the jungle since then. In fact, the jungle seemed to be withering, and not just at the nuked area. The ecosystem even of the great jungles of South America clearly was dying out, no longer needing the active hand of man to destroy it, as cascade biosystem mass failure was in progress. The world ecosystem collapse had gone far worse than had been imagined; but then, if the Clarke Belt City civilization plan to jump-start the ecosystem back to long term sustainability, once people had temporarily vacated the surface, that jump-

start would have already turned the ecosystem collapse back around toward blossoming new health by now.

But no, it was not to happen, as the greed of some men seeing opportunity for great wealth and power, had once again monkeyed up the works. A clever pirate group of alpha males had grabbed young women from among the last of the exodus from the ground up to temporary living in the Clarke Belt City Ring, and those guys had thus taken over the world for free. The takeover had worked perfectly, having been in secret plan for over two decades by then. That group of elite alpha males, whose bred-in arrogance was as big as the minimum 7 foot tall, 250 pounds of muscle and bone that was the smallest they allowed to live as one of them, had grabbed a huge group of young women as breeding stock, and then as the last of the people boarded the KESTS to GEO for their assumed temporary homes, the pirate alpha male bunch took over the planet. What they had not realized, was that to run a planet-wide civilization, it takes a planet full of people to do it. And even though the original 5,000 alpha males and the 20,000 young women they had kidnapped, began to produce offspring, once their revelry in the riches of the world had passed, they found that there simply were not enough of them to do what it takes to run a world, especially when the underlings were now all up there in the GEO Clarke Belt, a situation the huge elitists had never realized could happen, that of being without a horde of underlings to direct.

Meantime, the phenomenon of ecosystem collapse was progressing unimpeded. The elitists, being utterly exploitive by breeding, could not comprehend that the world needed nurturing with tender loving care by all concerned. In dismay, the environmental engineers up in the Clarke Belt, now unable to do their job of re-starting the ecosystem of the earth, simply had to wait in frustration for some way to resolve the problems. The pirate group on the ground

focused their efforts on destroying the KESTS by using the remaining commercial spacecraft, each rigged with a nuke removed from military stores, to make forays against the KESTS, thinking once the KESTS was downed, it would seal their ownership of the planet forever, thus the greatest winners of all. But the great planet-sized prize they had won was a dying prize, dying at their own arrogant hand. And they could not comprehend that it was they themselves that were guaranteeing that loss; even if so, it would have made no difference to them, believing that if they could not own the world, nobody would.

Donna thought that probably the great alpha males had fractionated when supplies were clearly running low; and killed each other off. And down there now, not much lived, no animals moved, and the plants were fading, what was left of them.

The problems did not end there. The great ring of Clarke Belt Cities, spanning completely around the Earth in the equatorial plane at GEO altitude, 22,300 miles above the planet's surface; and housing some seven billion people currently, would eventually die too. Deprived of the supplemental push from the Earth's mass coupled via the KESTS structure, to make up for the miniscule but finite orbital resistance slowing the ring of cities around the planet, which would eventually crumple them together and cause collapse. But long before that, they would run out of critical supplies.

Their mini-vacation break over, John and Donna headed over to the Lunar terminal, where the now idle great robot construction machines which had interfaced with the habitat construction materials launched from the Moon during the 20 years it took to build the Clarke Belt Cities and populate them. During construction's heyday, even the rocket-propelled freighters plying between the Moon and GEO were

piloted roboticly, teleoperator's merely continuously fine tuning the semi-autonomous robotic construction process. The sheer scale of the prefab components brought from the Moon were far beyond what mere men could manhandle, the structural sections of the 600-foot diameter width, mile diameter wheel-like cities were immense, and the Stanford Torus type rotating artificial gravity cities of 10,000 people each were being built at a rate of a hundred a day at the peak of production, a task that the burly construction workers that built skyscraper buildings on earth could not begin to muscle around. The concepts of automatic production facilities for manufacturing took on a huge scale, but otherwise not much different from systems long used in manufacturing on the ground. The dynamics of energies and inertia in freefall without air to assist or impede, were the main new parameters in the hard vacuum manufacturing process. 'Bigger faster cheaper' had taken on a new scale of meaning, up here.

Now, however, the construction yard was motionless, its job long done. There were some manned spacecraft there in the yard, which had been used to ferry personnel and precision small payloads between GEO and the Lunar facilities, and the couple selected one of these for their trip to the Moon. Their mutual skills as spacecraft pilots, having brought them together in conflict, would now unite them in a venture to go get a load of lunar dust, for reaction mass to assist in the maintenance of the orbital velocity of the Clarke Belt Cities. The dust would be injected into the tiny hydrogen-oxygen rocket motors that were now sustaining rotational velocity, its mass becoming part of the reaction mass.

The amount of energy exchange when traveling between the lunar surface and GEO was far less than that between the Earth surface and the lunar surface, making the use of Lunar material for construction in GEO far more efficient. Then, after being used to bring up all construction and supply

materials from the earth surface to build the first pair of research Stanford Torus type 10,000-person space cities in GEO, the KESTS was freed to be used just to bring up water, hydrocarbons, and of course the people and their minimum household goods for their planned 5 year stay in the Clarke belt, while the ground ecosystem was jump-started back into sustainability again.

Their spacecraft was reaction engine powered, fueled by liquid hydrogen and liquid oxygen that had been converted from water at GEO using solar electric power. The same fuel was being used on the small thrusters that currently were rigged to keep the Clarke Belt cities from slowing down; it did not take much energy as not much was lost per month by the huge GEO-infilling ring of space cities; but orbits do slowly degrade if not provided a little push to stay exactly in place up there. Problem was, it was slowly but surely using up their water reserves, huge as they were; their lives depended on water in other ways. And this trip to the moon was also using up a significant amount of that water.

They played a game on the way there, neither getting a chance to fly a spacecraft much anymore. The game was to see who was providing a trajectory that was more fuel efficient; and neither were trained in such matters, both being high performance engine users, he a defensive fighter pilot, and she as an offensive bomb pilot on a one-way trip from the ground, with but one goal in mind, engine fuel use was the least of concerns. The onboard computer displayed who was providing the more optimum piloting, and followed that course.

They circled halfway around the Moon, landing in the center of the nearside of the Moon. Here was the now motionless gigantic materials processing robotic facilities where the majority of the structural components of the Clarke Belt cities were built. This location was chosen because it had

two forms of transportation included, one was a fiberglass anchored tether extending up from the lunar surface out through the L-1 balance point between the Moon and the Earth. The other was a Solid KESTS, a fiberglas band that continuously spun in place, going around the Moon and up to L-2 balance above the farside of the Moon. Its velocity was high enough to stay stretched in tension, despite the variations in load from the occasional small payload sent up along the KESTS, to the station-keeping function of a way-point facility located at L-1 itself.

Their spacecraft landed at the runway track, which finalized the capture of the spacecraft, absorbed some of its kinetic energy and stored the energy to be used later to give the spacecraft a little boost as it left the Moon. The tracks positioned the spacecraft up to the airlock, into which they stepped after verifying adequate environmental conditions were stabilized inside, oxygen, CO_2, humidity and temperature at comfortable levels for people. Comfort was important, as the operators there needed to make the best possible decisions as they varied the parameters of the huge facility's millions of functions ongoing during manufacturing. It was all shut down now, their job having been finished over a decade ago. Bringing the computer displays up to select among the options, the search engine located what they sought, a rather primitive function. The machinery to perform the function of selecting lunar dust within a limited range of size, and filling the spacecraft's cargo bay with the dust, was begun.

Going to the recreation lounge, an observation bay there provided a spectacular view of the Earth from here on the center of the nearside of the Moon. The stars were the same as seen from Earth, even though they appeared to take 29 days to go around instead of 24 hours. They rested there on a lounge in each other's arms, lovers in the 1/6 gee under the starry sky, rejuvenation for the upcoming effort they would

make to get the load of lunar fine dust delivered to GEO.

Chapter 2 Maybe to Malaysia

Awakened by the signal that their spacecraft had been fully loaded with the requested fine-grained lunar dust, John and Donna used the recreation facilities there, exercise equipment along with coffee awakening them up fully. John reset the facility controls to 'hibernate' and they were soon in the spacecraft, being given the boost along the tracks from the stored energy of their landing, before they ignited their reaction engines. After a few seconds into the curved trajectory, Donna activated the dust feed to the engines, supplying the cheap reaction mass to the oxygen-hydrogen engines.

The Lunar surface rotated more rapidly above them, their spacecraft being inverted for the spectacular view, and eventually earthrise occurred, always an impressive sight. After a day of coasting in the vast starry night with Moon shrinking behind them and Earth growing in front, they decelerated to dock back at the Clarke Belt main construction port site, and gave instructions for the unloading of their humble but essential dusty cargo.

“How did the designers of this place make it so easy for us to carry out this task, interfacing with that huge array of complex systems of which we had no prior training in usage?” Donna asked. “It was almost as if the designers had anticipated our arrival and needs.”

“Yes, that's correct.” John replied, “The philosophy used in the design recognized the system complexity far beyond what people can learn in a lifetime of education; so the system interface was designed so as to respond to questions and requests by those people with little familiarity of the systems, knowing only what they needed to make happen.” "User-friendly was the root term, an attitude of design found

quite effective in a complex ever-changing world, if they wanted their products to be accepted for very long by the public. The principle of designing to be user-friendly then became a prime principle from then on, and has saved people from countless errors up here in the Clarke belt Cities, where almost everything is new and unfamiliar yet even little mistakes could be disastrous. It works great. Remember that principle when you design things up here, and you surely will do that sooner or later in this ever changing world."

Back home in their condominium high on the rim of one of the 700,000 wheel-shaped cities forming the Clarke Belt city ring, they entered their couple-version of the Holoterminal, that gave them a level of intimacy so delightful yet essential for a fully ever-functioning relationship. They each seemed converted to light of vast intertwined complexity, there in the Holoterminal, as was everything else in and around their condominium, even to the furthest reaches of the Clarke Belt if they were to direct their attention that far. Couple version of the Holoterminal enabled them to go as a pair while into the light-being adventures far and wide and deep into the essences of everything of interest. "Here is the reference to the user-friendly philosophy of all interfaces between man and machine" he showed her, then let her explore that by herself to some extent while he went exploring. After she had re-surfaced from the learning experience about user-friendliness, John's essence was there waiting, and led her to the archives of history.

"Donna, look what is here in the history, you are in it. You are more than just another post-menopausal Haremmate sent to be still useful as a bombpilot. See, Donna Bulguarde was the name given to you by your mother, Artesiana, while she was temporarily captured and bred before escaping to become essential to the building of the KESTS that enabled all this to be built. You were then given to a surrogate mother

for a couple of years before you were put into the harem's school complex. And Catalie was your grandmother! Your grandparents were the ones who had been key people during the building up of the first space transportation structures and wheel-shaped space station, all essential in the path to the making of this place where we are, and the life we live. You would be famous if fame were something of any interest anymore. And it is amazing, you almost destroyed the work of the dreams of your direct ancestors. You have much of their competency and ability to dream; although also some of the tougher qualities of your father." Donna was motionless for a long time, as she took this news in; and then went on via the Holoterminal to explore the archives in her light-personage.

She spent all her free time for the next few weeks after that, in the Holoterminal, getting familiarized with the overall situation facing their gigantic home up here, and the increasingly desolate planet below them, the Mother Earth that had given birth to humanity and all of life that had been there. The deep ego-driven urge of greed lurking within the mind of man seemed to have finally managed to destroy itself along with all the constructed works of the people who had overcome the ego's attempts to compel. Even she had almost been involved in terrible destruction's success. She could see the similar brutishness of her father still engraved into her deep psyche, a lurking powerhouse that she intended to ever have harnessed and guided by a better way. A better way that was not only driven by loving kindness for all life here and on the planet below, but also because, well, all this was making life really a lot of fun and interesting for her. And she was determined to do what it took to fix the big problems, just as were her Mom and grandparents determined.

She had been just as determined to solve the big problems as a bombpilot, of course; but now she realized it was all in the

definition of what the problems were, and what one allowed oneself to do to resolve them. The same determination could make a big mess of things; so she now realized that responsibility to the larger system was the key to a better source for decision. And the holoterminal was utterly honest by intrinsic nature, a fantastic source of data for making decisions. She went exploring, learning and exploring more, via the Holoterminal.

In the vast light-world accessed via the Holoterminal, there was a meeting place, a message board kind of thing, where the concerns of others were integrated into patterns of intensity and connectiveness. It was there, one evening with John exploring together the Holoworld, that Donna came to the conclusion that since the Lunar materials were lacking in some resources essential to the survival up here in GEO, like carbon and nitrogen for examples, that they were going to have to get them from Earth below unless they wanted to try for possible asteroidal sources which were still quite beyond early usefulness. So she remarked to John that they were going to have to build a new KESTS to access the resources on the earth below.

“Malaysia”, she went on, “has equatorial plane access, and is far from the influence of the possible remnants of the pirate alpha males who consider they own the planet now. Remember the solid-KESTS hoop that links the Moon's farside site with L-1, its eccentric hoop encircling the Moon, held up by the stretch of centrifugal force as it spins along itself all around the Moon? Let's see if we can build one of those, attaching to the ground in Malaysia, since the Cayembe site in Ecuador is such a mess now.”

John pondered this a minute then replied “Malaysia is indeed far from Ecuador and the American continent so ruled by your father's brutal ilk. But it also is far from all possible sources of technology to build a KESTS type of structure.

And besides, the reason a solid-KESTS works in the Lunar environment is because the Moon has no atmosphere with which to erode the meteoric velocity such a hoop would be spinning at through the atmosphere."

She replied "There is an aerodynamic difference between something punching through the atmosphere at meteoric velocities, and something that is merely following something at meteoric velocity already going through the air. Think of the boundary layer along such a continuous high velocity band, once established, ought to act like an air bearing set of layers. And it would only be dragging on the structure where it is within the atmosphere, so the majority of the structure's time would be spent high in space within a hard vacuum environment, just dipping down through the air once a revolution. So it would just take more energy input to the KESTS at the ground terminal accelerator, that's all."

"So how are we going to get the special materials down there in Malaysia to build this spinning hoop up from there, and get the accelerators built down there to power the spin of the hoop?" John asked. Her reply was that the hoop was not going to be launched from down there, it would be launched from up here at the high point of its trajectory, not from the ground site. Up here it can be made of the finest materials and techniques. The fun was going to be down there on the ground, capturing the roaring dragon as it sizzles through the atmosphere past them. "Past ... us?" he noticed; she replied "Yep, it is up to you and me to do this thing. It is our responsibility. We are heading for Malaysia, as soon as we can get the solid KESTS material built up here, along with a launcher port facility that will create an intersection with wherever we choose the ground terminal to be in Malaysia."

John was beginning to think that mating Donna Bulguarde was going to be a wilder ride than he ever imagined could be. And the imagined adventure of it all had captured his

dreams. They were going to do it, yeah.

They moved their residence to a Clarke Belt City that was in GEO high above the east coast of Brazil, which was not only opposite the globe from Malaysia but also happened to be where telescopic observation of the Cayembe terminal site's wreckage was visible, reminder of what can result when things go wrong. People-stuff things going wrong, in that case. As if technical problems were not enough challenge, the egos of people were ever a potential loose cannon in the progress of civilization.

Maybe the huge powerful obnoxious egos of people could be brought into partnership, she wondered. She recalled that people once had ridden horses for transportation, the horse being a huge beast with a kind of mind of its own that could be quite unruly and dangerous to its rider and all around; horsemanship involved letting the horse's mind and physical prowess deal with the nitty-gritty of the terrain to be crossed, while the rider dealt with the overall logistics and purposes of the trips, a mutually beneficial partnership. Maybe the human ego could be like the horse, becoming a worthy partner instead of a lurking obstinate huge potential master of the situation. But also, she recalled, there was an old saying, something about bringing the horse to water, but being unable to make him drink; the horse not comprehending the long waterless trek ahead they both must start upon now. And remembering that her own father's ego was one of the masterminds of what had become the present disaster, one of the pirate alpha males that had made such a mess of civilization's struggle to survive and revive the planet that bore it. How much could she count on her inherited ego to cooperate in wholesome partnership with her, and through her partnership with civilization in dire stress?

And her now unlimited access to knowledge through the

Holoterminal, brought to mind the unfortunate discovery about the old kind of higher educational systems, that the popular idea of the educated person in science becoming a “mad scientist” who seeks to invent a machine of vast destruction so as to enable the 'mad scientist' to 'rule the world,' was actually not the person educated in the natural sciences; but it was the person educated in the social sciences such as in politics and business, who were far more likely to use their education-acquired knowledge for purposes to manipulate the society in which they lived, to try to 'rule the world.' People who were focused on the natural sciences like physics and biology, usually had little interest in controlling other people; and the thought of the responsibilities of 'ruling the world' would be abhorrent to them. It was the bullies that acquired an education for the purposes of learning people-control techniques, that went for becoming “mad social scientists' bent on 'ruling the world” or ruling as much of it as they could manage; and having little thought of it involving “responsibilities” for that which was ruled. It was the ego-thing again, so powerful and diabolically insidiously clever, ever lurking, that could cause the devastation via the hand of man, if it was left untamed to rule its owner. She felt uneasy about her own powerful ego, her inner partner mostly lurking watchfully concealed from her conscious sight, would it always remain a cooperative partner with her rational, loving mind? The responsibility for keeping that ego harnessed civilly, was hers alone, and it worried her.

Meanwhile, John was busy getting the cargo of lunar dust distributed to the various sites in the Clarke Belt that had the oxygen-hydrogen thrusters installed, and coordinating modifications to those engines so as to inject lunar dust into the engine's combustion chamber to give it much more passive mass to thrust with. This ought to greatly conserve on the water that was being sacrificed to make the thruster's fuel being used to maintain the Clarke Belt City ring around the Earth from shifting position, lacking a KESTS structure

anymore to mechanically couple position directly to the Earth's rotation. Yet it still always involved some loss of the precious water from their reserves; they already had to shut down several of the pre-built Stanford-Torus cities that would have supported another 10,000 people each as their population grew, simply to extract the water from the mothballed city's stored supplies, to replace the water lost elsewhere, including that from use in the spin-boosting reaction motors.

Chapter 3 A continuous band KESTS

The biggest problem longer term, of course, was the need to supplement the kinds of elements that were not present in the Lunar crust. They once had actually spent the energy for delta-vee to experimentally bring back a small asteroid of a few hundred pounds, but it had little carbon and nitrogen, and no water to provide fuel for delta-vee to go get more asteroidal material. Capturing an icy comet was more of a massive project than they wanted to try to tackle yet, considering their difficult state; as the Clarke Belt ring of cities was never intended for full occupation for more than a half dozen years, and certainly not with the lack of supply of some materials exchange between them and the ground below, via the KESTS transportation structure. So Donna's daring plan to strive to build a kind of KESTS, to again link the Clarke Belt with the ground somewhere, to gather desperately needed materials, like water, carbon, and nitrogen, might solve lots of problems, wild and risky as it was.

He mused that it was kind of like the old fairy tale of “Jack and the Beanstalk,” except in reverse: starting from up here they were planning a raid to far below, instead of up to high above; and the “treasure” would not be gold, but instead water and coal. He smiled to himself at the change in things.

Floating in the observation dome at the hub of their newly arrived at city in the Clarke Belt, admiring the view of the Earth from over the east coast of equatorial Brazil, Donna was chattering about her latest ideas for creating a new KESTS structure between here and Malaysia, half way around the world. “How many of the fighter spacecraft remain, of the type you flew to intercept me? Is there any way one could be loaded with the materials for a thin solid KESTS to be launched from Malaysia?” she asked, perhaps

more to herself than to John. “Well,” he replied after a moment, “all they carry is the one nuke rocket for its one shot at a bombship; and that is attached to the outside of the fighter. Perhaps it could carry a load externally in a streamlined container. The spacecraft does have wings, as it would glide to a landing at the Cayembe airport after its defensive run; and wings would similarly be needed to make it through the atmosphere to land in Malaysia. I doubt there are many of the fighter spacecraft remaining, as mostly they were re-used after landing at Cayembe airport, being brought back up here by the KESTS to be refurbished and readied for the next bombship defensive run. Several were lost, including mine when stopping you; and I don't know what happened to the one which tried to intercept the bombship which destroyed the Cayembe KESTS terminal site including its airport, since it had no way to get back up here, nor probably any other place to land safely. And, it will take a lot of equipment to launch and then sustain energy in the thin solid KESTS, which will have to be somehow gotten into place in a good site in Malaysia, and a fighter spacecraft won't be able to do all that.”

They floated thoughtfully awhile, looking wistfully down at the west coast of Ecuador, dimly visible some 22,300 miles away, as they remembered the sight of the majestic KESTS hoop that once had linked the two civilization sites together.

With that mental image in mind, John suddenly had another idea. “Maybe we can do it differently. Remember, in your original enthusiasm you had suggested that the new KESTS be constructed from up here? Maybe the thin solid KESTS could be launched from up here, into the Orbital Transfer Trajectory shape path to graze Malaysia at the Equator and continue back around the planet to link back up with itself here. And if the direction of launch of that one strand of KESTS is retrograde to the Clarke Belt City Ring's motion, the reaction force's direction would be such as to help

replace the energy the ring is gradually losing, cutting down on the energy needed expended in the rocket thrusters. It would be just applied at the one point on the ring, of course. Anyway, there are some potential plusses to this mode of emplacement of the seed KESTS between here and Malaysia."

So it was a whole new ball game, a new kind of KESTS emplacement and construction project, that of starting from above instead of from below.

"Wowee," she responded, "it will be a wild ride in Malaysia to capture that thing and get it into an accelerator channel down there on the ground!" But then, she paused thoughtfully a long time, absorbing the implications of the dangerous and difficult task that had never been done before, so far away in an unknown land and no way to get back up here if it all failed.

"Let's see if we can soft-land a heat-shielded re-entry form of vehicle." John mused. "The early Moon landings returned to Earth using that technology, cumbersome as it seems and utterly wasteful of energy, but it worked back then. Although we don't have the records of how they built and guided them back in the mid-1900's, we do have a lab up here that was equipped to build manned landers for the trip to Mars, and they used heat-shielded landers. The equations ought to be adaptable to an Earth-atmosphere re-entry."

Donna replied that she was not eager to be constrained a pilot as to be stuffed into what was essentially a man-made meteor, without wings nor guidance control, limited to just setting the attitude of re-entry and stabilizing spin, and away we go, like a "cannonball" jump into a swimming pool, good luck. And it would have to be a hard landing on land, there being no recovery ships for a recovery at sea, like was used in the Mercury-Gemini-Apollo vehicle days. "The Russians

used such re-entry vehicles that landed on ground, with their fiery re-entry and parachute descent, well into the early 2000's", John added. "There are probably no usable airstrips where we need to build the ground terminal anyway. Who knows what happened in Malaysia during the world ecosystem collapse created by the greed of the Ownma Corporation."

Chapter 4 Another use for the Mars Lab

Entering the still unused Mars Project's lab, they found it was mostly a group of workstations and stacks of materials, a facility that had been prepared but not used. Desks and computers never set up and put to use; chairs never sat upon. It had been intended for a project to put a self-sustaining colony on Mars, using the mammoth spacecraft assembly facilities here at the high spaceports in GEO, an adventure impossible in scale if considered only being launched from the Earth's surface. Constructing and launching from GEO, instead of a handful of people heading to Mars in a ground-launched system barely way-stationed in LEO, this project built and launched already high up in GEO would have put a thousand person rotating space station into Mars orbit, and 300 more people living on the surface itself, enough to do what would be needed for probable survival there long term, no matter what. It was partly conceived as a project to keep the people of the Clarke Belt City Ring busy during the many years wait while the environmental engineers finished the jump-start of Earth's ecosystem, as well as bring Mars into useful linkage with human civilization's expansion.

Even after the majority of the 7 billion people in the Clarke Belt Cities returned down to their homes in the jump-started and re-grown newly thriving earth surface ecosystem, there would always be many who would choose to stay up here in orbit, and some of them would have continued to support the Mars Project. But of course, all those dreams were stopped when the sudden takeover of the Earth was done by the greedy elitist pirates. From then on, no resources could be used up here except those for direct long term survival. Thoughts of going to Mars quickly faded from peoples' attention.

Now some of the technology for that adventure was needed

to return to the Earth surface, instead of that of Mars.

The Mars atmospheric entry system would have used a heat shield for most of the descent energy dissipation; then a winged vehicle would unfold to finish the journey to the Mars surface, an aircraft useful for other travels later. Its huge unfurled wings, needed at first landing to support the heavy cargo, would later be useful for efficient exploration in the thin atmosphere around the planet. The wings could be furled back in, like a bird does, to hunker down in the severe Mars windstorm times. The use of the technology now would not need to have wings that would close back up; but would still need a winged craft for the final landing in Malaysia; and the winged craft would likely be needed again later during the capture of the thin KESTS and somehow get it into the ground terminal. The plan was developing in their minds, sometimes retracing steps, but becoming more confident when finding they had come back to an earlier conclusion, multiple paths coming to the same conclusions.

Their first efforts in the Mars Project lab was to bring all of it into the Holoterminal consciousness system. From then on, they would need to go to the lab physically only for some of the construction tasks to build the actual vehicle. Much of the manufacturing and assembly of the Mars Project vehicles and ground equipment had been intended to be done robotically, as were most of the Cities built up here; and so surely the design could be altered to do an earthward descent, yet still be built robotically by the Mars Project's lab, being guided through the Holoterminal located at home, thousands of miles around the GEO orbital perimeter from the lab. So, several days were spent applying the unique HoloPaint to the parts of the lab which had not been pre-built with the Paint as part of it. Then, the local Holoterminal was activated, and they merged their consciousness with the vast knowledge base of the Mars Project designers, as well as with all the equipment and materials of the lab and

manufacturing facilities. Since the Paint was an Omnipresence unifying substance, from a Holoterminal even the performance of equipment landing on Mars could be felt as if there themselves in minute detail. It would work just as well during the adventure of creating a new KESTS linking them with the earth's surface.

First they were going to have a test lander built, and learn from experiencing what it does in an initial attempt to land in Malaysia. A pair of lenses focused on a pair of HoloPainted surfaces effectively formed a stereo remote camera, so they would be able to watch the landing, and then the surrounding terrain once down. Their plans got more vague beyond that, awaiting some reality-testing's data.

Preparation done in the lab, it now up and running semi-autonomously, they headed for the local City's hub, where they entered an inter-city capsule, locked it onto one of the cables that ever rotated around the Clarke Belt, going past every City's hub. It did not go very fast, and so the vehicles all were sleepers with food facilities, and soon they were fed and snuggled together in sleep as the cable towed them around the perimeter of the Clarke Belt City Ring, thousands of miles to go before reaching their newly adopted home City.

Chapter 5 Speared by a native

“Just why did you pick Malaysia as the place to build a solid KESTS, Donna?” John asked one day, as they relaxed at home. “Malaysia does not quite even reach the equator, and does not seem to have high places from which to connect.”

Donna looked up from her task of simulating trajectories of heat-shielded re-entry vehicles from GEO, thought back a minute, then mused “It was just a quick imaginative guess, some place far away from the Ecuadorean area and the American continent which was taken over. I remember as a child reading stories of the Malay pirate's adventurers, sailing out from the islands to capture passing ships long enough to get goodies from them including taking off their beautiful women passengers. This was interesting reading among those of the Bulguarde Harem, where I was raised, bred to produce my children, and lived until menopause and then was sent to do bombship duty, which led to here. But now, as I do simulations for landing anywhere around Malaysia to establish a supply terminal for a solid KESTS connecting up to here, I'm thinking of the peaks of some of the Indonesian islands of the Ring of Fire would be better, but some place which does not have recent history of severe volcanism or earthquakes. Borneo looks a bit too flat, and who knows what remains of their jungle or natives there who refused to move up here. Singapore could be a source of high tech stuff maybe, and is close to the equator. But hopefully from up here we can set down all we need for the terminal, establish the initial facility down there, scale the solid KESTS up just enough to haul water and hydrocarbons up here to last long enough for us all to figure out a better plan.”

“Eventually we will have to build a KESTS of equivalent capacity to the one that was originally used for populating and supplying the Clarke Belt Cities' John added. 'We

eventually will need to move the majority of people back down the the surface and back to their homes, and the capacity of the original full-scale KESTS took 20 years to do that, and surely will need that long to return people and their belongings from up here. And long term it will need the structural strength to supply a push on the whole Clarke Belt Ring to make up for the orbital decay of the Ring, just as the now-destroyed KESTS had done previously. It is quite possible that we ultimately will have to re-capture and clean up the Cayembe Peak terminal, to build such a structure. But I don't want to have to deal with the folks who might still be down there, at this point."

They got into their dual Holoterminal, and their light-essence joined up with that of the Mars Project facility, partway around the Clarke Belt. They input the modification parameters for an earth-atmosphere vehicular landing, and had the project's computer do the tweaking of the parameters of the design, starting with the ones initially intended for a large scale Mars colony landing from an orbiting space station circling Mars. In this case, the starting orbit was GEO, the gravitational field was that of the Earth, the atmosphere was that of the Earth, and the intended landing site was the peak of a mountain somewhere among the Indonesian islands. And the first mission was an unmanned descent, teleoperated landing.

The spacecraft assembly was done by the facility, out in the microgravity hard vacuum just outside the nearest hub to the facility, built up by directed molecular beams, slices built up from the ionized bins of the various elements and compounds it needed. The sub-assemblies were then robotically connected, and a few days later the signal came that it was ready for the first test, telemetered to the extreme degree that the Holoterminal presence technology could do. The launch acceleration track was modified to provide a retrograde push instead of the originally intended boost to

head for Mars.

At the timing selected by Donna's specification, the spacecraft was given a retrograde push sufficient to de-orbit, and down it went; drifting in free-fall, drawn in by the tenuous but insistent embracing arms of the Earth's gravitational field, up here only 2% of the gravitational field strength of that on the ground.

Eventually they were signaled that the spacecraft was experiencing significant deceleration as it entered the upper atmosphere. Its spin and orientation put its heat shield so as to lead the way along its path, a meteor coming back home. After a fiery slowing down, then the flying part of the spacecraft ejected itself from behind the heat shield disk, and the wings were swung into place and inflated to shape by the force of the onrushing air. As they watched through their virtual stereo cameras on the spacecraft, John took the pilot's role - after all, Donna had been trained to go up, not down; he pointed out to her with a smile - and the view was high over the ocean, a string of mountainous islands visible below, as the wings caught the air and the comparatively lazy glide down began, a gigantic machine-made seabird looking for a roost.

Looking out at the approaching world through the virtual HoloPainted eyes on the gliding lander, what they saw looked like a stage set, just a facade, not quite real. They could not see beyond the face value of things out there. They still had enough altitude to make a high altitude pass over three islands, each seemed the peak of some undersea mountain range, just the top sprouting above water. One was quite pointed at the top, others showed a more complex terrain in the higher elevations. 'Let's set down on that one over there, it is high yet has sort of flat areas near the top, where we might land easier; and there looks like an easier climb down to seal level too' Donna suggested. That seemed

reasonable to John, so he began a descent spiral around that island. But close up the flat-looking area became a jumble of broken volcanic rock; the craft was to low to go for another island so he used his last bit of flight time to land on a beach area at the base of the island. An abrupt stop, and they were staring at a beach and sea cliff view; the camera optical surfaces had no provision to swivel, so they were stuck with that view. They admired the facade-like view for awhile, admiring their first earth surface view up close in three years. But nothing moved, except the lapping of small waves upon the beach, off to one side. No birds, no people, no palm trees swaying in the wind; except for the water, it looked as lifeless as the Moon. But that water - all that water! - looked really nice. Surely that great sea would not mind giving up a wee bit of its vast supply of water, say a few hundred thousand gallons? Would never notice.

Suddenly the view tipped, and all they could see was sky and off to one side what looked like an old fashioned primitive point of a wooden, fire-hardened spear tip that had appeared out of nowhere. Eyes wide, they watched while nothing stirred for a long time, then lots of jiggling and an occasional view of what appeared to be parts of a jungle man came into view, wresting his spear back out. Then he departed with his spear, apparently having decided that this bird was too tough for the stew pot.

Glad that it was not they which had landed this time and would now be unwillingly headed for some village stew pot, it was apparent that there was going to be more involved to this project than they had guessed. They knew that there would be people who had not been included in the exodus, like jungle people in isolated areas; and that the massive ecosystem collapse worldwide, including that of the ocean fisheries, would have made food scarce everywhere, and was likely that any survivors would be preying on each other by now, being the top of the food chain and not much left below

them. Their circling landing craft must have caught someone's eye down there; watchful eyes must really be part of the name of the game going on down on the earth surface about now.

Back connected to the Mars Project facility, they changed the parameters of the next lander to be built, to include optical surfaces enough to see all directions; and a slightly larger wing surface to extend their gliding range a bit more. When it was built by the facility, they launched it and down they went once again, along the same retrograde trajectory that had worked fine before. When the heat shield had done its part, and the wings were deployed, suddenly they had eyes in all directions as experienced in their dual HoloTerminal, like they were really out there. Since they had no way to record the experience, they relied on memory of what they had seen the previous trip down. The chain of mountainous Indonesian islands appeared again, but this time they chose a different one to land upon. Once again they found just a jumble of volcanic rock where it had looked like sort of smooth landing could have been made; veering off, they again hurriedly sought some beach area to land on. Finding none, they chose an area near the edge of the island, where a stand of dead palm trees held their ground; they got in between the stumps without collision, and again they were stopped. To the HoloVision eyes in all directions, they seemed to be suspended a meter above the ground, with wings and tail surfaces sprouting out in places; they looked up at the sad remains of the once proud and luxurious palm trees. Sandy soil below them, and they were nearly on top of the remains of a seabird, its skeleton partially filled in with drifting sand. That suggested to them that this place was not a hunting ground for the savages, who would not have left something edible; although it had been a long time since the creature had made its final landing. Their bird, too, had made its final landing; and it was good for just looking but not much else.

Thinking back to how the upper parts of the island looked, the job of landing there and building an accelerator channel for a Solid KESTS in that jumbled hard basalt was not looking easy at all.

Chapter 6 Indonesia instead

Searching the news archives from the period just before the building of the Clarke Belt Cities, they discovered an interesting news item. There was an Indonesian mountain peak where one of the Lorbital ring pressurized steel towers had been built to connect that part of the world easily to the Cayembe KESTS terminal port. But before the tower was built, Indonesia had started to build their own KESTS to GEO, but had given up and chose to use the circular Low Orbital path instead. Had the tower survived the loss of the Low Orbital ring's collapse when the KESTS had fallen? Maybe they could use the abandoned site for their Solid KESTS terminal.

So their next lander design parameters were optimized for maximum glide time in the altitude range of 10 to 5 miles high. The Mars Project's fabricator again built up the lander's subassemblies in the zero-gee hard vacuum, streams of various elements and compounds were sprayed on the ever-growing sub-assemblies until they were finished, then the pieces were robotically put together, and set on the retrograde launch tracks, and away it went downward.

Again in their dual Holoterminal, their light essence merges with the optical surfaces on the lander, once it was freed from the heat shield and was on its glide path down along the equatorial plane, 15 miles up. They focused their efforts on finding what might be a complete Lorbital tower, 15 miles high steel-skinned balloon, its internal pressure holding up the immense high narrow structure, which was used to lift conventional counterbalanced elevator cars between the ground and its top, where the Lorbital ring had been flowing, a primitive Solid KESTS type thing itself, a solid ring of steel that was spinning around the planet at slightly faster

than the orbital velocity at that level. The ring continuously circulated around the world in the thin air at 15 miles up, providing a monorail-like support for vehicles which continuously rode it, providing efficient transportation from any of the pylons around the world, to arrive at the pylon that was located next to the KESTS terminal at Cayembe Peak in Ecuador. This part of the worldwide transportation system that was built primarily to move the 7 billion people from around the world, over the Cayembe and then up to the Clarke Belt Cities.

But when the KESTS was destroyed, in its fall it destroyed the equatorial Lorbital ring and all the rings that had crossed the equator up there 15 miles high. Probably most of the pylons had been punctured by the fragments of the associated Lorbital rings, losing internal pressure and thus collapsing to the ground, like any deflated balloon does. They hoped the one marking the Indonesian Lorbital tower had survived, to mark where the old attempt to build a KESTS terminal could be found. But they found no tower remaining standing in their glide across the islands and mainland, no such luck. They doubled their glider back and they strained to see the ground below for remains of a collapsed tower, as they continued their one-way glide down. taking turns at flying the path while the other concentrated on the ground passing below.

Then they spotted the remains of a tower, was it the one they sought? They circled the site with the last of their altitude's energy, and managed to land it near the base of the tower's remains. The last glimpses before landing had shown a hill area nearby with some warehouse-like structures aligned along an east-west direction, which seemed to have been avoided by the network of new streets and hastily constructed building that were once a busy new city at the base of the tower. They were down in the middle of a street. It was a ghost town, nothing stirred.

Donna shifted her attention in in the Holoterminal over to the main bulletin board system of the City Ring, asking for presence of any who had used the Indonesian pylon elevator and could help with some identification. Within minutes, they discovered that the lander down there was the focus of attention of tens of thousands of people who had left their homes down there in Indonesia. When they learned of the lander's gliding descent's visual view, the Indonesians requested another such lander be built just for the experience of them all watching as it circled around the country on its way down, and would just be for the purpose of them seeing their long lost homeland once again, if only in glimpses. Their excitement soon focused on the other two landers where they lay on the islands; just a view of the ground, real-time, was an instant major event for them.

Eventually as the excitement subsided, some of the people returned to the original question of any knowledge of having seen anything that might have been the remains of the effort to build an Indonesian KESTS. It was looking like they indeed had found the site.

It was not just the Indonesians, but close to 5 billion people in their Holoterminals on the Clarke Belt City Ring that had their light presence with them as Donna and John made their next virtual descent down to the planet. This was to be partly a tourist excursion for the entertainment value of those other people, so they made their re-entry further north and then turned back down so they could sweep across more of Indonesia, the energy of excitement of billions of people, tens of thousands of them eagerly looking for a glimpse of their home town along the way, was intense. At the last minute, John did not have the heart to finish their landing at the desolate tower remains, so instead he quickly diverted their path to a landing in front of one of Indonesia's most cherished places; then he and Donna left the craft's presence

to return to their project, while much of the rest of the population rejoiced at the fantastic view from the lander there on the ground.

By the time they had determined the new parameters for their next lander, they found that they had to wait in line at the Mars Project assembly facility; people from all around the world wanted a lander to be built and flown down for a view of the places they had left years ago, thinking to be up here only a half dozen years, only to find they had been cut off from their homelands by the treachery of those who wanted to own the wold for themselves, a dying world or not. So now was their chance to get peeks of how things are down there now real time, via landers. John promised to fly the next lander down, partly as a training mission for the thousands of former pilots among them, who would thereafter fly the 'tourist' landings, in return for being let next in line for use of the Mars Project's facilities to build a lander.

Donna did not go down on that flight training mission with John, as she was busy collating the hundreds of bits of reports people had supplied about what they had seen or knew of the aborted KESTS project in Indonesia, there at the base of the fallen tower. The folks who had been first in line at the Mars Project assembly facilities were a bunch of former aerospace people from Southern California, and they wanted a fly-around which made its final landing in Exposition Park's Rose Garden in Los Angeles. The retrograde launch tracks had to be adjusted to do what it could to get re-entry closer to that area, a bit slower descent so the lander could drift half way further around the world before making its dip into the atmosphere. They could imagine the double-boom spreading across Southern California, the first since the space shuttle and private spacecraft vehicle landings had ceased landing in the Mojave Desert.

High over San Diego they swerved northward, circling the Los Angeles basin, noticing that there was no smog, a strange sight in itself. Past City Hall's old towering pointed roof building and the higher skyscrapers of downtown LA, across streets and freeways which were strangely motionlessly vacant everywhere, over the USC campus and around over the colosseum oval to finally land in the remains of the Rose Garden, as requested. There, the myriad virtual presences of the Clarke Belt Cities population stared out at the rectangle of lifeless soil, the dry circle of the fountain in its middle, the surrounding structures of the dome of the old Natural History Museum and USC oddly silent, motionless, a vast ghost town where nobody, nothing lived anymore, not even the roses in the Rose Garden. Silent leafless hulks of once great trees stood in the corners; all else was dust. The waiting line at the Mars Project assembly facility suddenly shortened by quite a bit after that; but the remainder needed to take a randomly selected priority for their lander's construction.

It looked like it was going to be a long time before they could have another lander built after this one, so John and Donna put extra effort into the design of this one. The Mars Project had been set up originally to include a pair of solar powered roving vehicles which would go explore further, and they shifted the design parameters for these to be built for use on the ground on Earth, simplified for direct operation via the Holoterminal system, and some battery power storage for exploring the hoped-for tunnel. The design included a LED headlight that too could be operated at least briefly, and a stereo pair of virtual acoustical pickups so they could hear what was going on while they moved around down there via the lander's vehicles.

Chapter 7 Landers for the tourists view

This next landing was rather direct and to the site of the fallen pylon, since the glider was carrying extra load, the two little vehicles to drive around so as to give more range than from wherever the glider put down for its final resting place on the ground. They trundled out the two wheeled robots from where the glider had stopped, atop the middle of the hill where they hoped would be the remains of an attempt to build a KESTS from here in Indonesia, something they could use for their own effort to build a lightweight bridge to again connect between ground and the Clarke Belt. They drove separate vehicles, even though through the virtual presence system of the Holoterminals, they were always with each other anyway; it was just a difference in who was making the decisions as to the operation of each of the vehicles.

Over at the building that seemed to mark one end of a tunnel, they found the door to the metal shed had been forced open, its lock broken. This was both good news and bad news; they had not known how they would open any such doors, so this one was open for free, but the bad news was that whoever had broken in might still be around or in there to bash them. Nudging the door wide open to let in light, the then headed inside, and when it grew too dark, the lead vehicle turned on its little battery powered light, while the other vehicle conserved its power and just followed along right behind. They passed the remains of a person's skeleton, most likely that of their benefactor who had opened the door for them. The building had provided a facade for the tunnel entrance, an east-west tunnel, which by their guess ran for about 400 meters, which the battery ought to be able to light the way there and back, along with providing drive power for the vehicle; the other vehicle had battery power in reserve, keeping its lights off. The tunnel passageway was flat and clean, making easy going. eventually at about 450 meters

they encountered another door, this one closed, and looked like the one they had passed through at the other end. The vehicles retraced their path, getting back out into the sunlight early enough to recharge batteries for a few hours before sundown. It indeed appeared that they had found the tunnel they had sought. But what to do with it was still another question.

Via their Holoterminal at home they discussed a major question, of how to get a continuous loop to go through the tunnel and reconnect with itself after that. A trench would not have that kind of problem, but would have other ones if they hoped to expand the structure, scaling it up.

“Maybe we could place a maglev bearing pillow block there, which initially is open at the top, and when the Solid KESTS loop is dropped into the bearing, it closes up and begins to function as a stabilization point for minor fluctuations in position, and while we monitor what such a structure does in reality. Then we get both doors open in the tunnel, mount another magnetic bearing pillow block inside, and use the first KESTS to guide a second one's leading edge to be positioned such as to go through the tunnel and get captured in the maglev bearing in there. Then we add layers to the KESTS until the pillow block is full; we then use the structure to be used to slide more pillow blocks down to rest against the first one, doing that from both directions. Then we anchor all those bearings to the rock inside the tunnel, a more substantial guideway. At some point the KESTS will be able to carry a useful payload; we could try sending things down, and bring other things up. Hopefully we will have learned enough about the realities of such a structure by then as to make more decisions as to where to go with it next. Right now, it looks like a structure with only one useful side, the side that is going upward, the side against which something can drag to make a gentle descent, and same side to drag against to get lifted up to here,” went their

Holoterminal unified thoughts. Having a pair of contra-rotating such solid KESTS side by side would take a lot of maglev track weight between them to keep them from rubbing against each other, so that upward-bound movement was available on both sides of the loop, like the original KESTS type was. This structure only had to be used to bring up a few hundred thousand gallons of sea water, and a few hundred tons of hydrocarbons, then it was done. Probably it could also be used to move a few dozen people up and down; it could be that some people might choose to stay down there, too. Perhaps the environmental engineers could get a head start, doing some research into what exactly has happened for real in the cascade collapse of the ecosystem, so as to refine their plans for jump-starting the world ecosystem back to living balance, as much as possible.

At this point, there were too many things built on 'ifs' to go much further in plans; it was time to do some more reality testing, to get some more solid pieces to their puzzle.

And it would be helpful to find out if there were going to be stragglers down there remaining who might be dangerous in their desperation for food. They needed more landers; but now the waiting list for landers was very long, so many people wanting in on seeing their home places. 'Maybe we can again get up front in line for lander construction at the Mars Project facility' John suggested to Donna. Part of the problem is the fairly short look-see time while the glider is making its final landing at some choice spot for the tourists. Could we create a glider that is a glider-shaped inflated structure, filled with hydrogen so as to be neutral buoyancy? If so, the tourist trade would get a big boost, and if we get first use of the first one, as part of the deal, we could use it to prowl around all over the area nearby the tower base, searching for dangerous animals or people ... and the tourists could come along too while we were doing that. In fact, maybe we could keep the vehicle and let tourists to watch the

progress of our project as we go along.'

The idea caught on so well that they got to have every other lander next coming up to be theirs; and the awareness of their efforts at a small temporary KESTS was expanded rapidly throughout the Clarke Belt Cities. Soon their next lander was doing its meteoric thing ramming through the upper atmosphere, but then instead of a glider, a parachuted package slowed the next several miles down, until at about a mile up from the ocean, the canister of hydrogen inflated the glider-shaped rigid balloon, its electric motors started, parachute released, and the craft was on its way. Solar cells on top of its wings and fuselage recharged its batteries and ran the propeller-driving motor and powered the escapement controls, as Donna piloted the craft to the mainland of Indonesia, millions of virtual tourists going along for the ride with the all-direction view.

And suddenly all orders for the next landers were for such vehicles; the tourist trade was going to get a great boost with such vehicles from now on, able to cruise indefinitely, looking here and there and just about everywhere their tourists chose to go. Even individual homes could eventually be observed for a few minutes each. She found its low mass and ample control surfaces made it very acrobatic and fun to fly, but its small solar-driven propeller did not provide much speed, and was a bit at the mercy of whatever winds were present. When it got windy and not in a direction where she was going, she had to drop down to hover behind some part of the landscape that could provide wind shelter. The next such plane would need some latching surfaces, like talons on a bird's feet. In fact, this was a lot like being a bird. Were there any real birds left on the planet, she wondered. The Environmental Engineers were going to have to re-create the world ecosystem almost from scratch, she was beginning to realize; and the situation was getting worse by the minute down there. They needed to get the reclamation project going

as soon as possible, and that meant ways to get the folks and equipment down there as soon as possible.

Aghast at what they were finding everywhere the tourists went, nothing alive, no people, animals, or birds; and the jellyfish ruled the seas; the people of the Clarke Belt Cities decided it was time to get a head start in fixing the world so they could return to their homes. Operation Jump-start was quite revised from how it was originally envisioned, but start it did. And if there were any people left alive on the continents, they were going to have to cope with the new variables in their already hard life.

The Environmental Engineers finally were having their day. The first part was to drop capsules in the wind streams of the world, full of a collection of bacteria that were intended to aggressively munch all organic material down there, to create a baseline system for the hydrocarbons of the world. Then it was wait and watch, the instrumentation stations which they had set up in remote places around the world for that purpose before the exodus was completed were activated to start sending data up regarding their chemical analysis data measurements ongoing. Other canisters which had been placed where the winds were slow, were remotely detonated to release their first set of bacteria into their surrounds. And then it was watch and wait while the aerobic part of the worldwide garbage dump had been converted to a baseline level chemistry worldwide. The bacteria count and composition suddenly dropped as seen at the monitoring stations one by one, as all the food was gone for that kind of bacteria mix.

The next worldwide wind seeding was of lichens, the original building blocks needing only rain and sunshine to slowly decompose the rocks. Spread so thoroughly and fairly uniformly, quickly they had re-established themselves, and so when the next mix of bacteria were spread around the

world, these fed on the lichens but slower that the lichens reproduced; the atmospheric composition approached livable conditions finally, and some lakes were seeded with a complex of plant life and algae, minnows that ate algae, along with a diverse clutter of crustaceans, worms, microbes of what were in a proportional mix before the ecosystem collapse. Some of the inflated gliders were built to be remote analysis vehicles, complete with microscopes and chemical analysis tools for remote DNA analysis. The scientists watched for some stabilization point in the mix of diverse life within these initial lake's mini-ecosystems. It began to be clear that when the first Environmental Engineers finally set foot on the ground again, life was going to already be taking root there.

Chapter 8 Fiber-leading microspacecraft

Apparently the life remaining on the planet consisted of a few islanders living on the relatively isolated mini-ecosystems of isolated islands - at least extrapolating from the one person they had encountered who had speared their early lander glider - jellyfish, micro-fauna and seaweed in the sea, and insects on the land. And those insects, such as remained down there, were hungry. The Environmental Engineers and Scientists discovered that their little experimental tiny reviving ecosystems centering on a few ponds, were discovered by some of the surviving insects, which put big unknowns into their equations. The long-hungry insects munched away at the edges of the little micro-zoos of the seeded ponds, quite eagerly, clearly part of the equations.

John and Donna began to compile lists of what they would need down there; finally the reality sinking in, that their return to the ground to build a new kind of KESTS mini-terminal was actually likely to happen soon. Some of the items were quite bulky, such as the need for a Holoterminal and a spare one, so they could connect back up the the Mars Project assembly lab to be able to have unexpected items that had become necessary, to be dropped down to them. They would need a tent, one that was fairly sealed as the biosystem down there was no longer all that great for people outdoors; and could be inflatable, surely, less bulky. Furniture inside could be inflatable too. They would need to wear environmental suits when outdoors too, which had to first be designed and fabricated up here; at least they did not need to deal with a hard vacuum and wide thermal transients as spacesuits do. They would need to bring down food and water for their sustenance for as long as they would be there - and they had no way of returning up to the Clarke Belt Cities unless they could get the KESTS to work and work

well enough to bring them back, at least.

They looked at the upcoming event as 'an on-the-job camping trip adventure construction project' except when it was looking like all the loose ends just were not going together; then they sometimes reverted into some much less positive descriptions about it. The gravitational well of the planet Earth was deep, 7.9KWh per pound deep to be exact; and they up here in the Clarke Belt had escaped 91% out of that well or pit, as some described it. Now they were going back down into that pit to a place that no longer was fit for them to live.

On the other hand, the viewpoint could be taken that all the folks up here now in the Clarke Belt Cities, some 7 billion of them, had come up here for an extended camping trip, and they were now ready to go back home and get to work again.

They made their packing list at several interrelated levels, from absolute necessity for life, to wishful thinking items. They decided a second inflatable tent, transparent to sunlight, would be used for a mini-farm, to recycle their air, and have a mix of quail and sanitarily-raised cockroaches of the standard menu type, along with some grain and veggies, to stretch out their pre-packaged foodstuffs and drinking water. A variety of tools, general purpose tools as well as those necessary to convert the old tunnel to be a functional KESTS terminal. The maglev clamping pillow blocks into which the solidKESTS would need to be guided and then clamped closed. The rectenna to receive and convert energy down from GEO SPS, to power their life there and to eventually power the KESTS re-accelerator.

They used landers to put down the supplies at the site, and a couple of robots to lug around some of the items. Using the Holopresence terminal to live a virtual existence down there via the gliders and robots, provided an intimacy of control

that enabled lots of things to be done remotely; but there was nothing like the human frame to really get things done on the spot. But with the landers and robots they managed to get both ends of the tunnel opened up, sets of clamping maglev bearings set up in the tunnel, including a wider aperture guide input maglev bearing at the incoming side, and a basic band-accelerator assembly on the output side; this KESTS was to rotate in just one direction. A small rectenna was dropped and inflated nearby, where a worrisomely tight beam of microwaves would be beamed from solar receptors in GEO, to power it all; the robots were able to connect the rectenna's power output up to the maglev bearings and re-accelerator. Then the robots vacated the tunnel, it was time to make the first pitch in that direction.

The first spool of the experimental SolidKESTS fiber was mounted at the hub of their city, overlooking the west coast of what had been Brazil. The fiber was a single woven strand of carbon nanotubes, a fraction of a millimeter in diameter overall, almost invisible to the eye, and which had particles of steel embedded in the carbon fiber, which had been magnetized into alternating polarity every few meters along its length. Inside the micro-spacecraft at its leading edge, were the controls for making adjustments as it was flown through the atmosphere, with the intention of going right through the centerline of the maglev bearings down there in the tunnel in Indonesia. Virtual cockpits need not be large nor have creature comforts, and so the vehicle was barely a few millimeters in diameter and several meters long, yet to the pilot the cockpit would look as large as that of a full sized aircraft. They expected that this first flight would be a learning experience; succeeding ones would be improved upon by what they had learned from the earlier flights, until they finally got the flight to really be perfect enough to go through the maglev bearings. Then testing of the next set of variables would begin.

As with the glider's first flight, John was in the pilot's seat, Donna the co-pilot. It was all operated from their dual Holoterminal at home, but their intense virtual experience would be of quite different places and things in action. The small oxy-hydrogen reaction engine started, the little spacecraft led the way pulling the fiber off the spindle, as it began its retrograde launch out along the equatorial plane, then it was a long free-fall wait as they drifted downward, a small synchronous accelerator at the launch spindle normalizing the velocity as the fiber de-spooled ever faster. Donna sat in at the controls when John rested, but there was little to do except wait as it all slid down the return portion of an Orbital Transfer Trajectory path intersecting with the tunnel entrance far below and partway around the planet. John was refreshed and back at the controls as the first wisps of the upper atmosphere were encountered, and soon the nearly horizontal path through the lower atmosphere was ongoing, the hot ionized leading edge of their vehicle requiring shift of spectrum to see through it as they streaked as a meteor at 10 Km/s ever closer to the planet, the reflexes of the autopilot filling in to fine tune the path as it barreled across the land and seascapes in a flash, and then it went dark.

Replay of the last few milliseconds showed that the microspacecraft had struck the hillside where the tunnel was located; they severed the fiber at the launch site in the wheel-city's hub, and the remainder of the 70,000 km of fiber was let continue its fate to impact below, a microthread that would have been a problem to a bird were there any left down there in the way, but little else would be effected by it. Further post-flight analysis of the telemetry showed that the autopilot had pegged out the airfoil surfaces at the last few seconds of flight in effort to correct its path, but was not sufficient to do the job.

So they set up several laser beams to retroflect from the

ground back up to places along the Clarke Belt to get samples of the instantaneous mix of air pressure eddies at places near the path of future launch trajectories, so that the little oxy-hydrogen rocket motor could be fired a last time just before re-entry began, a last moment course correction based on the instantaneous atmospheric conditions it would then plummet through.

Once again the fiber-leading microspacecraft launched, this time with Donna at the virtual controls the first shift. And she was again at the controls when re-entry started, keying on the autopilot to fire the course-correction rocket engines before they ejected. Sensory spectrum shrunk to the edge of where the Holopresence operated, compensating for the meteroric fireball as they plummeted across the land and seascape in the last few seconds; this time the lights did not suddenly go out, but it was soon clear that she had indeed passed through the eye of the needle of the tunnel, but missed the maglev bearings, and soon it was apparent they were losing velocity and were dropping away from the elliptical path, lacking in the energy replenishment that the re-accelerator in the tunnel would have given them.

Post flight analysis showed that the flight controls had only pegged out on one axis; the autopilot control was good but it needed a bit better start into its flight path. They analyzed the optical path scintillation from the retro-reflectors on the ground during the re-entry period, and adjusted their computer modeling a bit to hopefully improve the controls of the rocket engines and then the flight surfaces as it headed to the tunnel's gateway to the earth surface. At their best guess, their uncertainty factor was about the same size as the aperture in the maglev bearings down there.

A new spool of fiber and new spacecraft ready, John and Donna at the virtual cockpit flight controls, down they went again, de-spooling the tiny fiber behind them. The

minirockets fired just as they hit the upper atmosphere, then it was fireball time as they input their flight control data into the autopilot as they streaked for the tunnel ... and they were through the tunnel, and the green light on the cockpit showed that the re-accelerator in the tunnel had kicked in with its energy input, so they were through the maglev bearings too; John then fired the fireball-powered ablation surfaces in the back of their microspacecraft to provide energy to make up for atmospheric friction losses as they spent a few seconds more, then they were back up out of the atmosphere, coasting around in freefall, trailing their fiber as they coasted upward back toward GEO.

Chapter 9 A package sent around

As the microspacecraft's view began to show the magnificent sight of the Clarke Belt City Ring they were approaching, it began to be clear that they were not going to reach it; their return trajectory falling far short of their target. So once again the fiber was severed as it was de-spooling, but the re-accelerator on the ground was left running until the end of the fiber had finished passing through it later, to clear the remainder out of the system.

Post flight analysis showed that they now had a good chance of being able every time to be on target through the maglev bearings and that the re-accelerator was able to indeed sense the presence of the alternating polarities of the magnetized steel particles embedded in the fiber and synchronize its acceleration pulses so as to boost their velocity, replacing the energy lost through atmospheric friction. But the structure always had to be in tension, so it could not boost the velocity out of the ground re-accelerator much above coasting freefall velocity as it passed the earth's surface, and yet there still was a lot of energy to be squandered as the leading spacecraft punched the path back upward. Some energy extra could be added, making a somewhat wiggle shape of the fiber as it went back upward, how much of that was tolerable was something they would need to find out. But what they needed was a small bit of reaction propelling them as they went back upward, plus some energy for maneuvering to zero in on the starting point up here in GEO, then binding to the outgoing fiber, and then the next phase would have been achieved.

A problem they had not expected was that the polarization of the magnets was on the front part of the descending fiber, the wake of the plasma heating the steel magnetized particles in the carbon nanotube fiber above their Curie temperature.

Once the fiber had made a place for itself in the air, heating became minimal due to residual boundary layer friction. But somehow they would need to snip out that demagnetized front area of the fiber before splicing to the tail end of the de-spooling loop up in GEO.

And just how to do that fastening together had yet to be resolved, as it involved making a strong bond splice between two ends of the fiber loop which both were going at 10 Km/s past the splicing point. The perimeter of the loop was going to be significantly larger than that of the discontinuous-armature KESTS, as the SolidKESTS took a much more circular shape, all parts of it being at the same high velocity; and so instead of armatures slowing down as they climbed in the conventional KESTS as the armatures exchanged much of their kinetic energy with potential energy the higher they went, the SolidKESTS single zillion-pole armature self used its internal tensile stress to take up the slack at the higher altitudes, giving the overall structure a much more circular shape, thus the longer perimeter, more fiber needed.

But, one problem at a time, was the philosophy; just get rolling and then keep things moving in the right direction for now. The overall task always seemed of insurmountable difficulty. Yet, it all needed to be done. A waiting world up here longed to return home; and a broken world down there was needing healing, from a mankind that had trod far too hard on her for too long, before being able to once again host a world of people once again.

Finally they were ready to do a full linkup test of a SolidKESTS minimal structure. Since the shape was going to be more circular, they slung carbon vapor units below the hubs of many cities in front of the de-spooling site, to weld the two ends of the carbon nanotube fiber together once the loop had been closed. And as the struggling leading edge spacecraft headed toward the de-spool maglev bearing sites,

several of which were slung from hubs on that side of the expected loop, puffs of gasses would steer the incoming microspacecraft into home port.

And away they went, in their virtual cockpit of the millimeter-cross-sectioned spacecraft, front runner of 150,000 Km of fiber spooled at the launch site. Down they drifted in retrograde motion, boring days, ever picking up speed as they fell toward the planet and helping to pull the fiber behind it ever faster, although the de-spooler was ever faster accelerating the fiber off the spinner as the fiber de-spooled off of it, faster than the little spacecraft was going, so the fiber was forming a snakelike path wiggling downward. Then with a flash of heat and light they meteroricaly sped through the atmosphere, their autopilot making the microsecond precision last instant flying to zero in on the string of maglev bearings and accelerator tube in the tunnel in Indonesia, and they were through the tunnel, the accelerator humming powerfully to get the fiber going faster even than the leading edge spacecraft, taking up the slack from the incoming fiber. John fired the second set of ablation surfaces in the back of the spacecraft, using some of their fireball energy to propel them faster through the air, the added mass injected behind them into the hot gas reacting against them and they pulled hard on the fiber they led. Then they were through the atmosphere, last-instant airfoil guidance to put them on a free-fall path up toward GEO, as behind them the ground terminal accelerator was spewing out fiber faster than the spacecraft went, and the fiber behind them began to again take up lots of wiggles in shape as they almost bunched up behind. Then they were going past the guidance gas jets strung along below the Clarke Belt Ring, as if cheering them on in their final approach, all their vertical velocity component gone into potential energy, speeding into the maglev bearings slung down there too, then they were into the de-spooling terminal alongside the outgoing fiber. Both fibers then were together inside the maglev guides

where a blast of carbon ions welded the fibers together for several kilometers, then a microcharge was fired that severed the little spacecraft and the few meters behind it that had been heated beyond the magnetized steel's Curie point, and the tiny spacecraft began its final dive toward the planet's atmosphere, now abandoned by the virtual presence of its two pilots.

Their consciousness snapped back into their dual Holoterminal at home, John and Donna immediately shifted their virtual presence to watch what was happening to the dynamics of the wiggly-perimeter closed loop, as the two accelerators, one on the ground and one in GEO, synchronously poured kinetic energy into the passing magnetized steel particles in the loop, ever speeding it up. Then all the slack was gone, and the loop stretched out into a huge loop, all of it going at exactly the same speed now, the entire loop in tension. However, there were still transients that the loop weaved and waved a bit, eventually getting ironed out as they loop passed through the re-accelerators. Little energy was needed now, losses only as the fiber followed itself within its boundary layer through the atmosphere at over 10 Km/s. The huge perimeter, but microscopic thickness, loop of carbon fiber nanotube with embedded steel particles, held. It was time to take a break.

Another spool of carbon nanotube fiber was brought to the Clarke belt terminal there high above the eastern coast of Brazil, and it was sped up by a magnetic accelerator to join the incoming loop fiber; a blast of carbon ions welded the two strands together, then the last step was to re-heat the fibers above the Curie point of the steel particles embedded in the two now-joined strands of fiber, applying alternating magnetic fields as the joined strands exited the facility, now having the same polarity having been re-magnetized together.

Strand after strand was added to the loop this way, then it was formed as a band growing sideways, the thickness of the band limited by the ability to re-magnetize the steel all the way through the material as it exited the terminal.

Finally the loop had enough mass to send a test package down the upward-moving side of the loop, its maglev bearing contact with the high velocity loop moving upward through it as it descended, electromagnetically dragging on the magnetic fields of the magnets in the loop, gently lowering the package, while the loop itself slightly sagged under the load. The loop had to absorb 15 KWh of energy per pound of package, was why the loop had to be built up with mass; and the ability to absorb the payload's descending package determined the maximum payload. The package leisurely descended to near the Indonesian tunnel site, then de-clamped to drop the rest of the way to the ground.

Then a second package was thusly lowered, but when it approached the ground terminal, they doubled its electromagnetic drag on the KESTS loop speeding though its maglev bearings in the upward-headed direction, and with more upward drag than needed to overcome the force of gravity, back up the loop the package came, eventually reaching GEO again, the package becoming a souvenir for a museum they hoped to build someday, to commemorate what they hoped was their return to the earth surface, back to their homes again. Back down to Earth.

One of the Lunar Shuttle spacecraft was brought over to the incoming side of the loop, basis for a gondola to shuttle back and forth along the SolidKESTS loop; now built up in cross-sectional fibers enough to hold a substantial load. Stripping off the fuel tanks, engines, and cargo hold, the cabin with its life support equipment was about all that remained; along with its docking port. The Lunar Shuttle had been designed to provide comfortable living for five upper management

personnel while they cruised back and forth between the Clarke Belt Cities and the farside of the Moon's construction facilities, which they oversaw in operation during the construction of the enormous ring of Cities in GEO. So the gondola had ample room for John and Donna along with their camping gear and a few sets of experiments for the Environmental Engineers, as they got into the gondola after testing its ability to go up and down the KESTS several times, with equivalent payload mass inside.

There had been quite a controversy as to who was going to go first. The Environmental Engineers claimed it was their job, had to get going on it down there ASAP. Some rather powerful people among the Clarke Belt Cities pulled strings in effort to go first. But in the end, all agreed that John and Donna would be the first to go, especially after John pointed out in detail what life was going to be like down there for a long time. They would work to establish a survival zone; then if it looked stable enough, would start inviting others down to join them. They did not want to have another Jamestown type disaster down there, on the first settlement back on Earth.

John and Donna were stuffed into the Gondola, along with cages of quail and the whole microfauna system and seeds for grain to feed the quail in a closed facility; and of course the little box of German cockroaches, kept in pristine conditions, which would do a short recycle of the garbage produced. They were going to build down there as if on the Moon, except lacking the pressure vessel strength needs for the shelters. It still was a hostile land and air down there, not ready for the return of the creatures that had so wreaked havoc across the world, even innocently.

Chapter 10 Gondola to the ground

The gondola's velocity profile was to drop fast while building up enough speed to get through the radiation belts as fast as possible; then slow with a gee-load as high as the SolidKESTS loop could safely tolerate while they were dropping along the part of the loop more directly vertical relative to the planet's surface, then go easier with the slowing until they finally reached the tunnel site, where they would stop the dynamic braking, hopefully sitting on the pad out in front of the tunnel by then. This form of KESTS was a one-vehicle transportation system by nature; so the gondola would just sit on the pad until ready to climb back up to GEO, where it would similarly wait for its next trip down. One vehicle at a time; although it could be swapped for a different equivalent load vehicle, at either terminal.

The gondola had a Holoterminal built into it, as part of its original piloting system intended for Lunar trips. They additionally had a Holoterminal to take with them into their enclosure on the ground, so they had two potential ways to link into the communication system.

They seemed about as ready as they would ever be, so they released the docking security clamp after verifying the dynamic braking against the 10 km/s ribbon armature train could provide at least a 2-gee upward acceleration, far more than they expected to need on their way down. An electromagnetic ramp track gave them a good shove in the direction the Clarke Belt was moving, which was the direction the SolidKESTS was moving upward from, so it was only the downward curvature of the loop that got them headed downward. They hoped that soon the SolidKESTS loop could be modified to have equal upward and downward armatures, like a real KESTS did; but that began to involve a lot of weighty lateral coupling machinery along the loop; but

it would solve the problem of how to head downward faster at the beginning.

The sight of the ring of Cities in GEO quickly faded into a dimly visible line, but the huge globe of the Earth was slow in gaining size, in the starry blackness of the Universe out there all around them. They still were in free-fall, but the Earth's gravitational field was still quite weak, less than 10% of that on the ground. But the lower they got along the KESTS loop, the less their orbital component cancelled their downward gravitational component, and gradually they dropped faster. Into the Van Allen Radiation belts, they simply huddled into a ball and used the rest of their payload for whatever shielding mass it would provide; but mostly it was just a wait and get through it. The original KESTS of course had lots of shielding as well as high speed when it went through the belts, minimizing the exposure; but for now they were just glad they had something in which to get down there and back up again. Improvements would come later.

They took turns in the cockpit's Holoterminal, spending time in the virtual essence of all that had been incorporated into the system. From there they could go visit any of the landers, or peek in on the adventures of any of the inflated gliders that the tourist agencies were operating around the world. Looking in on their little robots at their destination site, all seemed unchanged; it was a world that indeed had to have a jump-start to live again in any form resembling what it had been before.

As the gondola approached the planet's surface, it did not look a bit like the surface of the moon which this cockpit had been so familiar with a decade ago. Yet it was almost as lifeless as the surface of the Moon, especially as the residual hydrocarbons had been munched by the bacteria seeded earlier as part of the initial clearing to enable a controlled jump-start of life's diverse interlocking web of life here

again.

Finally they entered the atmosphere and continued sliding down the nearly horizontal SolidKESTS, coasting until reaching the pad for the gondola's rest was reached. They had touched the braking a bit too much as the station approached, and so they had to wait several minutes impatiently as they moved only an inch a second for the last few tens of meters, then they were down. “It's Down to Earth!” they shouted to the countless tourist virtual eyes that had accompanied them on their progress down.

They took a moment to look out with real eyes on the scene around them. Ahead of them was the dark tunnel opening in a hillside, through which the ribbon vanished. One of their little tracked robots sat motionless nearby, from which they had also watched their arrival moments ago through their virtual Holoterminal presence. Donna, in the cockpit's Holoterminal waved and saw herself wave through the eyes of the little robot; maybe they were not quite as alone as they had realized before.

Sealing their environmental suits, they went through the airlock, and stood a bit unsteadily on terra firma; they had spent a couple of days in various gee-levels on the way down, and the planet had no coriolis force for which one needed to compensate instinctively as one did on the Clarke Belt mile-diameter cities, even though the apparent gee-load was the same here as in the cities' rims. The silence here was very strange too; the cities ever were noisily busy of man and machine's doings up there. Well, they were going to change the silence here, Mankind had arrived. Hopefully the planet would again be glad of it, this time around.

They began to set up camp quickly; it was not just they themselves that were tired of being cramped up inside the gondola. Filtered air was used to inflate their little farm's

dome, and they set out the seedlings in the soil brought with them, loosed the quail to run in the dome, and set up their feeders and watering dishes; the little birds scampered around as if at home. Inflating a habitat for the little German cockroaches, they too seemed to enjoy the room in which to stretch their legs even though they could not go beyond the habitat's confines. Nevermind, they would find a way to go further, as they always had done so since before the dinosaurs. Donna inflated their own home dome nearby, while John inflated the tubular passageway between the two domes, all interconnected but did have means to seal off their own new home. An airlock was prepared from their own tent-dome to the outer landscape, which would be pumped down then back up with filtered air, when passing between the landscape and the living space of the dome. They hauled in the portable Holoterminal and other furniture and housewares. Finally John dragged the power cable over to connect to the electrical power being beamed down to the rectenna here, power that also drove the re-accelerator inside the tunnel; the electrical power would now also power their life in their sealed miniature environments. Back inside their newly inflated and equipped home at dusk, John found it strange that the world outside had its lights go out quite obstinately; light was ever on call in the cities up in the Clarke Belt, the world in which he was born and raised.

The next morning, the world similarly obstinately turned the lights back on outside, and the couple sleepily arose from their snuggling slumbers together after their hard work setting up the new Earth station yesterday. Breakfasted and refreshed, environmental suits back on, out they went. Even outside they were no longer surrounded by silence; the hum of the domes' air conditioners audible for quite a distance. It was hot out here, and not just because it was on the equator; early morning and it was already 130ºF outside. They set up a third dome; but this one had a floor that was the natural earth soil on the spot. Here they were going to test out the

progress of their first guess as to a microfauna mix; a third air conditioner was set up, to cool the dome to not exceed 120ºF; but more to extract water from the high humidity outside, to water their little gardens inside the dome. Raking the rocks over to one side of the dome, John set out several boxes of the lunar-based soil used in the Clarke Belt's agricultural areas, each box with a different mix of microfauna. at three points around each of the boxes, were set a section of HoloPainted hydrocarbon and DNA analysis surfaces, to monitor the progress of the microfauna's adventures beyond their little box homes in which they rode down here. This dome was not directly connected to their living space dome and the associated farm dome; they were not taking chances with some rampant thing happening as the microbes and bacteria began to feast on the local lichens that had been taking root, seeded by the Environmental Engineers months ago, especially in this area. Seeds awaited sprouting when conditions were within their living range, and insect eggs similarly awaited the beginnings of a livable would out there in the dome.

The world's rotation once again turned the lights off and later back on again. John spent the early morning to use the inflated solar-powered glider that was dedicated to the area around the SolidKESTS terminal here; all seemed normal. A bit eager, he and Donna put their environmental suits on and went for a hike to see what the place looked like with real eyes. To Donna, having been born and raised on the ground, it looked like a strangely dead world; to John, it more resembled the Moon than the Cities in which he was born and raised. Every step crunched on the ground; a bit of a random breeze invisibly puffed at their suits. The Sun torched down at them, slowly moving across the sky, and the terrain was ever sloping, here on the high part of a mountain, even though more flat than the steeper slopes of the mountainside to which they arrived and looked down. Far off down to one side, they could see water, the surf was slowly

rippling onto a beach area way down there. It was a very huge space out there, this world was to John. And yet, it had to be experienced from inside their environmental suits, their helmets more like that of a spacesuit than a hiker's gear. They headed back to their inflated homes again, a place in which they could move and breathe without their confining suits.

Back in their new home again and refreshed from their hike, the two agreed that it all appeared livable for a reasonable period of time, safe and secure; so they sent the gondola back up the SolidKESTS loop to be loaded with the next batch of supplies and equipment. What they wanted most was the stuff with which to build a tram down the side of the mountain to the beach they had seen, a place where there was water, far more than could be squeezed out of the air here by the air conditioner condensers. Living systems needed the raw stuff of sunlight and water, to get the biofactory of a diverse ecosystem to run.

Chapter 11 Water

When the gondola returned with the equipment for building an initial tramway down to the beach, and included more food and water to tide them over for several months in case things went sour, they unloaded it and immediately sent it back up again for more equipment. Then they began putting out the little pylons, leading away from a shallow natural depression near them, to be used as a pond, when seawater began arriving. They hiked down the mountain, setting up the pylons for several hours; then hiked back up the mountainside to rest for the next go at it the next day. Eventually they made it down to the beach, the vast span of water seen up close was magnificent to their eyes. Little waves rolled in, spreading a random way onto the sandy beach, then vanished back out to the sea again. They set up a few more pylons, wading out into the sandy surf area, scooped up a sample of water, and headed back up the mountainside.

The gondola was waiting again for them when they awoke the next morning; they put their sample of seawater into the gondola along with cannisters of the natural dirt in their area, to be sent up for analysis by the environmental conversion team of scientists and engineers up there. They unloaded the carbon nanofiber and began to string it down the pulleys atop the row of pylons they had emplaced headed toward the beach far below, both sides at the same time, starting with the tension arm. Down at the beach end, they waded out into the surf to string it around the farthest pylon, brought the end out; and where easier on the shore, wove the ends together and glued the weaving together, a complete loop now. Again they began to long climb up the side of the mountain, hopefully one of the last times; the next time they hopefully could ride the tram up and down to the beach. The next morning they attached the tram cable drive motor and

hooked it up to the rectenna power supply output, recalling that the power availability to be beamed down here was enough to run the whole high tech civilization, as was its original intention; although much of its power was currently diverted to run the cities ringing the planet up there in GEO. But there was plenty of solar-derived electric power available up there in GEO to beam down here to do most anything they wanted, electrically. Then they began to attach the dippers along the tram cable, as it was slowly moving the cable along, dipper after dipper. A few hundred of them and the supply received so far was depleted, so they speeded the tram cable up to what they expected would be a usual speed, and waited. Soon, the first dipper arrived back up here, and as it passed the basin they had selected for a repository for the sea water, the dipper passed over a cam that tipped the dipper, and the first splash of sea water was spilled into the basin, their pond begun.

They set up a reflective solar still next to the new pond; even though they had electrical energy galore to power their water distiller they brought down with them, no sense in wasting the local solar power and the high temperatures existing much of the day here; although they had to wait until nighttime to condense the last bit of the vaporized water; heat radiated out to space into the dark night sky. Soon they had plenty of water to water their indoor gardens, including the one using native soil as its starting point. The telemetry from the sensors scattered around the boxes of various mixes of microorganisms, eggs and seeds, began to produce data for the Environmental Restoration team up in the Clarke Belt Cities, data they had dreamed of receiving long ago. But anyway, was finally happening.

The next gondola of equipment consisted mostly of a huge shade structure, which was installed out across the ground quite a ways from their domed habitats, yet close enough to pipe distilled water over to irrigate it. In the center of the

shaded area, was placed a single box of microfauna, the best guess for a mix, as determined by the scientists based on the earlier set of data within the enclosed ground area. Again, Holopresence sensors were poked into the dirt in the area under the big shade, as well as sensors completely outside the shaded area, then they waited and watched the spread of life out from the initial box. It was very slow, as most of the microcritters either did not have legs or were just too small to travel far on their own. The shade and the water made a big difference in what could survive there, however; it simulated what were more like the conditions at much higher latitudes in some places around the world. The KESTS could not reach those places itself; but the inflated gliders could possibly haul some biosystem origination boxes off to such places, given lots of time, the winds, and the length of time the boxes would remain viable while they were being slowly flown.

With the pond of seawater growing in size, some of it was going to be used as payload when the gondola was making the return trip up to the Clarke Belt. The two worlds were finally engaged in trade again. When the seawater arrived up there, it was analyzed for biological content, then sent to the total recycling plants, where solar energy was used to turn incoming material of any kind, into a plasma of ionized atoms and molecules, which were separated as to polarity then electrostatically accelerated and magnetically focused to a standard velocity as the ions launched into the hard vacuum of space, going across a powerful magnet which bent the ions' trajectories to angles dependent on their mass-charge ratio. Buckets ringed the fan of ionized materials produced by the thusly separated masses, buckets cooled by the deep heatsink of the blackness of space. The principle was the same as the very early mass-spectrometers, nothing new; it was just humongous in size, enabled by the vast environment up there in GEO of hard vacuum and zero-gee. In buckets that were collecting gasses, such as the hydrogen

and oxygen buckets from the water elemental components in this case, the liquid oxygen and liquid hydrogen were pumped into containers so they would not re-evaporate into space.

The liquid hydrogen and oxygen were greedily used by the reaction motors around the Clarke Belt which were compensating for the slow orbital decay, keeping them fine tuned in place. As the supply of seawater increased beyond this immediate need, it was readied for use to begin powering up some of the mothballed vehicles that had plied between the lunar and GEO areas during the construction of the Clarke Belt City Ring. They had been mothballed when the last ring of Cities was completed, needed for overall system balance, even if the last few thousand Cities never got populated, as the Earth had been essentially depleted of people, as as that phase of the project proceeded.

To prevent unnecessary torque on the hub bearing of the cities as the ring of cities rotated in space, the overall design had chosen for the inside rotating part of the cities to rotate in the Earth's equatorial plane; this made the “packing density” of each ring of the wheel cities much lower than if they had been hub-to-hub. The rings of cities were 11 deep, enabling the 1,500,000 cities that were needed to support the whole human population during their now-extended stay up in the Clarke belt. So the Cities were linked in symmetric contra-rotating pairs, alternating direction of rotation also city to city, all balancing gyroscopic precession forces and differential velocity at the rims, even though they each had their non-rotating passive shielding made of water ice frozen with sawdust as reinforcing fiber. The influx of water from the Earth's vast seas now eased the pressure to start cannibalizing the shielding mass of some of the unoccupied Cities; their internal water storage had already been used up for propellant needs. There were many cities still with their water storage, however; used as the population expanded up

here; but one of the “dry” ones was now being set up to mimic the existing conditions on the earth surface, as a test bed for the Environmental Engineers' experiments, for a larger scale test of the oscillations between population growths as biological components where changed, in a large context which was still much smaller than that of the Earth surface herself.

Now the huge manufacturing facilities on the farside of the Moon were being slightly re-awakened, along with a few of the fleet of transport spacecraft. It had been decided to speed up the return process by just a little bit, by using large-scale ablation re-entry vehicles to get supplies and people down at locations far from the tiny facility in Indonesia. They would not carry out the process so much that it would adversely affect the overall dust content of the air of the world. The Lunar manufacturing facilities were also put to work building vast quantities of hydrogen-inflated wing-like guided balloon-gliders, which were designed to shift to a horizontal position when the sun shown on them, and shift to a vertical orientation at night. It would take a huge number of them put into the planetary atmosphere, to significantly lower that average solar influx so as to cool the planet down again; but that was what the huge manufacturing facilities were good at - robotically making huge amounts of things. And the ever helpful robot type systems enabled this expanding fleet of sunshades to avoid collision with the SolidKESTS, as well as circle over specific areas to keep it a bit cooler.

All this activity needed water, and the SolidKESTS was the only thing that was currently bringing water up for these many uses. More layers of the magnetized-steel particle embedded carbon nanotube fiber was built up onto the original structure, exponentially building up the girth and thus the capacity of the ribbon loop around the world. As the carrying capacity increased, gondolas designed to just ferry

water up were built, and although the SolidKESTS could only be used for one-way traffic at a time, multiple gondolas could be going up or down at the same time; and the multiple vehicles spread the load too.

Chapter 12 Tanker follows inflated glider

During a break time, Donna used their local inflated glider remote scout vehicle to go see if the savage could be found, that had speared the first lander-glider on an island offshore. The wind was calm, and the slow little solar powered floating glider took awhile to get over to the island, and did not arrive until the next day. Then she cruised the beaches until she found the lander-glider. It appeared to not have been moved; still had quite a lot of damage from the spearing. There was a worn footpath not far from there, so she followed it, staying well above spear-throwing height. Eventually it faded out into multiple paths which spread through the remains of the jungle; so she backtracked to check out the footpath in the other direction. Eventually it headed into a cove, and what appeared to be a beached oil tanker was there. No sign of recent activity there on the beach; the atmosphere was not very healthy anymore, after the bacterial cleansing by the biological engineers, although it was possible that the filtered air inside the crew quarters of the tanker was reasonably fit. The tanker appeared to have been there a long time, rusted hull, yet upright. Such a tanker's hold could have kept an auxiliary powerplant running for a very long time, and might still be running.

How could she contact people who might be in there? Likely they had weapons more modern than spears, for special occasions, and she did not want her little aircraft to be another casualty of those folks. Yet it was important to attempt to save any people who they could, who might still be alive down here.

She circled at a safe distance for a few minutes while she shifted the attention of her Holoterminal to the Mars Project lab up in the Clarke Belt City Ring, accessing its little-used

facility for robotically building radio communications gear, and set it to work building the equivalent of a maritime radio communications transceiver. Then her attention back to the little robot aircraft over at the island, feeling a little mischievous she used the craft's “claws” to pick up a small rock; and, flying over what appeared to be the tanker's crew quarters, dropped the rock to bounce off its roof. Then she went to get another small rock, and again dropped it on the roof, then circled at a safe distance, saw some people come out to look to see what was going on, holding a cloth over their face, no doubt to help with breathing outside. People! There were people alive here! She headed her little robot craft back on its long slow journey back to the KESTS tunnel site, let its autopilot do the rest of the piloting job; and she returned to her work projects.

When the maritime frequency transceiver got sent down with the next shipment of supplies, she and John set up an antenna and began letting the transceiver scan for signals. Lots of static, including some associated with their own equipment's operation, but not much else. There did not appear to be much activity on the radio, so they sent a message on the emergency channels, was anyone out there, they asked. They set the radio to periodically send the message, on all channels, one at a time, then listen for awhile, then go to the next channel. The island was quite a ways away, and the tanker was on the far side of the island, so they sent the transceiver with a battery for it, in their little robot plane, over to fly around near the beached tanker, doing its broadcast thing, scanning.

Suddenly they heard a reply, in broken English, but understandable. “Hello, hello, you out there in the flying saucer, we are people from the planet Earth. do you read me?” was the response. “Please stop dropping rocks on our roof, we are not at war with you.” Donna looked around and spotted another floating aircraft in the area, one of the ones

operated by a tourist company; and, yes, it was also following Donna's sport of dropping rocks on the tanker's crew quarters to get people to come out, for the excitement of the billions of tourists who were in virtual attendance, the word having spread fast about living people on Earth. Well, living people besides John and Donna, that is.

Donna made a quick communication to the tourist robot vehicle to cease dropping rocks, then keyed her transceiver on, and acknowledged the communication; said that they were people like themselves, not aliens in flying saucers. And that they would like to chat about how things were going on the tanker.

The tanker had been there for over 30 years, powered by the fuel it had been carrying. They had discovered that the world's people had vanished, and there was no place that wanted their last load of fuel oil; in fact, there were no port facilities left open for them to dock anymore. So, they had beached the tanker here in this secluded cove, and had lived off the land and sea ever since. Their crew had included families and now had doubled in size, getting a bit crowded in there. And now that the air outside had turned bad, cabin fever was breaking out at times. This contact was very welcome. So where were they from, if not aliens in flying saucers?

“Have you seen a streak of reflected light going from east to west straight overhead?” Donna asked. Yes, came the reply, what is that. She explained that the place the world of people had gone to, was up there in that place, which they can see a a streak of light when the Sun was at the right angle. A long silence and then disbelief about being able to get up there. Donna continued, explaining that it had been a project long in the making in far parts of the world, part of a plan to revive the dying earth ecosystem. And that the plan was starting to happen; and unfortunately part of its early phases

involved the air being a bit unpleasant, as they surely had noticed. “Where are you?” came the reply. “Those little plastic airplanes are not big enough for humans to fly in.”

Donna did not try to explain that there were billions of tourists now watching the tanker and listening in on the conversation, billions in virtual attendance in the little plastic airplane but physically up in that streak of light far overhead. Nor that she was not there in person either, but was at least on the ground, a couple of hundred miles away, at a fragile campsite. But she was able to get the tanker's people to understand that these were just model airplanes, flying remotely, scouting out the land, while the actual pilots of the model aircraft were far away, using radio to communicate and fly the aircraft. Was there anything that the people in the tanker needed, that could be given them? Suddenly the person on the ship's microphone was merely one of a lot of people shouting things they desperately needed. The tanker still had over half its original fuel supply remaining, and the people on the tanker were willing to trade some of it for things they needed. Fuel oil would be a fine raw hydrocarbon resource material, needed up in the Clarke Belt Cities. But transporting stuff back and forth was a big problem. The tanker's captain said that probably they could put back out to sea, if they had a place to go not too far away.

So the tanker was able to revive itself and make its way, following one of the inflated aircraft, over to the mainland, then anchor near where the water scoop facility was located, on the beach below the mountain on which the SolidKESTS worked. Material was sent down the KESTS to build another bucket tram, this one to bring up fuel oil. And items which were needed by the tanker people were built up in GEO and sent down on gondolas, used in trade for fuel oil. Another inflated living dome with an associated enclosed little farm was given the tanker people so some of them could live on the beach, relieving the population pressure in the tanker's

crew quarters. Soon the labor force on the ground had increased by quite a few hundred percent.

They had done their job here, back on Earth for now; establishing a livable area, and even acquiring a nearby local workforce. It was time for the Environmental Engineers to take the facility over. The next gondola down had 5 couples in it, each couple had at least one who was an Environmental Engineer or Scientist. They were trading places with John and Donna. It was going to be cozy for them awhile, 10 people living where two had done so before; but more dome tents were being fabricated and would be sent down soon. Squeezed out of their little campsite, Donna and John headed back up the SolidKESTS in the gondola, which was needed up there to send goodies back down to the new residents of Planet Earth.

Back home at last in their City in the Clarke Belt high over the east coast of Brazil, the couple relaxed and rejuvenated, luxuriating in the many creature comforts of living in totally man-made worlds. It had been fun out camping; now, they were home and enjoying luxurious baths and equally plush beds upon which to sleep. They frequently used their Dual Holoterminal to have virtual presence back down at their former campsite, see how things were going and occasionally provide some helpful hints about survival there.

They had just gotten acclimated to the relative luxury of normal life again, when they received a message: they were needed to go on another “camping trip,” this one down to the former KESTS terminal on Cayembe Peak in the Andes Mountains of Ecuador. And there was no KESTS to bring them back up from there; as they would have to go down on a one-way journey using a heat-shielded re-entry vehicle.

Chapter 13 Old tunnel's dream renewed

Their new transportation vehicle was much like the first lander that they had done in a cooperative design with the Mars project assembly lab: except much larger. The team that had taken over the lander design effort had done a good job; the model of lander they now were climbing into had already been used to set supplies down at the Cayembe Peak site, this one having been modified for two human passengers, primarily.

Down the retrograde path they went, canceling much their orbital velocity component; then a spiraling drop through several orbits of the planet, only to do a spectacular meteoric atmospheric entry slowdown. They then separated from the heat shield and continued rapid but somewhat controlled descent in their heat-resistant rigid glider, shaped much like the old Space Shuttle orbiter except much smaller. Then when velocity and altitude had slowed enough, the vehicle flew almost to a stall at 4,000 meters altitude, then did a rapid pressurization of a large vehicular glider shape, solar cells on its upper surfaces that powered a small electric motor driven propellor; the hydrogen used to inflate the craft provided a neutral buoyancy aircraft; part airplane, part blimp. They headed for the remains of the Cayembe airstrip, and set down next to two similar inflated vehicles, which were the supply transports that had proceeded them here. They did a brief touch down, sent the message of their arrival, but immediately lifted off, to take an aerial survey of the situation.

They had looked long at this place from the telescope up in the Clarke Belt; but that was not like seeing it up close. Donna's HaremMate bombpilot had wreaked havoc, detonating her nuke 100 meters above the KESTS terminal tunnel, frying everyone within the compound defended by

the Clarke Belt city ring folks, along with also all the militants that had been assigned to ring them in, to prevent their start of the restoration of the planetary ecosystem. All life snuffed out in one instant. And the fall of the KESTS to GEO, immensely strong as it was by then, but could not compensate for the nuclear blast shock wave; and down it began to fall. The pylon elevator stretching up to the circular KESTS ringing the planet 15 miles up, was also blown down, initiating collapse of that part of the transportation system too. The mess littered the landscape, buildings swatted down and various human skeletons piled up by the wind blast, against whatever structure foundations that had held position. The Geiger Counter was buzzing away with its alarming message: danger, danger, everywhere.

The mission's start was blessed with the message of the Clarke Belt City people: please find a way to make it all work again. Nothing else would possibly be able to move them back to their homes on the planetary surface in the lifetimes of most of them; even the KESTS here had been only able to lift a million people a day, along with their immediate household belongings for the half dozen years it would take to restore the ecosystem, then they would return down the KESTS from GEO, back to their homes again, they had thought. Even at a million people a day, it would take another 20 years until the last of them returned home. Although surely a lot of people would elect to stay up there in the Clarke Belt Cities, a far better life than they had had down on the ground before the exodus; many of the poor of Africa, for example, had been suffering from malnutrition before going up to the Clarke Belt Cities, where they lived just as well as everybody else, condominiums of their own, and adequate locally grown food, why go back to starvation, even if the environment had begun to live again down there? Many would not go down. But billions would, and only the KESTS gigantic hoop structure around the planet could do the job adequately.

But restoring all this mess looked utterly impossible. Yet, it had to be done. Perhaps it was analogous to the task of restoring the whole planet's ecosystem to diverse working balance, damaged even further by the greedy power grabs of the gang which had plotted takeover of the world, clever guys, utterly arrogant and seeing only their easy conquest of a vast people who were making sacrifice of some years of their lives so as to bring their beloved Mother Earth back to life; easy marks for the “powerful.”

John and Donna flew their inflated aircraft up to the entrance of the huge tunnel through the Cayembe mountain peak, which in its heyday had been both the re-accelerator site and the transportation hub that handled a million people a day along with their household goods. They flew into the tunnel, now essentially cleaned out by the meteoric final ride of the millions of armature segments which happened to be passing through the KESTS structure at 40,000 km/s at the moment their track structure burst, an energy blast rivaling that of the nuclear fireball still in progress at the time above the mountain peak. The sweep of the armature segments did do one helpful thing, their own blast had kept the nuclear mess out of the tunnel, and so as they flew into the tunnel's darkness, their Geiger Counter ceased alarming sounds, dropping down to a normal background few clicks a minute.

They then landed, donned their environmental suits, and finally stepped down onto terra firma once again, there in the darkness of the tunnel, lit only by their flashlights. Off to the sides of the tunnel had been thriving shopping malls and restaurants of all kinds, catering to the millions of busy travelers there from around the world, who were readying to go up to even further places from here. The task now was to apply the HoloPaint which they carried, to anything that looked like it might still be useful in re-constructing this place. All the shops and restaurants were gone, their

structures removed by the enormous hail of armature segments then fireballs at 40 km/s, taking all they encountered on out of the tunnel along with themselves, to become the debris fields still visible from space that extended out from both ends of the tunnel. The pair walked with their flashlights to the sides of the huge tunnel, their shoes crunching on the hardened meteoric fragments still there. It looked more hopeless than anybody had imagined; there simply was nothing left there. They walked down past the long tunnel wall, still astonished at how thorough a sweep had been done. The energy stored up inside the KESTS structure as it was scaled up to operational girth, was as immense as the structure itself, for that stored energy had supported the huge structure, all the way to GEO and back, encircling the world in the process, the centrifugal force of their path around the hoop more than balancing the force of gravity on the non-moving part of the hoop; and all the energy present in the local area had been released at once, as the structure experienced a cascade failure not unlike a nuclear blast; except no radiation of its own, of course.

Then they found a door in the wall of the tunnel, which was still sealed. They began to watch for such sealed doors as they continued their walk, and found many of them, largely disguised by the sandpapering of the tunnel wall by the armature segment fragments. Yet the outline of such doors was discoverable if knowing what to look for. Finally they found one that had not been fully shut at the moment of catastrophe; its door's edges were mangled some, but the hinges still worked, as they pried the solid door open, and entered the passageway beyond. Soon they found what appeared to be an undamaged power panel. Finally something found that was undamaged; so they applied some of their HoloPaint to it. And suddenly the whole place lit up with the HoloPresence. The original KESTS had been created concurrently with the invention of the Holoterminal technology even though not technically related, the

HoloPresence enabled the awareness of all the billions of its parts, the data needed to fix things long before any failure could happen. The HoloPaint has been improved over time, and yet now there were similarities with the original Holopainted innards of the utility distribution system of what had been the greatest transportation hub mankind had built. And now it was linked with the new Holoterminal system of omnipresence. Even using the low resolution Holoterminals built into their helmets, they could see the whole of the utility section throughout the tunnel.

They could see the electrical conduits go to the edge of the tunnel, where they had once linked to the vast rectenna system which had received the solar-derived energy beamed down by Solar Power Satellites in GEO, gigawatts 24 hours a day, year after year, clean electrical power from space, that made all this work. Or had made all that had been here before, work. There were all the other utility piping and conduits through here too, water, air, sewer, communications, control systems. Now, that looked interesting, those control systems; they headed to where they could now “see” some of the computer rooms. Finding one that looked like a main control system computer, they checked its state; even though long without power, they could see that it had done its job of activating the circuit breakers everywhere, as everything outside had gone into overload; the computer here had stopped everything to protect itself and all its substations throughout the tunnel's lateral caverns. It all likely was still in working condition! If it had anything to do, that is; and had the power with which to do it.

Well, power galore was available from above; the Solar Power Satellites still were in GEO, ready since the beginning to take over the task of electrically powering a renewed civilization on the ground, never to need to burn coal or fuel oil to generate power again. It was part of the plan to restore the planetary ecosystem, and return humanity to their homes,

but no longer using hydrocarbon combustion for the energy civilization required in such huge quantities. No more greenhouse gasses to eventually tip the environmental scales again. Anyway, what they first needed to do is build a small rectenna off the end of the tunnel, and get it hooked up to the power distribution system in here. Then have one of the SPS in GEO set to beam energy down here, and see what happens. Things were looking up, finally.

Returning to their aircraft, they directed the robot aircraft which carried the rectenna that was to power their activities down here in an environmental tent, instead was sent to land adjacent to one end of the tunnel. There John and Donna patiently unrolled thousands of meters of rectenna mesh, and unrolled its power cable over to where the molten remains of the power conductors that had gone out to one of the rectennas before, and tied the metal wiring together as best they could, the little wires to the huge wires. Backing away from their kluged wiring, they requested the nearest line-of-sight Solar Power Satellite in GEO be aimed here and turned on; and they went back into the tunnel, into the utility tunnels, to the main control computer equipment. Yes voltage was there, so they powered the computer up. It immediately gave a very dismal picture of the state of things; in fact, it had just decided that nothing was working right, and kept power from going to anything that was not working right. Only its own control system remained powered up, along with the lights and other minimal environmental systems for personnel who might need to service anything here, long ago. But now the place was habitable for people again, a better home for John and Donna for now, much better than the radiation-poisoned world that lay outside the tunnel.

They brought their camping gear into the computer control room, set up their sleeping section and bedded down. It had been a very long day; and the hum of all the equipment around them felt almost like home.

The next morning, awakening in the computer room of the old KESTS terminal, brought urges for coffee and breakfast; soon they were busy at their day; first task was to set up the first of the two Holoterminals they had brought down with them. Essential to be connected into the rest of human civilization, the Holoterminal did that excellently. Except it only connected to that which had been “painted.” So getting everything covered or filled with the Holopaint was standard procedure.

They dabbed some of their Paint onto the computer panels, which updated the Holopaint the equipment already had from way back. Entering the Holoterminal, and inspecting in finer detail than their helmet-mounted Holoterminal port enabled, they discovered that the underground utility tunnel complex here was all in good shape, but it was all like a brain without a body, the shops, restaurants, and the KESTS itself all were gone. Yet, it was a very welcome addition to the resources available to the seemingly impossible restoration of a KESTS on this site. One step at a time.

They set to work documenting all the functioning resources they were finding; a lot of it, actually. And as they virtually explored the utility tunnel system with its miscellaneous intact materials and equipment, they found some utility tunnel maintenance robots. Bringing them back to life, their batteries energized by fresh electrical power beamed down from GEO at long last, John instructed them to do a cleanup of the tunnel system. When that task was done, he instructed one of them to exit the utility tunnel through the open door which he and Donna had gotten pried open, and had it monitor the state of its batteries while doing a bit of scooping of the floor littering shards; he did not want it to run out of energy out there in the main tunnel. How well the batteries would hold up, after sitting idle for decades, was quite uncertain. He went out and watched it toil to clear a little

space in front of the doorway, then trundled itself back inside to dump its load of debris and freshen its battery charge. He noticed that the sweeper robot had sent a message to another maintenance robot, which came out to the door, and began to cut and weld on the door, repairing it, without being told to do that by John. Impressive; they were going to have help, it looked like.

Bringing a sackful of the floor debris of the tunnel, he and Donna began to evaluate what the stuff was. Mostly were fragments of armature segments that had abruptly ceased their 40,000 km/s endless slides around the KESTS structure in a hard vacuum along maglev track channels, to an abrupt stop among millions of its neighbors and their tracks, now all mangled into shards. They hoped to find some relatively undamaged armature segments as they sorted through the mess. And they did, the armature segments were tough little rascals built to withstand a degree of track-scraping and coping with some dust in the system before the particles were scrubbed by the hard vacuum system; and that same toughness of the little rascals had seen some of them through the melee at the end.

Donna programmed the robot to just sweep the debris up to one area around the doorway into the main tunnel, clearing the path; then to spend part of its time inspecting the debris and saving out items which fit the parameters of the relatively intact armature segments which had already been sorted out. They did not set size limits, only shape and composition. They would come back later and see what had been discovered by the little robot; it seemed to scamper back to its charging station well in advance of its battery full discharge, taking good care of itself.

The last act of the computer managing the KESTS control system, responding in nanoseconds to the data of first impact by the nuclear blast, was to command all the maglev tracks

to initiate electrodynamic braking at the maximum. Such internal braking was normally used among the laterally distributed armature mass streams, to provide a differential torque on the tracked tube, to resist wind loads, primarily. But in times of puncture of the tube, a “dead-man” control function was built-in, calling for rapid slowing of everything, to minimize damage and to constrain the armature segments as much as possible, avoiding a high velocity escape from the system and becoming somewhat a nuisance, even maybe hazardous in some potential cases. But here, although the huge KESTS hoop had the major part of its structure still intact, was rapidly severed by the nuclear blast just in the vicinity of the ground terminal; and so the vast majority of the armature segments had nearly halted within their tubes before the structure finished impacting down. Further readout of the computer's log showed that it considered that many of the armatures could be easily refurbished and restored to the system; it did not realize that there was no system left, however.

So could there be lots of usable armature segments out there along the lower parts of the KESTS collapsed structure? Taking some cutting tools, the two flew their inflated aircraft out of the tunnel, out along the equatorial path of the downed KESTS structure, looking for the end of it just beyond where it was vaporized by the nuke. They found it far down the mountainside; they landed alongside the maglev track structure, its meter-diameter core KESTS support tube structure looking relatively intact. The radioactivity here was negligible, 15 kilometers from the terminal site. They did a cross-section sawing through the KESTS core there, where it still was partially fused and mangled by the blast, and Painted all that which was thereby exposed by the slice through.

Returning to their new “home” inside the computer room inside the utility tunnel, John used their Holoterminal to

remotely examine the sawn-through section which they had just Painted; the complex meter-diameter circular section illumined by the paint was available for examination in minute detail, even down to sub-atomic composition. They found that the outer 90% of the tubes used to scale the structure up were of uniform diameter, but at its lower edge 10% it had a much smaller diameter set of tube tracks, and then at the very lowest part, less than 1% of the cross-section, were the very small tubes which had been the seed KESTS from which all the rest had been built, using the earlier KESTS structure to support the temporary weight load of the next layer of KESTS tubing before it too was brought up to speed and thus support its own weight as well as external load, ever expanding the girth of the KESTS until it was up to the full operational size needed for the task of temporarily relocating the human population of the planet.

They again flew out to where the end of the fallen KESTS was lying, and cut a thin slice of the KESTS core cross-section, only a couple centimeters thick; which was all they could carry. After the slice was cut, they tilted it into a sack, and a couple of intact armature segments fell out of the smaller tubes, just what they wanted now. They flew the slice of section back to their new base camp in the tunnel's computer room, Painted it all and thus connected the enormous scientific and engineering resource facilities up in the Clarke Belt City Ring, to get to work on analyzing it all.

Checking on the progress of the little sweeper maintenance robot working on the debris in the main tunnel, they found it had found a half dozen of the smallest armature segments which were only a half centimeter long and a half millimeter in diameter, a few seemed undamaged. Some of the medium sized armature segments were found relatively undamaged too, and dozens of the large sized armature segments. For each intact one were a dozen of them fairly undamaged, too, yet still maybe useful as potential building material. It was

hard to imagine getting anything built without the mass-spectrometer type total recycling plants in GEO, even recycling the manufacturing debris, which would have converted the debris on the tunnel floor back into fully useful raw material; but it would take a KESTS to get this stuff up there to be recycled, and the lack of a KESTS was the problem. The original KESTS to GEO was built from this very place, and without a KESTS to start, nor any facilities in GEO yet, no recycler up there either. And they were going to have to do it again, without those resources.
They had a head start over the original makers: they now knew for sure it could work; and had samples of some of the final working parts. They had all the resources of a civilization up in the Clarke belt eagerly wanting it to be built; but when the KESTS to GEO was first planned and being built, there was a lot of opposition to its creation, which also was endured by those early makers, ever hindering their efforts; as if the technological challenges were not enough. It was a wonder that it got built at all.

After adjusting their helmet Holovision adapter, they decided to go on an outing, outside away from the rockiness of the tunnel world they were living in. In their environmental suits, they went on a hike just beyond where the radiation level was too high for such a casual walk, looking along the path of armature segments; their helmets tuned to the older type of HoloPaint. Climbing along a mountainside was a welcome change of activity, although inside environmental suits the adventure lacked much of the sense of being out in nature. But nature had taken a turn for the worse worldwide, extending even up here in the Andes mountain range. They started spotting “glowing” things in the area, things which had been painted with the old form of HoloPaint. Stooping to pick some of the glowing tiny objects, they found most were fragments of the tubing and track structure; but they eventually found a few of the smallest size of armature segments, ones in fairly undamaged condition. It had been a

worthwhile hike; and they returned to their aircraft, flew it back to the tunnel entrance and parked it.

They had the earlier landers' inflated aircraft remotely fly from the airfield over to land near the tunnel entrances, some just inside the tunnel, where at least some sunshine would reach their wing's solar panels to recharge their batteries, even if left sitting a long time. They unloaded the food and water supplies sent down in those landers which arrived before they had come down; there were no minifarms here yet to provide food and water. And beyond the tunnel was a local radioactive wasteland, and the air worldwide was still fairly toxic to breathe. The coolness of the tunnel was welcome too; the typical daytime temperature here at the equator being 130 ºF outside. They decided to request the makings for a domed minifarm of quail and little cockroaches, rice and quinoa grain, and a water distillery; they had enough power coming down to their rectenna outside, to easily provide the lights and air conditioning for such an environmentally protected minifarm placed inside the tunnel. They directed one of the little sweeper robots to begin a long project to sweep a path clear to the flooring, all the way to the entrance where their airplane was parked, and to clear an area large enough there for a minifarm's dome tent. They requested the minifarm's makings be sent down in the next lander's cargo; the food source would be good survival insurance, they instinctively knew. There was no way to get home from here, halfway around the planet from the SolidKESTS, which was currently the only pathway for people to get back up to the Clarke Belt Cities.

They brainstormed about if there was any way to reclaim working KESTS material from the part of the old KESTS that had fallen across to the east, along the equator in Ecuador and Brazil. The salty seawater would have corroded anything fallen into its watery kingdom, surely. But there was the segments of the big structure in varying conditions

where it fell across the land to east and west of Cayembe Peak. They would be able to find armature segments in places, such as where the KESTS had fallen across a sharp outcropping of mountain rock, for example, spilling out armature segments from the thousands of maglev track tubes split open there. But to build a new working seed KESTS, they would need the tubing and maglev track too. Thousands of kilometers of it, just for the atmospheric path part of the structure. Higher up into hard vacuum, the configuration was a bit different and a bit lighter mass; but that part had mostly burned up on entry into the atmosphere where it fell from thousands of kilometers up.

Meantime, the engineers and scientists up in the Clarke Belt Cities had done the remote analysis of the entire system of armature segments and the maglev tracks upon which they rode. From that they extrapolated a morphing system to cover lower velocities all the way down to zero. And they sent an experiment down on the next lander, along with the minifarm.

When the next lander's inflated aircraft flew into the tunnel directly, it landed where the floor had been cleared out for the minifarm. John and Donna got busy immediately putting the domed minifarm up and get its air conditioner going; the quail especially would not last long, sealed inside the cannisters in which they had just plummeted tens of thousands of kilometers and burned they way through the atmosphere, endured their glider section's deployments, and now were sitting awaiting a chance to get out and run around. The cockroaches and grain seed were patient and tolerant, but also needed getting settled into their new home. It was another long day for them, building it all, getting it running and watching to see if the conditions settled into acceptable environmental values, before turning in for much needed rest.

The next morning, they were eager to play with the other thing sent down this time. They had gotten the little robot to sweep a straight path from one end of the tunnel to the other, just a meter wide. Into this cleared path, they set down a length of mini-accelerator coils. then attached the big coil of fine-gauge flexible tubing down the path to the end of the tunnel, where they loaded it into their inflated aircraft. Flying the aircraft over the top of Cayembe Peak, spooling out the tubing, to drop on the terrain out there, all the way up and over, then into the other tunnel's entrance. Landing there, they manually rolled the now quite small roll of tubing down the cleared path to then be connected to the other end of the mini-accelerator.

Donna had eagerly pitched in on the doing of this project so far, engrossed in the physical activity. But now she frowned at the thing they had assembled there, recalling the limp shape the tubing had taken as it was dropped across the rugged terrain of the mountain peak above them. “What kind of KESTS is that? It goes overhead, and not down under around the planet. A KESTS has to use the gravitational field of the whole planet to bend itself around to join back again to itself in the big loop. Here, the gravitational field just collapses it all back on itself.”

“This is not a KESTS structure, Donna,” John explained. “But it is hoped it will function as an earlier form of kinetically supported structure. Several years before the KESTS concept was born, a concept called 'The Launch Loop' was conceived. Its intent was to use the outward force on a rapidly rotating loop that would extend up to the fringes of the atmosphere; this loop would have been used to lift rocket vehicles up through the atmosphere, and the rockets would then launch from up at the loop's top, a bit of a head start up, but more to enable the rocket engines to be optimized for operation in a vacuum, more efficient design than engines needing to also work in the atmosphere's back-

pressure. So this is hoped to be a model of a sort of Launch Loop. Let's see what it actually does, shall we?"

This experiment actually was to test out a lot of things. The equations that modeled the morphing of the derived KESTS sliding armature system, to allow it to move along even from a standing start; and the armature was actually a lot like a SolidKESTS in that it was a continuous ribbon loop, with embedded magnetic sections alternating in polarity down its length, to be sensed and pushed upon synchronously by the accelerator section, which was anchored to the ground. It had worked during testing up there in GEO, but what would it do in an actual planetary gravitation field down on the surface?

They hooked it up to the power system of the newly revived utility area of the tunnel, and watched it through their Holovision sets inside their helmets; the physical structure was much too tiny to examine standing there, and anyway what was going on there was inside the tubing, hidden. They could see the accelerator coils were not exactly aligned with the spacing of the magnetic fields along the inner ribbon, which allowed it to get moving a little bit if exactly stopped in alignment between the two fields; the one of the armature set, and the other of the accelerator. The ribbon began to move, its sliding a mixture of mechanical contact with teflon plating and of maglev fields across the irregular path of the loop up over the mountaintop. The ribbon increased in speed more and more. Things like to go in a straight line unless forced to change direction by an outside force; so where the enclosing track curved up and over the mountaintop above them, the bending of the track forced change of direction of the armature moving along at a brisk pace inside the tube, and so the armature pushed back against the tube as the armature was forced by the tracked tubing into the closed loop shape. Faster and faster the armature band went, pushing harder and harder against the tubing which forced its path. Finally the outward pressure against the tubing forced

the whole thing to form a nice loop, not touching the rugged mountain's surface above them anywhere. The whole experiment was also being monitored in detail via the Holoterminal system, by the folks up in GEO, and they already were fine-tweaking the equations for morphing the complex interactions between electromagnetic, Newton's kinetic, and gravitational forces as manifested in the real world of constructible things.

Seeing the now smoothly rounded loop both through the tunnel and up around and over the mountaintop above them, Donna finally asked what it was good for, not seeing any purpose of the tiny tubing loop. John explained that it was modelmaking, that is all. Just making a tiny thing that resembles a bigger thing in some ways, to show that it can be built and it moves. And in this case, the modeling was being closely matched to highly complex equations which were forming thusly proven mathematical models, so that other larger structures might be built in already working condition, even the first time. For example, an actual KESTS type structure, far bigger around than a planet's circumference, not a simple model to build and test; but could use some of the same equations in part.

They ended the experiment by slowing the inner band's velocity to a stop when it exactly aligned with the splice mechanism sites, and disconnected the pieces, flying their inflated aircraft up over the mountaintop above the tunnel while the tiny tubing was wound back up on its reel.

The next day, John was chattering about how the engineers up in the Clarke belt were having all the fun these days. The folks up there were planning on building a loop similar to the one they had just tested here, except that it would be strung along the earth side of the Clarke belt ring of cities, and the solid armature inside the tubing would have equal mass as the tubing in which it slid on maglev tracks. The cross-

section was only a millimeter, but the circumference of the thing was immense, that of the orbit of GEO. They then were going to speed up the armature inside the tubing, while slowing down the tubing itself. The goal was to have the outer tubing slow to a full stop in space, while the inner band was going at twice the orbital velocity there in GEO; this would prove out the KESTS basic support concept, different than a SolidKESTS which had no outer protective sleeving lined with force-coupling maglev tracks.

They were fairly certain that it would all work, and it would check out the maglev track system and the links to the inner moving armature part of the big hoop.

Then the next test was to build such an enclosed SolidKESTS armature band inside tubing, anchored at a fairly elaborate site on the Clarke Belt City Ring that was above the earth opposite to the Ecuadorean site, the same location as was the terminal when the now-destroyed KESTS was delivering a million people a day up here. But this time, the anchor terminal would be up here, and also they were going to test out ways to shrink the perimeter of the tube and the inner armature, as the armature passed through the GEO anchor site, high velocity cut-and-splice.

That was going to be quite a feat, if they could do it. If so, the perimeter could hopefully be gradually shrunk until a mix of armature speed and overall perimeter would drop the lower end of the structure to graze the far side of the planet, getting somewhat close to where John and Donna were at now. Now that was starting to look interesting to folks eager to get back home again, way down there.

All this conceptual modeling of kinetically supported structures had been working in John's subconscious, until one morning he awoke with an idea for another possible way out of this mess. Linking in via the Holoterminal presence

conferencing, he found that a half dozen of the original inflated steel towers were still standing, which were the links around the planet for much of the transportation to the Cayembe Peak Earth surface terminal of the KESTS. One of the remaining towers was in Brazil, east of Cayembe. John's question to the folks up in the Clarke Belt was this: since most of the people would need to use such a circular KESTS connecting the top of the inflated steel towers to get closer to their destinations, why bother having people go down to the tunnel site? Could the KESTS to GEO, have its low point at one of those towers, 15 miles above the ground? Guy wires could anchor the tower to brace for the thrust of the accelerator there, coupling the push down to the Earth's mass that way. It would be a whole lot more efficient transportation overall, for people going to other continents, especially; merely transferring to the re-built circular KESTS linking the 15 mile high tops of the pressure-supported steel tower elevator structures. And that would save having to build the KESTS to GEO to endure the lower 15 miles of the atmosphere, much lower lateral wind loads to be able to compensate. And if they connected to the still standing tower in Brazil, it would be within flying range for he and Donna.

Chapter 14 Only Ecuador's tunnel enough

However, the decision was that a full sized KESTS will need to be as big as the one that failed, and such a structure needs a massively solid anchor site like in a mountain tunnel; there was no way to create such a massively solid place atop a 15 mile high inflated steel tower, since the towers were pushing the limits of ability for such a structure just barely supporting their own weight and its elevator loads. But they might consider the possibility of a tower being built to intersect the KESTS where it passed the 15 mile high altitude level, the tower also being part of the Earth-girdling CircularKESTS linking all the continents around the equator, as before. Then people might get on and off the KESTS there, and head directly along the circular KESTS to the tower on the continent closest to their home.

Getting the eventual larger design better integrated in advance, things to work toward, even though now it all still seems nearly impossible. Well, not long ago it was just plain "impossible," so things seem improved a bit now.

Right now, real life was mere living in a tunnel behind a tunnel, amid the hum of old maintenance and control equipment intended for use on things long gone, and surrounded outside by a radioactive wasteland, and more biological wasteland beyond that, an almost lifeless world now slowly being jump-started into as best a diverse biological balance as possible by the ingenuity of the Environmental Scientists and Engineers, largely using the species which they had been able to acquire living samples of, or just DNA of those already expiring back in the environmental collapse years. And meanwhile, somehow re-create a KESTS to GEO or some other means for the billions now trapped up in GEO, to safely get back down to their homes around the world, if and when the world could again

support them. John and Donna, and a handfull of armature segments and fragments of shattered maglev track, was what they now actually had here. Could they really get there from here? Sometimes it was just best to go to bed and sleep on it.

But the next morning, things still looked dismal. They recalled their time in the lunar manufacturing management lounge facilities as being much better than life here. How could life be better on the far side of the Moon, than be down here on Earth, their homeland of eons past? It wasn't their fault that the world was in such a mess out there; it was other people who had done that in their ignorance, greed, and sometimes just efforts to survive day by day, not having access to the Big Picture of what was happening in the aggregate of all their daily doings, big and small. It wasn't John and Donna's fault that caused their fate here ... well, Donna had almost played a big part in it; but a lot of luck and John's skill had prevented that and saved her life too. So maybe it was part of human nature; and the measure of human nature would prove out, in how well human civilization pulled this one off.

Keeping track of the news of what was going on up in the Clarke Belt Cities, the Holoterminal showed in endless available detail how people were getting antsy, now that a few people had gotten back down on the ground. People were planning on using the re-entry ablation fireball technique to get back home; that the billions of such vehicles needed for the whole population would create a dust blanket on the earth that would ruin the environment once again, not to mention there was no way enough resource material up there to build all those vehicles. There even was talk of using some of the as-yet unpopulated pre-built Stanford Torus cities as a kind of huge re-entry vehicle, de-orbiting and then using its massive sawdust-reinforced water-ice outer passive radiation shield as ablation material lasting until it slowed enough to enable the 10,000 people it carried to escape

safely before the huge thing crashed somewhere; the water-ice would not pollute the planet during the meteoric atmospheric entry. That the loss of even one of the rings of cities in GEO would make the whole ring of cities unstable, was not discussed by increasingly desperate people.

Something had to be done, to show some progress. There would have to be a SolidKESTS built here, like was built in Indonesia. Trouble was, two SolidKESTS would contact each other high in space, and how would they keep from destroying each other? Would they have to dismantle the one in Indonesia, and if so, what about the folks already down there? Could a regular type KESTS be built with its terminal at the Indonesian site? That had been decided against, is why John and Donna had been sent here, halfway around the world from the Indonesian terminal where they had been.

Finally it was decided to re-create the SolidKESTS from over here in Ecuador. which meant the one in Indonesia had to be dismantled. There were lots of powerful people in the Indonesian section of the ClarkeBelt Cities, and they were pulling strings to go down first, before it was dismantled. So compromises were made; it still was not quite livable outdoors down there, but they could use the gondolas to set down more of the domed tents, mini-farms and the number of people which it would support, and do so for one month; then it must stop, and progress made toward the longer range way. The gondolas would continue to bring water and fuel oil up the SolidKESTS at Indonesia, and taking down the tents and people and their gear. Lots were drawn among those who wanted to go down that way, people who believed that maybe no others would ever make it back down. So about 150 Indonesian people returned to Indonesia, and it would be hard for even that many to survive on the domed farm resources they were able to bring with them; but it was possible if they all cooperated.

During that month, the mechanisms were installed along the Clarke Belt hub system, halfway around the ring in GEO. When the 30 days were up, the gondolas were brought up to GEO and stayed there. Then they began to peel off a strand of the SolidKESTS ribbon as it passed through the GEO terminal, and the strand was sent along the series of guides which had been installed halfway around GEO, and when the leading edge arrived at its new terminal site in GEO, it was mated instantly with a re-entry guide craft, an improved vehicle from the one which had started the Indonesian structure; the rocket propelled acceleration of this vehicle precisely timed to reach the GEO terminal when the leading edge of the first strand arrived, so as to be there to mate together at 10 km/s. Their technology was getting better with practice, and they did it.

Anyone in the Holoterminal consciousness system could be the pilot, and they gave the honor to Donna this time, with John as co-pilot, since they had done it the first time; and although all that experience was stored in the HoloPresence complex, these two had been there and done that. So while they were physically in the tunnel complex deep inside the Andes mountains in Ecuador, the two had their consciousness ride and fly the sturdy arrow down around from GEO terminal in a great curving arc toward the Earth, slamming through the atmosphere in a meteoric streak as the leading edge of the carbon fiber strand, barreled through the big tunnel at Cayembe, even through the maglev pillow block bearings and mini-accelerator in their alignment, and with the load of the pulled strand taken off them by the energy input by the little accelerator in the tunnel, they fired their ablation material in back to use their fireball to slam them upward through the atmosphere again, and then coast up and up and arcing around the planet to be pulled into final alignment as they went through the GEO terminal, where their strand linked up with the beginnings of the next stand from the Indonesian structure was just starting through, then

the little arrow was grabbed and saved for the museum.

Having “been there and done that” before, did not reduce the stress on the pilots doing it once again. Sitting back from their Holoterminal, they luxuriated in a few seconds of adrenalin-laced amazement that it was done again; then they went into a de-stress routine, eventually ending up back snuggled together in bed, resting from a day's work well done.

Chapter 15 SolidKESTS through Cayembe

First thing the next morning, they checked how well went the effort to provide a little separation between the temporarily co-existing SolidKESTS hoops in the Earth's equatorial plane. The shifts from the pushes and pulls of varying wind loads on the structure along their path within the Earth's atmosphere, as well as distant gravitational forces from the Sun and Moon, all shifted the structure's position yet were fairly predictable. And the structures were really thin, a few centimeters wide, did not have to miss each other by much to stay intact. The two tunnels on the ground were neither absolutely on the equator, too. All they had to worry about was the sway, but being tiny girth they did not need to miss each other by much. It appeared that they were missing each other, or the larger Indonesian hoop would have wiped out the fledgling Ecuadorean hoop by now.

It took about two weeks for all the original SolidKESTS fibers to be skimmed off as they passed through the GEO terminal, then be bypassed halfway around the Clarke Belt orbit, then get re-wound onto the growing SolidKESTS being re-created but now going through the tunnel at the site of the original KESTS to GEO. During that time, John had the sweeper robots finish clearing out the floor of the tunnel, going through the debris and saving out potentially refurbishable Sliding Armature Segments of the three sizes, along with the maglev track scraps for possible use as easier material for re-creation of maglev tracks, assuming they could figure out exactly how it was all made, way back when. So, visible progress was being made. Soon, gondola transport would be re-established between the Clarke Belt City ring and the Earth's surface, like it had been before in Indonesia. But coming down to this place was no improvement in life potentials, this radioactive desolation. It thus was not a solution; but hopefully would lead to a

solution. How could they use the SolidKESTS to build a real KESTS to GEO? Surely it ought to be useful as a support for a seed KESTS from which to scale up to full functionality girth.

Yet by its nature, the SolidKESTS was always on the move. Maybe they could make a small girth maglev track, like was on the original KESTS's every tube, all around the speedy SolidKESTS, yet the maglev track being anchored to the Earth surface here; the SolidKESTS would be speeded up to provide an outward centrifugal force upward against the maglev track mass sufficient to balance the force of gravity on the unmoving maglev track. If that worked, go from there.

One problem is that the SolidKESTS rotated around only one direction, so it did not have upward moving armatures on both of its sides, to provide variable upward drag to do servopositioning all around the hoop. Could a structure be made such that the part that was anchored to the ground, and held tracks for the spacecraft to go up and down, sit only on the upward-moving side of the SolidKESTS? The downward side of the high velocity continuous armature band then would go unrestrained back around and down; it would make for a very lopsided-looking structure, and there would be much higher tension loads on the downward part of the armature bands, but could it be made to work? A big enough girth on the fixed part under the upward-moving part of the armature, could possibly enable two-way traffic, not needing the two sides of the overall KESTS. That way, they would not need to laterally couple the two contra-rotating armature bands via maglev tracks everywhere. Something to think about, they all decided for now. To use the gondolas over in the new position of the SolidKESTS, the gondolas had to be moved the 125,000 km halfway around the circumference of the Clarke Belt City ring. There were no internal corridors big enough for a gondola, and besides, disrupting the lives of those in the hundreds of thousands of cities along the way, by

trundling the dozen gondolas through their hubways, would take months and surely would find obstacles including people gripes. So they designed, and had the Mars Project lab build, a small rocket engined tug. Attached to the first gondola at the terminal above Ecuador in GEO, the little tug decelerated the first gondola using its oxygen-hydrogen rocket motor, and the gondola dropped to a lower orbit while the the GEO ring of cities slowly spun past; then as the new terminal approached, the rocket motor reversed direction, re-accelerated the gondola, coming up and with some jiggling about got the gondola docked where it could attach to the SolidKESTS which now connected down to the Cayembe tunnel. Then the little tug headed on around GEO by a similar maneuver, and awaited until the old GEO terminal again approached, and went to get the next gondola.

The test run of the first gondola down to the Cayembe Peak tunnel in Ecuador proceeded as if this was old stuff. It carried a token payload of food and water, along with another Holoterminal and cans of HoloPaint. John put half of their collection of armature segments in the gondola, along with shards of the original maglev track material, and sent the gondola on its way back up, with their apologies that they had no ocean water nor oil tanker's hydrocarbons to give in return from this location. They pointed out that they were being nice by not sending up some of their surrounding environment, radioactive desolation stuff. The next gondola load that came down was filled with accelerator equipment and maglev pillow blocks. And it carried a request: have the robots stuff as much of that radioactive crud as possible, into the cargo hold; they were going to do an experiment by putting it all into the local Clarke Belt City's total-recycler, which would sort it all out into basic elements including the radioactive components; that total-recycler was being modified to do the very precise separation of those maverick substances.

Chapter 16 Cleaning the radioactive mess

They complied with the request for some of the radioactive dirt surrounding the tunnel, and did it one better: They packaged it up in small samples, labeling each as to location and depth to which the sample was taken. After that gondola load of dirt samples was processed by the total recycler, the data was interesting, even though the processing took a lot longer than necessary as all traces of each sample had to clear the processing system of the ancient-type mass-spectrometer built in giga-proportions before the next bag of dirt went in for being totally decomposed into its component elements. They found that the scientists were able to model the nuclear blast that had destroyed the terminal and its surrounding area; this showed that the peak itself had shielded the west end of the tunnel and that side of the mountain area. Worst ravaged was the area to the east of the Cayembe tunnel which included the airstrip and the town of Cayembe a bit to the north. Demolished was essentially all of the developed area around the Earth terminal of the once greatest port facilities built by mankind, itself located in what had been a very inaccessible part of the planet.

So the good news was that facilities could be built out from the tunnel's west opening. This was not a very hospitable area, steeper than the eastern slope; but yet an area which conceivably could be built up before having to wait for ways to cope with the nuked mess on the other side. Their rectenna net had been placed out from that end; so they requested that more rectenna materials be delivered by gondola, along with vertical supports that matched the profile of the steep curved terrain out to the west of the tunnel's westward opening. And after that, they requested a Holopresence-driven electric bulldozer-backhoe with enough cable to range around that rectenna which would power it, clearing flat areas for

construction of facilities outside the tunnel. And the gondola delivery after that needed to have the makings of an outdoor tent structure and associated farm, double-domed inflatable mostly transparent tent structures so as to insulate from the severe cold weather and storms that sometimes happened.

Donna had been exploring the utility tunnel complex which she found extended beyond what was “Painted” back then, finding that a direct access tunnel had been built by one of the businesses located in the terminal tunnel's vast shopping mall area, near the west end of the tunnel. This access tunnel led to a flat area on the west slope of Cayembe Peak, which apparently had been the company's own helicopter landing pad. The tunnel had angled quite a way from the main tunnel so as to locate the landing pad as far as possible from the KESTS that extended through the tunnel. The helicopter landing pad thus had been located in a somewhat sheltered ravine. Although there were no structures built there, a full set of utilities extended through the access tunnel out to the pad, apparently to supply electric power, communications, water and sewage removal from what must have been executive flying mobile home type helicopters that had berthed there. To John and Donna, this looked like a fine place to build some structures external to the tunnel. Especially since as far as they knew, there were no remaining functional executive helicopters flying around anymore, that would need to land there anytime soon.

Since the gondola could only deliver to the tunnel, John and Donna had to manually lug the prefab domed tent structures all the way down the special access tunnel, and out onto the former executive helicopter landing pad. Even using hand trucks this was quite a job. John drew up fabrication instructions for building connections between the domed tent complex that would connect to the kind of fittings that had been supplied to service the huge helicopter. Meantime John kluged connection for electric power; then using the

electricity to power the inflation pumps and internal lights, heaters, and similar amenities. It had been inflated and heated by the next afternoon; they toted their basic stuff into it and spent their first night outside of the tunnel since arriving back down at Cayembe.

Meanwhile, the gondolas going up had been carrying their payload capacity of radioactive mess scooped from the eastern area beyond the tunnel's other opening. The original depth profile mapping of radioactive content showed that three centimeters of dirt would dig below any significant radioactive material there, and so a small space was being gradually cleaned outside of that end of the tunnel too, a slow process, that ultimately would need to get into full swing when a true KESTS was again built there. The little electric bulldozer-backhoe had finished its initial task of clearing construction space out near the west tunnel entrance, and so was put to the task of scraping radioactive dirt for the gondola trips back up to GEO, and in between then was used to scrape the land off down to the mapped necessary depth to clear radioactive debris, scooping it down into a gully area where the radiation would be blocked from direct view of the areas around the east tunnel entrance, there to await much more capable lift someday up to the solar-powered total-recyclers up in GEO. This began to drop the exposure rate outside the east tunnel entrance, off a bit toward where had been the original vast port city's facilities outside the tunnel itself.

Meanwhile, billions of people up in the Clarke Belt Cities spent much of their recreational time using the Holoterminal system to be in virtual attendance of much of the activities down there in Ecuador. And like in Indonesia, some efforts to pull strings to get to go down to the ground ASAP were going on up there. However, such private aspirations had long ago been automatically integrated into the governance of the vast HoloPresence-accessed city facilities, and

maintained a rational and compassionate action result. There were now two areas for people to live outdoors, besides the former helicopter landing pad now used by John, Donna, and their little farm creatures.

So not only the descending gondolas, but also a series of more of the large re-entry type landing systems went into action, and soon there were lots of people living and working there, including a half dozen armed military personnel who had come down in the re-entry ablation, double-form glider morphed into a solar powered inflated aircraft of neutral buoyancy, which were somewhat armor-plated on their underside. In these “military" aircraft, pairs of the military personnel would make frequent sorties out into the surrounding terrain as far as they could range, recording what they saw, and especially looked for signs of any recent life out there. Eventually they were returning looking as haggard as soldiers having come back from combat, having essentially found a dead planet out there as far as they could see. The dream world to which they had all imagined they would be returning to, did not exist; that they could find.

The decades of delays caused by the greed of the guys who had for awhile “owned the world” through their treachery, had allowed far more extensive collapse of the world ecosystem than the original plan for jump-starting the world ecosystem had been prepared to do. The Environmental Engineers had now been able to essentially set the biological matrix worldwide to a stable state, and had seeded patches of the complex of micro-fauna & -flora in places reachable from the Indonesian port when it was in operation; but that was halfway around the world. None had arrived here in the winds yet.

Freed of fears of being raided by survivors from the past here, ever guarded anyway by the military personnel, an area well off to the side of the east tunnel entrance was cleared of

radioactive stuff, and boxes of biological material suitable for life up here in the rugged high Andes mountain environment, were set in place by the first team of Environmental Engineers who had arrived along with the soldiers. The highest life form among those microbeings was Quinoa seed, which if it all took hold, would be a usable crop. But it was “a long row to hoe” for all the microfauna and flora, and the folks who were carefully tending them, ever tracking their progress at all levels of the biological food chain.

Although the vast international traffic through this transportation hub had been almost entirely serviced by the inflated steel towers and earth-girdling circular KESTS 15 miles up, there also had been minor access by helicopters, conventional aircraft, and wheeled vehicles.

Roads still existed that wound down to the rest of the world from here. A pair of wheeled hydrogen-electric mini-vehicles were delivered down from GEO; the rectennas supplied the energy to hydrolyze melted snow, the hydrogen collected and compressed to power the little enclosed cars which began to be used to explore down the roads. Winds limited the safe range of the solar powered inflated aircraft's explorations from here, so the little cars could hug the ground as they slowly cruised the roadways, equipped with small bulldozer-like blades in front to clear debris from the road first time through.

It was on one such exploration trip that Donna spotted what she thought looked like green vegetation off in a canyon across which the road passed. John got his binoculars out and agreed, it looked like there was life stuff over there. They were far away from the Cayembe peak disaster area, about at the end of the range of the hydrogen-powered cars, so they got out and hiked in their environmental suits over to where they could get a better glimpse of the greener area in the

little valley. There appeared to be a large quinoa field there, nestled below the harsh winter winds. And there appeared to be several primitive dwellings that had some animals there, alpacas. No sign of people; but after adjusting his binoculars for telescopic function, attached to a stable tripod, examining the huts over there, he could see what appeared to be eyes looking in their direction.

Realizing that in their environmental suits they probably looked like alien invaders from some other world, they used their helmet Holoterminals to get historians involved from up in the Clarke Belt Cities. Word of the discovery flashed through the Cities up there, and within minutes a billion virtual observers were there with them, along with more expert advise than they wanted right now. What were they carrying that might be left as an offering understandable by these people? Donna related the contents of their daypacks; moments later they were advised to leave one of their lunch sacks and utensil kits, after raising it high in the air so it could be seen, then slowly lowering it down and placing it on the ground; then turning their backs, retracing their steps back to their car.

The next gondola down carried a crew who could speak the native language of the native people of the area, along with one who considered herself an expert at “first contact” procedures. After a couple days of preparation and acclimation to the environment, the team took both cars and headed down the road, hoping to make contact. Of course, via the helmet Holoterminals they wore, billions of other people were virtually accompanying them. Millions of advise messages piled in, as these first contact folks made their way down the road to the valley where the huts had been seen by Donna and John a week before.

The four-person team made their way along the route taken by John and Donna, to where the lunch pack had been left,

and it was no longer there. Still no people in sight, and the alpacas were not visible either. The lead person took her helmet off, having oxygenated as much as possible first, and while holding high what clearly were more of the food and utensil kits in her hands, she slowly approached one of the huts.

She set the gifts down in front of the hut, then returned to where the other team members were waiting. They sat down there, in plain sight, obviously waiting. Finally an old man came out of the hut, clothed in woven finery, and stood by the pile of gifts, but did not pick them up, just stood there and looked at the strangers. The lead person took her helmet off again and walked slowly back to the hut, carrying a couple more lunch kits, to stand before the old man. She struggled to speak a greeting in the native language known to be in the area. And was greeted in return.

This was not first-contact with some alien species from a far away planet; but in some ways it was similar in action. She offered the lunch packets directly to the old man; he held his ground and accepted them, and went inside with them. Soon he returned to get the other food packets and take them inside.

Awhile later he came out and brought with him a small alpaca lamb, and offered it to the visitor, apparently in exchange for the gifts. She gave the lamb back, realizing how few must be the resources of the people here. She covertly did get a DNA sample, however; before giving it back. Soon conversation was going on. The little family had always lived here, and had found it increasingly difficult to get things to grow; but they were familiar with the harsh environment here and were able to keep this little valley alive. But they were all starving slowly; it had been hard to keep from eating too much of the quinoa and alpaca, yet they had long known of the necessary balance among living

things, and had made almost a science of it. This was of great interest to the Environmental Engineers, and soon a trading system was established which provided immediate sustenance for these people and their farmland. In exchange, they asked for help in making this kind of farmland grow beyond this little valley. It looked like a good deal for all concerned, and so an unexpected kind of life outpost was established and expanded as rapidly as possible, something positive happening in this wasteland.

Chapter 17 Andean mountain folk

Asking about what was in the other two huts in the group, the old man led them over and introduced the visitors to the little families in each of the other huts. The last one just had a young woman and a small child; they looked just as emaciated as the other folks in the huts, except the young woman was too weak to get up. The team dug out their own lunch kits brought for the trip and gave it to her; she looked at the strange things but the old man showed her how to open one of the packages, and even demonstrated how to use the spork with it. Soon the woman was greedily eating the food, then getting her child to eat some too. But they seemed almost too weak to even eat.

Asking for a speck of saliva sample from the two, putting it into the sample tray of one of their helmet Holoterminals, analysis came back almost instantly from the doctors up in the Clarke Belt. Starvation had progressed so far that it was not likely they could survive on their own; and an airborne infection had set in too. The young woman would not be alive for another week.

The team gathered together outside the hut, and discussed the findings with the old man, the leader of this little surviving extended family. He agreed that it seemed likely too; they had lost most of their members already in a similar progression of starvation to the end. Without another word, the lead interpreter unzipped her environmental suit, removed her helmet, and carried it into the hut. Even gasping in the air, she asked for one of the cloths the native folk used when going outside to cover their mouth to breath, the young lady in the hut gave the cloth to her, a bit wide-eyed at the change in appearance of the visitor. With some explanation, the ill woman was persuaded to don the environmental suit

and helmet. Advising that the suit and helmet be left on as much time as possible, the “first contact” team hastily made their way back to their vehicles parked out on the road, and returned as fast as the machines would go back to the Cayembe outpost, with one of their members gasping through the cloth and suffering from the cold.

As all Holoterminals are ever in contact with each other, data was coming in fast from the suit sensors which had been left to clothe the sick woman. The suit had been automatically providing first aid, which had already wiped out the pathogen causing the sickness and was providing a minor balancing of many of the internal organs, reflex action of the suit to protect the person wearing it. The nutrition from the lunch kits was starting to be assimilated; the dysbiosis self-digestion stopped and a slow rebuilding began.

The returning team got chided at the loss of an environmental suit; there were no spares, and everybody had their own suit. So the interpreter who had donated her environmental suit had to remain inside the pressurized tent where she lived with the other “first contact” team, awaiting a new suit when the next gondola came down, along with a large supply of food and water for their new friends. Meanwhile, the three remaining team members quietly returned with the empty seat piled high with food rations to the little settlement, leaving them outside the three huts, and silently returned to their cars, avoiding having to be offered gifts in return from those who had so little. Besides, they were missing the one person who was able to talk in the language of these Andean mountain folk.

Actually, their interpreter was still busy at it. She spent her time in a Holoterminal, listening in on the helmet sounds from the suit which she left in the tiny village. She could also monitor the vital signs of the person wearing the suit; she watched for several days as the young Andean woman's vital

signs began a climb to acceptable values, and then observed the woman was actually up and walking around at times. Her little boy was improving too, having plenty of food for a change, but he still had the bad cough from the infection. The next day she observed very strange vital signs in the suit, then realized that the suit had been put on the little boy; the suit had done its automatic electronic first-aid thing and already the boy's cough was much better. But by the next day the environmental suit was back on his mother, who clearly realized that the boy's survival depended on her ability to survive and provide for him. There was occasional conversation finally going on now that they were feeling better enough to chat, and this gave the interpreter, in the Holoterminal, more practice at the nearly forgotten language. She recorded the sounds and attached her best guess as to what was being said, and from that growing set of recordings, she gradually improved her own pronunciation, she hoped.

It was two weeks before a replacement environmental suit was fabricated up in the Clarke Belt City ring and delivered by the next gondola downward trip. By then, the gifted environmental suit had gotten worn by two more sick adults for a few days at a time, until vital signs were clearly showing the infections were going away and vital signs on the upswing, largely because of the fresh supply of nutrition given them. Overheard conversation from the associated helmet indicated the others were unwilling to wear the suit, saying it was too foreign, and anyway they were getting better on their own. “First contact” had gone well, so far; and so there were now ten more human survivors known on the planet, and potential helpers some day.

The DNA samples from the alpaca lamb, young woman and her son, had been sent up on a gondola and had been eagerly received by the scientists in the vast Clarke belt City ring, many of whom had been long ready to begin using the

growth chambers that would be used in the attempts to bring back much of the vast diverse spectra of lifeforms that had once populated the planet they now circled. The scientists duplicated the DNA into stem cells for archival storage. And eager to get going on use of the growth chamber usage, to get some real-time experience, they decided to use the specimens they already had out, namely from the three which had come up from the little Andean village. They split the lamb's up into a hundred copies; the gestation processes could not be speeded up, so a big head start was advisable. And they also set in gestation one each of the two humans to see if it would work for them too; and if it did, what they could learn would be invaluable for the future; and if fully viable, two more added members would help the little tribe that had dwindled to a mere ten at present. They would take 9 months before “birth” and by then they would have had practice with the ones born earlier from the alpaca's nuclear and mitochrondial DNA.

Several of the previously never-occupied Clarke Belt Cities were in process of being set up for use as massive labs and farms, to be ready to produce the starters for life down below once again. The gestating alpacas and two humans were a featured high point of the facilities there, and were virtually visited every day by millions of well-wishers among those in the Clarke Belt, as well as the teams down on the ground.

It was actually beginning to look like the restoration might really happen. Even if only the present SolidKESTS were the only means of two-way transportation, in time a lot of creatures, people and equipment could be delivered down to the planet, perhaps to provide at least a localized balanced ecosystem that might then in time expand throughout the planet. But the hopes were now high for most of the people to get back down there to their homes once again.

The gondola usage was now going at maximum, trading

radiation-polluted topsoil from the eastward area around the tunnel, for foodstuffs, domed tents, light manufacturing equipment, and generally that which would be needed in case they were cut off from supply from the Clarke Belt Cities high above them. When they had demonstrated a balance between internal input and output for two weeks on the ground, the gondola was removed from the SolidKESTS.

A continuous half-shell tubing was then begun to be lowered down along the upcoming side of the SolidKESTS ribbon. This tubing included maglev tracks of the type which they had best derived from the fragments of the former KESTS' maglev tracking. However, it also had telemetered gravitational load sensors built in, and remotely controllable electrodynamic drag inductive brakes all along the tubing, so that upward energy from the high velocity ribbon was used to directly support the weight of the tubing. The SPS in GEO upped its energy beamed down to the rectenna at the Cayembe accelerator site, energy that was then input to the SolidKESTS to replace the energy used to support the weight of the tubing. They had gotten the tubing lowered three-fourths of the way down by the time the system parameters approached the limits for energy input and tolerable distortion of the overall hoop shape. So they slowly pulled the tubing back up into GEO, real-world data galore having been acquired during the experiment.

Changing the tubing tensile structural material to carbon nanotube fiber, they produced tubing that looked better than what had been used on the original KESTS. Again they lowered this new half-shell tubing down the upward-moving SolidKESTS, and this time made it to the ground. This new tubing also carried two other sets of km-sec high velocity maglev tracks in it, one within a laterally coupled tubing half shell, currently unused, and the other in the middle on the outside of the double-half-shell tubing. The overall shape of the hoop was quite distended on the downward side, having

no load to balance the shape, but of course it would not be able to support a dynamic-braking-coupled load since it was heading downward.

They then began to lower another pair of half-shell laterally coupled tubes, one of then supported by sliding on the downward high velocity armature mass stream's coupling to the maglev track on this new tubing. As they did so, they remotely disconnected the dynamic braking along the same altitude tubing section on the upward-moving side of the high velocity armature ribbon. balancing the forces in the equatorial plane. When the two sides were completely deployed and bonded together inside the Cayembe tunnel, all the dynamic braking was now unused, and the tubing hoop was entirely supported by the outward centrifugal force of the internal high velocity ribbon, which had been speeded up so as to have enough supra-orbital velocity to generate the excess outward centrifugal force to balance the weight of the tubing.

Then the next tricky part was started, that of starting a fiber along the empty side of the pair of tubes. Initially it did not need to go any faster than necessary to enable the high velocity maglev inductive tracks to function, making it a bit easier as it went down in a contra-rotating direction with respect to the initial high velocity armature ribbon. When this fiber reached the tunnel, it used dynamic braking against the upward-moving ribbon's field to haul it up. The fiber, having eventually reached back up to the terminal in GEO and welded to its other end there to form a complete loop, was then accelerated at both the GEO terminal and at the Cayembe tunnel second set of accelerators, and soon the new fiber was going at full speed.

Once again the SolidKESTS girth was scaled up as the other one had been done, strand by strand, until its ribbon girth was the same as the first SolidKESTS's. Now the full

structure was balanced with contra-rotating continuous armatures. Since the velocity was necessarily the same everywhere, it was an odd shaped hoop, as compared to that of the discontinuous-armature original KESTS technology, but it was still supporting the tubing connecting the Clarke Belt City ring once again to the solid earth. In its way, it was indeed a KESTS structure once again.

They then re-attached the gondola which had its maglev track and dynamic braking inductive coupler to just access the upward moving side of the pair of high velocity internal SolidKESTS within the structure, and down it went. When it arrived at the Cayembe tunnel terminal, it was opened to find merely a handwritten note, saying “Welcome to the new KESTS transportation structure's gondola. Anybody want a ride back up?”

Chapter 18 Groking the task

Up in GEO, the little rocket propelled robot tug was sent around the GEO ring to the former GEO terminal site, to bring over the remaining gondolas one by one. As the gondolas arrived at the new GEO terminal, they were modified to ride the new type of KESTS maglev tracks; and now one side of the KESTS hoop could be used for downward gondolas, while the other side for upward moving gondolas. No longer having to wait for a round trip to re-use a gondola, the materials throughput increased enormously.

Now that it was proven, the modified KESTS structure was used to send down the components for a more spatially efficient set of armature accelerators. These were of a new type that stretched almost the full length of the Cayembe tunnel floor, and the diameter of each accelerator set was the same as that of the associated tubing; that was why it had to be so long, to provide the same energy input despite much smaller girth. These new sets of accelerators were placed across ten meters of floor of the tunnel; the next scale up of the KESTS was going to add serious carrying capacity to the transportation system, they hoped. Not nearly enough to do the main task, but one which would allow large scale construction of the support area around the terminal, and carry down the makings for a 15 mile high inflated steel tower to replace the one which had been there before.

There were still three of the original 15 mile high inflated steel elevator towers still standing around the world, enough to stabilize a replacement CircularKESTS located 15 miles above the surface along the equatorial plane, as it had been before. A replacement tower built here at Cayembe would restore the access to such a hoop around the planet, along which gondolas would carry people and goods back to a closest home tower, down which they would descend to the

ground, and make their way back home on the ground from there. All of a sudden, the 7 billion people in the Clarke Belt Cities started thinking of actually packing up and heading for their homes down there.

The tourist inflated aircraft virtual visits had found that 15 years of being empty, had not done well for many homes and buildings down there. 15 years of severe storms had wreaked havoc across many coastal areas, wiping out many areas completely. Millions of people no longer had homes to return to. Of course, other millions who never had much of a home down there, still had none to return to either. Homelessness was not a problem up in the Clarke Belt Cities; and a surprising number chose to remain even once there was opportunity to really return down there.

Yet even with an improved KESTS to GEO about to be re-created, there was much to do before people could return to their long-abandoned homes. The atmosphere itself was barely breathable down there, for example. The Environmental Engineers were finally getting to go into full swing, a project delayed by 15 years in which far more degradation of the world environment than had been anticipated, had occurred. Plantings of boxes of sets of organisms had now been set in place around Cayembe and at the former SolidKESTS terminal in Indonesia, and the spread of these seed systems was being monitored by the scientists. It was progressing slower than they had hoped, but was spreading; and the data about which organisms were getting going was very useful data, which showed the spacing of seed boxes and the composition of organisms needed. Even some hardy desert plants were beginning to grow. And the Andean mountain natives had shown that the ancient grain quinoa, the mother corn it was said, and a fine grain for livestock and people alike, could still be cultivated; the scientists asked for soil samples from the fields in which the Andean Ecuadoreans were growing it in now.

The project seemed to be going smoothly as could be expected; and so John spent time bringing the loose ends together somewhat. Donna was watching what John was doing, it was something different and had her curiosity. John had told her that he was paying bills. The project had to have at least as much income as what it cost to do. The cost is a measure of what it takes to provide something to someone else. She could understand the cost of processing 25 tons of radioactive soil, and receiving back the value of the purified elements that were produced thereby. But she was having some trouble with others, such as the charge from the environmental suit manufacturers for the suit left at the Ecuadorean village that had been used to perform electronic first aid to four severely ill people, who were now fully recovered from their illnesses and benefiting from the various optimizing of internal biology by the suit. There was a charge on the suit bill, one for each of the people which had been helped by wearing the loaned environmental suit. “How can they charge for helping save the lives of those poor folks in the village? They were suffering because of humanity's mess of the planet, not their fault; and besides, surely their help with agriculture will greatly speed up the reconditioning of at least the parts of the planet that are like up here, which is a lot of it by now, desolation everywhere. And besides, the energy it took to do that healing and biological system balancing surely did not cost more than a few cents, and nothing got significantly worn out or needed replacement. Yet we got charged hundreds of dollars apiece for each of those helped native folks."

John put the accounting setup into pause mode and leaned back, facing Donna; this was something not easy to explain. “Donna, the tradition for charging to heal others goes way back. The 'Big Picture' is not consulted, which would show that the healthier people are, the better they produce, and then more that is then available for the whole system to

function much better than before. The tradition goes back especially when some people took up the study of medicine because they believed it was a gift for them to give others, and would be admired and freely financially well rewarded by the beneficiaries of their medical healing of others.

But what they then found was that the world is a complex place. It includes some people who make a practice of suing doctors for malpractice, and thus receive huge reward for their complaints, much easier than working for a living, being clever that way. The doctor had done his best to heal the patient's complaints, but got sued as reward. The purpose of the person coming for a healing had not been to get healed, but to establish excuse to sue to get money to pay their rent and other bills. So the doctor has to pay a lot to buy malpractice insurance, to cover those costs which seem to have nothing to do with helping people be healthy, and instead basically to feed the crooks, a 'necessary evil' kind of thing.

Also the science of medicine then was often quite murky, supposedly supported by companies who hired scientists to make new medical products which then were sold to doctors and pharmacists who then sold them to patients. The doctor then needed to match up the patient's symptoms to the presumed functions of the medicines the companies had produced. It all became so complex that the government made efforts to moderate the whole thing, doing licensing of doctors and medicines, for example. And everything involved had murky aspects, from the patient's symptoms and their incredibly complex biological system changing every instant, to the doctor's memory of what had been learned in med school and from experience and articles read since then, to the medical chemicals which were produced by companies who were in it only to make money and not heal people, researched by scientists who did not want to work themselves out of their jobs, so the solutions that resulted

were beyond comprehension, so best-guesses was the rule of the times. Remember, that was back before the HoloPresence technology was invented, and so people had no way to grok the wholeness of things at a glance."

Donna replied they did not have the Holopresence technology where she grew up either, when she lived in the Harems of the BullMen, and in fact there were no doctors needed there either; anybody who got sick and was not getting well fast enough to get their duties done, simply went early to the digestion tanks; no need to heal anybody or have medicines.

"Well, that is not the way we do it here."'John replied, not immediately sure how to deal with that one. "People here are considered to be resources, not a person is to be wasted. When something breaks down, including people, it needs optimum repairing so it can get back doing its function in the Big Picture; and as I said, applies to people too.

And keeping things functioning optimum usually prevents them from breaking down anyway. There is an old saying that 'an ounce of prevention is worth a pound of cure' and that is standard practice here.

But back when doctors depended on a steady stream of sick and malfunctioning people, and the businesses providing the research and manufacturing of chemical medicines all depended on those dysfunctional people too; and to get them healthy enough to not need all that medicine nor doctoring would have put a huge number of people out of a job, and they were used to living quite well, and needed to keep the income source to stay about the same. Probably there was not much conscious decisions to make it that way; but surely everybody felt deep down that they needed to keep their job, their means of getting income so that they can pay their bills and live like they chose.

And that kind of thinking carried on into the system that evolved rather hurriedly up here in the Clarke Belt Cities, that everything had to be a vast system where each little part had to pay its way. The Holopresence system was able to prevent that consciousness from self-destructing when something vital to survival for all could not be provided because nothing was producing it for some reason or another. So the Holoterminal's enabling every individual to grok the wholeness pattern to see where their particular facet is and see what else is tied in throughout the allness, the missing parts are obvious in the Holoterminal display and nobody is so stupid as to let the gaps go unfilled, they want it all to work best possible. There are far too many real problems to deal with to let things dysfunction and not be usable when suddenly needing everything to work right, including the social system at that crisis."

Donna had paid attention for most of that explanation but somewhere along the way had gotten lost in thinking about what she was going to do tomorrow, the day's goal list forming in her mind, and had nothing to do with all this needless complexity.

Chapter 19 HoloPainting the place

The finances only needed to be done for the KESTS re-establishment project part of the system, John reflected thankfully. The KESTS project had large expenses, but little income so far. The majority of funds were coming from the funds set up for the relocation money set up at the beginning of the project to do a temporary exodus to GEO, then return. However, the return expenditure back then was expected to be the least of the expense areas, and so had only a little there for use, and much would still be needed for the return of people to their homes if and when the new KESTS was able to get them back down and close to home.

So far, income had come from the tourist trade via the operation of the tourist inflatable aircraft and virtual passengers; the water and fuel oil hydrocarbons brought up from their Indonesian SolidKESTS effort, and sale of some raw soil materials from the TotalRecycling of the radioactivity-contaminated topsoil around the Cayembe tunnel site. There also was a little income from the alpaca lambs purchased in advance by some pet owners up in GEO. But by far, the finances were more far more expenditures than incomes. It was decided to see if some income could be gotten from the fortuitous discovery of the little tribe of Ecuadorean native indians nearby, for the benefit of all of them.

Another visit was made to the little village, still limited to the crew that could be carried by the two little hydrogen fueled cars. This time, the interpreter was back among them, in her new environmental suit, plus one of their team now had been given a fast business training via the Holoterminal. All of the team now could understand and speak a few of the words in the language of the Ecuadorean natives, due to the knowledge accumulation by the interpreter and 'first contact'

expert among them. When the team arrived at the village, this time all came out to greet them. The team had brought more gifts of food, and once again they were offered in return an alpaca lamb. Returning the offered lamb, they began to practice communicating, picking up a few more words, and bringing the discussion of possibly conducting trade with these people. There were many reasons do do trade here, including some income from cloth items made of alpaca wool and maybe other native curios the wealthy up in the Clarke Belt Cities would be willing to purchase, and more importantly to get the help of these people in growing quinoa for far more people than just themselves.

The growing mutual vocabulary enabled the natives to understand that they were now considered a valuable resource potential for their knowledge of growing quinoa, their alpacas, and possible handicrafts made from the wool, the samples of the soil organism mix, and most of all for now, if they were willing, to grow far more of the quinoa than they themselves needed. In return, they were offered a wide variety of “trading goods” to see which ones they would be interested in acquiring in return, along with ratios of trading values, to be negotiated. The little village wanted to keep the environmental suit, so it was the first item to be negotiated; asking why they wanted it, they replied because it had magical healing powers very needed by the village members, but also that they had discovered the helmet had great entertainment value - the holistic religion of the tribe fit right into the operation of the small Holoterminal built into the helmet of the environmental suit, and they had been doing virtual exploration of the strange world they had found thereby. They also pointed out that they had similarly been observing the team's life at the Cayembe tunnel site; and then surprised the team when the little boy whose life had been saved by the environmental suit, spoke some English to them. So it looked like there was a market here for a few of the standard home Holoterminals of which there were

billions up in the Cities.

Discussion eventually turned to the requirements for expanding the quinoa cultivation. The quinoa had to have supplemental fertilizer, as the soil up here in the rugged mountains had little to support the growth of plants; the way the natives had gotten their little farmed area to grow was by both use of the alpaca fertilizer output spread carefully to the farmlands, but also it was essential for use of human urine to be saved and carefully doled out to the areas around each seedling's site to be. They could increase their acreage some with their “resources” of urine, but to do the great expansion requested, they would need to be given the urine from the people at the Cayembe site settlement. So part of the trade deal involved bringing large canisters of saved urine to the farmed areas.

When this information was received by the scientists up in the Clarke Belt City ring, the idea of using pathogen-cleared human urine as fertilizer for the soil they were in process of reviving, showed that it could speed up the re-growth process a thousand-fold, where it could be used. The sale of this concept cut the projected cost of the restoration of the earth's surface by hundreds of millions of dollars, and suddenly John had financial income far more than expenses, for the first time. He then ordered full sized holoterminals for each of the Ecuadorean's huts, along with the solar power cells to operate them, plus two environmental dome homes and a mini-farm dome, all to be given to the village folk, to see what they would do with them. When they were shown the new homes and Holoterminal equipment, and their uses explained, the hut which had contained two families had one of the families that was a bit more interested in the new weird things, to go live in the dome, which provided insulated warmth and electric power for some gadgets that seemed maybe useful to the Ecuadoreans. The trading activity was a good deal, both sides agreed. The soil for an

expanded farmland was immediately begun to be prepared for planting, and agreed to use much of their quinoa grain for seed for the next planting, in return for equivalent foodstuffs sent down from the Clarke Belt Cities.

Then a couple of the younger Ecuadorean men, now with their strength back, asked if the newcomers would like to go with them on a hunting trip, as they knew where there were some vegetables, herbs, berries and edible animals. And that turned out to become another farming project, where the Ecuadoreans would also encourage the growth of those plants and animals in return for food imported from the Clarke Belt Cities vast farms in the Cities, in return for one of the little cars to make the trip back and forth quicker for farming this new land area. A deal was a deal, and included specimen samples of the new agricultural products about to be expanded. Those soil, plant and animal specimens sent to the environmental scientists up in GEO, brought more knowledge about what could survive down here, and the organism mix in the soil that supported it all. And thus that knowledge brought John even more millions to spend on the KESTS project.

And the costs of the project were about to increase rapidly. It was decided to focus on building a new 15 mile high inflated tower there at the Cayembe peak site, and from there build a new SolidKESTS circular ring at that altitude ringing the planet in the equatorial plane, to enable efficient transportation to the locations where towers still stood from the former transportation system; one was in eastern Brazil, and two in Africa. The environmental engineers were eager to get busy reversing the destruction of what was remaining of the Brazillian jungles as well as those in Africa.

The fleet of floating “venetian blinds” circulating in the atmosphere had already lowered the average temperature of the planet by 1 degree, yet it was far to go before life could

be widely restored to the scorched planet. Since a major resource that the Clarke Belt Cities could deliver to the Earth surface easily in vast abundance was electrical power from Solar Power Satellites, whose huge antennas had been idle for the past 15 years. But what to do with the energy? Just beamed down would only raise the temperature, albeit a very small amount. So the environmental engineers had a re-entry drop of as big a machine as they could do, including a fairly hard splash landing of it off the coast. The device deployed itself as planned, and soon its unrolled rectenna floating atop the ocean was getting electrical power beamed down from GEO to run its pumps and sprayer at rated speed, a fountain that was spraying sea water high in the air, which evaporated before coming all the way back down; it was located upwind from the farmlands of the little Ecuadorean village people. The high mountain areas were still cold enough for snow to precipitate out of the air, and soon an abundance of snowfall was precipitating over the area, soon to melt and water things. Instrumentation aboard the little inflated robot aircraft gathered data on the whole process, models of the process were improved, and new projects were designed.

With essentially endless cheap electrical power that could be delivered to rectennas anywhere on the planet, the systems did not have to be particularly efficient, but just be able to do the unusual kind of tasks down there. The main expense was in the building of the re-entry type landers in the Mars Project's assembly facilities, which were running 24 hours a day already. The landers had to be self-deploying and maintaining, so they could only be used to do test evaluations of what could become much larger systems. One such was a lander that was put down at the base of the still standing tower on Brazil's equatorial coast. The lander unrolled the rectenna and began receiving power beamed from GEO, then deployed a louvered sunshade that reflected nearly all sunlight in the daytime, and opened up to the great heatsink of the dark night sky at night. Water precipitated out

of the air when the temperature got down low enough, even some of it froze by morning. And on the edges of this intelligent reflector, seeds of a specially engineered plant were sewn, watered by the precipitated water. This was a phototropic plant, engineered to amplify those properties, yet with coloration so it would have its leaves horizontal in the sunshine, then turn vertical at night, mimicking the mechanical version which sheltered it at first. Soon the plants were providing their own cooling enough to precipitate their own water, and they began to spread out away from the mechanical parent which had nurtured them to get started. When people arrived at the base of the tower there, they would find water and cool shelter waiting for them. Another rectenna was re-entry-dropped to the base of the tower, self-unrolled, which was connected with a power converter and enough hookup power cable to reach over to the base of the elevator tower.

John and Donna flew one of the original lander's inflatable aircraft across Ecuador to the east, on out across Ecuador along the equator, accompanied by two more of the inflatable aircraft each with two people and a variety of equipment. It was slow going, being just solar cell powered as they floated along for several days. Finally arriving at the base of the 15 mile high tower, they landed, John and Donna at the base of the tower where the rectenna and power converter lay, and the other two aircraft set down at the water and plant shade project, where camp was set up. John unrolled the power conductors over to the base of the tower, opened up the power panel there, hooked the power up and the huge Eastern Ecuador terminal sprang back into life. Hundreds of millions of people and their household belongings had passed through here during the 20 years of exodus to the Clarke Belt. and the terminal at the tower's base was almost a city itself. Highway, rail and sea had served this great terminal that led to space long ago; now it was intended to work in reverse.

The team methodically applied HoloPaint to just about everything. Nothing had been painted here with the original type Paint, so it was all new area being integrated into the vast HoloPresence system; and as fast as it got integrated, the engineers were on it in virtual presence. Guiding the hands of the ground team, system after system was brought back to life, and evaluated for what it could do, and what repair it would eventually need for the population's return from the Clarke Belt Cities. Finally the elevator system itself was energized, and up went John and Donna to the top. There they needed more than the usual environmental suits in the thin air, the original windowed embarkation area having been destroyed during the fall of the circular KESTS which had linked the whole equator of the planet with fast efficient transportation over the the tower which had served the original KESTS to GEO Space Carousel Escalator. But now the top was shattered ruin; they stayed there but a minute of gasping for breath, then they went back into the pressurized elevator car, and headed back down. It had been an incredible view from up there, yet even that brief look had shown a blighted landscape far below, once lush jungle galore.

Chapter 20 Watching plants grow

Although the great transportation terminal here was now back to life electrically, it was not back to life with the supplies it had used to serve the needs of tens of thousands of people who had coursed through here each day back in its heyday. The restaurants had no food nor wine, not even water now. The amount of water produced by their pilot project next to the tower could hardly have even begun to fill the water pipes in the vast terminal. As the terminal began to be de-mothballed back into partial running condition, the only things that could be brought back to life were the electrical things; the sandwich dispenser machines glowed brightly but had no sandwiches to dispense. But they had electrical power abundantly, beamed down from GEO. The air conditioning system labored to deal with the high temperatures outside and inside, beyond what they had been designed for, so only a few of them were operated, to cool down a relatively small area, and see how that went.

The team of six people gladly moved into the cooled area, bringing their food rations and plenty of water from the water plant nearby. They were used to the temperatures high in the Andes mountains in Ecuador, not the steamy equatorial heat of a planet gone roasted. The air conditioners pumped lots of water out of the cooled air, so even this water was useful; and they found a hose and ran it out to water an area next to the artificially watered area, where the plants could spread even faster now.

The shattered embarkation facility at the top of the tower was likely an example of what they would find at the other two towers still standing, over in Africa. They had brought along two sets of opened clamping maglev pillow blocks to be set near the edges of the upper terminal, and a small synchronous accelerator to be between them. The power and

control wiring at the top of the tower had been connected with massive conductors into sockets on the huge accelerator that had been up there when the original CircularKESTS had been jerked out during the destruction of the KESTS. Some of the connectors remained at the end of their conductors; others had gotten mangled and pulled off still with the sockets on the accelerator assembly when it went. So they would need to derive matching sockets for the ones that remained, and have both socket and plugs fabricated and brought here to replace the fully missing ones. It seemed wise to use connectors of size to be used on the fully functioning system in the future, even though for now just delivering a tiny fraction of the energy to the little re-accelerator that would be put up there for now.

And their environmental suits would need to be essentially spacesuits, at 15 mile altitude. Although there were plenty of spacesuits up in GEO facilities they could get, they were designed for hard vacuum zero-gee, and servicing facilities to match. They were heavy. So they decided to just have modified environmental suits made, thermally insulated and powered through small lightweight cords, and air compressors and filters supplying air into the normal space suit helmets, which they would wear, the collars modified to match. The virtually-present engineers were gathering this data along with the on site team; fabrication specs and test systems were being designed on the fly, up in the Clarke Belt Cities minute by minute.

John and Donna each had just one pressurized air backpack canister, which they started using after their second lift up the 15 mile high elevator to the top of the tower. Breathing their temporarily available extra air, they carried out the pillow blocks and accelerator assemblies, used a laser level to align them to each other in the east-west direction, welded them down to the base of the floor, and hooked up the connectors that would match, that they now had available.

Then they scrambled back into the pressurized elevator car's environment and shut off the air from the tanks; there was still a little remaining in the tanks but not much. Everything up there was now covered with the HoloPaint too, so it now had joined the vast domain of total presence of the Holoterminal system, so the technicians and engineers up in the Clarke Belt Cities were already at work examining the placement and connections as existed when they were put in place down on the Earth's surface, albeit 15 miles high above the Brazilian sea coast.

The team painted as much of the structure of the tower itself as they could easily reach, and made what other measurements of it that they could. They learned as much as they could about the fail-safe systems that monitored and topped off the enormous pressure inside the steel tube towers throughout their sustained mothballed period. They were still functioning, now half a dozen years past their initially expected maximum need to function autonomously. How long could it keep that up? Even those which had survived the fall of their circular KESTS to which they rose to connect, would crumple if their internal pressure flagged below the sustenance level, just like a rubber balloon would collapse when its air was let out. There were pressure bubble tanks built into the base of the tower, designed to burst through a flap valve into the interior of the tower, if there were a sudden drop of pressure between them; emergency power plants would start up burning hydrocarbon fuel to generate electricity to run pumps to supply more air to re-pressurize from slow diffusion leakage through the huge tower's steel shell exterior. The system was still working, and there still was fuel in the powerplant's tanks, but would need replenishing soon, based on the amount consumed already; being able to replenish hydrocarbon fuel anytime in the near future seemed unlikely, however. So already up in GEO a cable harness was being designed to be built and sent down on the next gondola to Cayembe, so that the pumps could be

operated from electric power from the plentiful energy beamed down from GEO, saving what fuel they could for true emergencies, if any. A request was also put in for a roll-out rectenna, to be unrolled down the eastern side of the tower from the top, so that power could be beamed direct from GEO to power the accelerator up there, as another backup emergency power system for the Circular KESTS they intended to somehow re-create passing through the top of this tower; if needed, one of the many unused solar power satellites in GEO could be aimed down at the side of the tower from an angle to illuminate the draped rectenna facing that direction.

The environmental engineering part of the team was busy making measurements of what the rate of transfer of water gathering function from the mechanical louver panels to the living phototropic plants. It looked like the growing edge of the plant cluster was able to adequately protect and supply water to its interior just a few centimeters from its growing edge, so they moved the whole mechanical array a couple of meters away from the growing cluster of plants, and started a new cluster growing from the edge of the mechanical water extraction plant analogue. They were wondering what would happen when the two growing clusters edges met; all should go well, but it needed real-world testing, and here was a great chance to test it. The growth would take weeks, they projected.

John and Donna did not have weeks to spend here watching plants grow, and so they took a minimal emergency ration of water and food in their solar-powered inflated aircraft and headed back toward Cayembe. Again a long journey in the slow airplane, and John got determined to put a rectenna grid over the solar panels on the wings and upper fuselage; the grid would shade only a few percent of solar energy from the photocells on the wings. And if they could get someone up in GEO to track their aircraft with one of the spare solar power

satellites, they might get quite a lot of extra energy to operate their engine. In fact, he decided part of that installation would be to add a couple more of the electric motor driven props on it.

They flew high, a few thousand meters above the fried jungle passing down below, so their visual inspection of what was possibly lurking down there was not very detailed. Were any survivors still down there? Would they be friendly? It was better to stay up high, even though it meant they could not see much of what was down there.

Finally after several days and nights of flying up there, the nights mostly marking position powered by their batteries, they arrived back home in Cayembe, back to their little inflated dome on the former helicopter pad the Elite once had used.

Chapter 21 The jump-starting begins

While they had been gone, a gondola delivery from GEO had included a small transparent inflatable dome for the environmental engineers at the site. It was being set up on the somewhat isolated flat space where John and Donna had their inflated dome home, so they went over to watch, their curiosity giving them a break from the steady workload. Single-layer domed, it would not be much protection from the cold up there, they noted. The dome had a different purpose, they learned, as it was to isolate what was inside somewhat from the larger world outside. Some of the dirt from the mountainside at the edge of the flat pad was scooped up and spread on the floor of the little domed chamber, then the chamber was sealed and inflated to dome shape. Finally a tiny pellet was injected through the dome and onto the surface of the dirt. They were invited to occasionally look in at the dirt inside the domed chamber.

The pellet had a mix of a bacteria and nutrients missing from the typical soil there. The bacteria had been engineered to change color to pink when the sun shone on it, and turn black at night. After a couple of days the tiny speck of pink of the pellet had spread to cover half of the floor of the domed container, the nutrients had been used up at that point. The somewhat thermally isolated chamber reflected most of the Sun's energy in the daytime, especially the infrared heat energies, and the temperature dropped inside the chamber. How low it would go was the question; it already was cool high up there in the Andes mountains, so the bacteria iced up, and expired, engineered to not tolerate temperatures below -5ºC. The experiment worked there where it was already fairly cold, so a similar package was flown over to the sea level site at the base of the Brazilian coastal tower. The experiment was repeated there, and once again it worked, that time starting from the roasting hot temperature

there, although the little bacteria were not able to bring the temperature of the poorly insulated chamber down all the way to freezing; but it got cold in there.

It was decided to set it loose there at the base of the tower, near where their plant experiment was proceeding well but slowly. If the biology went berserk, the staff there would be able to contain and destroy it. A tiny pellet of the bacteria and nutrients was set on the existing undisturbed surface 10 meters from their plant's growth current perimeter, and a spot of Paint placed on the ground near it. The bacteria quickly spread over the ground including the spot of Paint; the Painted spot took on a shade of pink in the sunshine just like the ground did. At night the growing patch of bacteria turned black and radiated heat out into space. Each morning found the blackened area covered with dew, which seeped into the ground, increasing the rate of growth of the spot. The experiment so far seemed a success, the Environmental Restoration Scientists decided up in the Clarke Belt Cities; so the Mars Project assembly facilities were again used, this time to make a re-entry lander of fairly unsophisticated design, making a hard landing sufficient to burst it open; but the controlled atmospheric entry would keep the temperatures inside the capsule in a comfortable range as it fell through the atmosphere. It was launched into a trajectory that impacted it on a small island, where the dead jungle biomass provided abundant nutrients for the bacteria; the island quickly turned a bright pink in the daytime and black as coal at night. Almost immediately temperatures in the center of the island when the air was calm dropped to levels which would enable jungle life to resume, and the test instrumentation package that had landed with the bacteria began to spot some of the jungle flora starting to sprout, cooled and watered by the dew collected by the bacteria in the mornings.

A similar hard lander was then put down at each of the poles

nearest land mass, barren with few nutrients, but a little cooler than the tropical islands around the equatorial plane of the planet. And soon the arctic had an area that was white again, for the first time in over a decade. True, was just a thin film of ice in the morning; but definitely below freezing there, at long last. However, the center of the area turned dark again, as the temperature dropped below -5ºC, killing the bacteria. It was a cyclic thing as bacteria grew back into the area, and restored the cooling cycle. Areas began to form in depressions in the land that had free standing fresh water collected by the process, and eventually the edges of the water became frozen all day long.

The planet had a long way to go to become generally habitable by the folks wanting to return to their homes down there; the experiment was looking capable and self-limiting, and so far had not mutated to some form they did not want. So a fleet of the unsophisticated landers was dropped all across the South American continent equatorial zone, 10º north and south of it. In a few weeks, the area was visible from GEO as turning a pink polkadot pattern. Where the dots had finished growing together, the condensation of dew was forming into free standing water, and then the Amazon River finally once again had a trickle of water in some areas. The much cooler air flowed off the land out into the Atlantic and Pacific coastal ocean areas, winds were rising, and fog began to form over the coastal waters as the cold air met the humid air over the sea. Another string of landers were dropped all along the eastern coastal areas of the north and South American continents, checking to see what would happen at higher latitudes. The average temperature of the planet had dropped by another 2 degrees, and winds were stirring. Australia and Europe were then seeded by the little hard landers with their cargo of bacteria, nutrients, and Painted instrumentation packages.

A variety of the bacteria was engineered to live in fresh

water, but not saline water of the seas. After brief testing, it was dropped into the ponds forming in the polar regions where the earlier type bacteria had been precipitating expanses of water. And soon the polar areas were sporting iced over ponds, at long last.

More of the artificial waterspout floating pumps were dropped into the seas around the world, powered by energy beamed down from Solar Power Satellites in GEO, their energy finally again being useful down there. Although in aggregate they were only putting about 1% of the needed water to saturate the air worldwide, it was enough to start rain in some areas of land; rain that soon evaporated off the hot parched land, but in so doing cooled the land a bit, and the water was back into the air to urge more rain again. Wind and rain began to appear in places around the world. Finally Asia and the African continent were peppered with the pink bacteria; within weeks the average worldwide temperature had dropped another 5 degrees, rainstorms were happening in places, former lake basins began to collect water once again. Water appeared in the American Great Lakes at long last, only a little at first, sinking quickly into the ground there, but eventually collecting sustained ponds here and there. The windstorms grew to be full fledged tropical windstorms, flooding coastal areas with rain; rivers began to flow again, and clouds drifting across the polar areas began to deposit snow to cover the land.

The phototropic shutter plants were seeded down the Andes clear into the former jungle areas, seeding all the ecological zones thereby, and the Ecosystem Scientists monitored the progress via the Painted instrumentation packages sprinkled across the terrain, one with each of the landers. The plants could not live in the now freezing altitudes, nor could they cope where windstorms lashed too severely, but there was a wide range of environment where they thrived, including the formerly roasted remains of the jungles. They too added to

the lowering of the average temperature, and collected water to sink into the soil around them.

The polar areas of the planet became continually covered in clouds, and the temperatures plummeted there. Temperature differentials around the world brought on raging rainstorms; rivers flowed worldwide again and lakes everywhere were starting to fill up. It was time to go into the next phase of environmental restoration, to urge a resulting balance of flora and fauna as close to as it was when civilization had thrived down there.

The solar-electric powered inflated aircraft no longer were useful in the windstorm-covered planet that they had created, so a new form of transportation was needed down there. A prototype aircraft was brought down in place of a gondola, which was in part also inflated to make it almost neutral buoyancy in the air, but it had a large wing and fuselage area with built in rectenna mesh across it, driving huge electrical motors which powered large propellors. John and Donna volunteered to test pilot it, climbing in where it was anchored a ways down on the slope of the mountain near their home. Up in GEO overhead, one of the Solar Power Satellites was modified so its beam was only a few times larger than the aircraft's wingspan, and was aimed down at the little aircraft. When the megawatts of microwave energy struck the rectenna-surfaced aircraft, the big electric engines roared into life, and the aircraft took off in a burst of speed, quickly headed eastward across the equator toward the Brazilian tower site. The microwave beam from GEO was then switched off, and the plane coasted quickly to float in the wind, its buoyancy holding the altitude but its low average density slowing rapidly in the air despite its streamlined configuration. John was able to control the direction and power output of the SPS up in GEO via the Holoterminal in his environmental suit's virtual omnipresence focused in that huge solar electric power plant high up there in endless

sunlight, and so he tracked his plane as it resumed its high speed as they flew high above the raging storms down below. Reaching the tower on the eastern coast of Brazil, they circled its towering projection going far above them; then they headed back for Cayembe, a successful test flight.

The airport at Cayembe had now been cleared of radioactive debris, and hangars needed to be built there to shelter the needed fleet of aircraft. No structures had been left standing at Cayembe after it had gotten nuked, so all had to be built somehow from scratch. But there were no building materials available in such quantities.

The trading arrangement with the little Ecuadorean tribe was going quite well, and a large crop of quinoa had already been harvested; and this time they also sold the leaves and stalks of the harvested crop. This fibrous material was shredded and mixed into a slurry filled with the pink bacteria, sprayed over the top of a large inflated dome next to the airport runway; the bacteria quickly dropped the temperature to -5ºC freezing the slurry into a reinforced ice igloo covering the inflated dome, thicker and stronger with every day's spraying on of more slurry. A hangar door was cut into the giant igloo on its side downwind from the prevailing winds. and the original microwave powered aircraft was moved in there, along with the original inflated solar cell powered aircraft that had come down as part of the original landers. A second such hangar was then built re-using the inflated dome which had been deflated and pulled out from under the first hangar's interior.

In the new hangar that was produced, a new vehicle was to be assembled, too big to be brought down on the SolidKESTS in one piece. It was fabricated in the vast shops in the Clarke Belt Cities in sections, then bundled together in nets that were lowered down the SolidKESTS by gondola-tugs. Made of automatically woven carbon fiber composite

matrix material, rectenna mesh on its upper surfaces, reflective foil lining the inside of the passenger and cargo areas in case of stray beam energy. This was a high performance aircraft, swept back wings and electric engines enclosed into nacelles driving the turbofans that would propel the plane at near supersonic speeds. Yet it needed no fuel to carry, and it had a neutral buoyancy system like a submarine except of hydrogen, not water, pumped in and out of chambers from pressure tanks to balance the weight of its cargo of equipment and people.

Chapter 22 A new kind of aircraft

John and Donna again were the test pilots on the new aircraft on its maiden flight, which also was carrying two Environmental Engineers who would remain on site, with their cargo of supplies, equipment, and terrariums of little flora and fauna preserved from a Brazilian tropical jungle of long ago, which the plane's cargo area carried. An electrically powered pulley pulled the aircraft out of the hangar and into where the beam from the SPS in GEO could reach it; John remotely focused and brought online the SPS' microwave beam centered on the plane; its big turbofan motors roared to life and the aircraft was in the air, and within a minute was at near supersonic speeds 15 km up, its low mass easy to accelerate, with megawatts of beamed energy from which to draw via the tracking microwave beam from a SPS in GEO. The sun shines 24 hours a day in GEO so the plane continued to hurtle at full speed into the night sky high above the storms down below, arriving at the Brazilian tower site at dawn the next day.

Setting the aircraft down on the leeward side of the huge transportation terminal at the base of the tower, John hopped out and drove anchors into the ground to moor the floating craft to the ground. He briefly wished that some of the Zeppelin folk were still around to appreciate such a ride, such a fine rigid airship he had just flown here; yet those folk of long ago did something like that too, for their day and technology.

The place had changed a lot since they had left it, much cooler, and wind-driven rain pelting them as they made their way into the terminal's entrance. Water now coursed through the terminal's plumbing, fed by the lakes refilling nearby. No sandwiches yet in the brightly shining dispensers, however; but that would change too, in time.

After a few hours to refresh themselves in the hotel facilities of the terminal, they donned their environmental suits again, this time not to provide protection from extreme temperatures and toxic air; but from driven rain. They unloaded another inflated dome building, anchored and inflated it next to the aircraft in the leeward side of the terminal structure, somewhat protected from the buffeting winds. The precious cargo of a diverse assortment of flora and fauna that had been gathered from the preserves among the Cities in GEO devoted to that purpose, parkland cities of each of the types of ecological zones typical on the planet before the collapse, lovingly cared for as giant zoos, terrariums, arboretums and even marine ecosystems still ongoing up there in GEO in the belief that each of their kind would return to Earth below to thrive again; and now samples of jungle worlds having been harvested and brought via the SolidKEST down to the planet's surface and then by the new aircraft back here to the jungle floor site from whence their progenitors had been gathered long ago. It was time to re-create the little jungle right here, under the watchful eye of the two Environmental Engineers who were going to remain here onsite.

Still with a week's supply of food and water, John and Donna flew their new plane rapidly up to gain altitude, powered by the SPS in GEO that had enough reserve power to power the largest of cities that would eventually spring back up around the planet. They would do their best to make it happen, anyway. Meanwhile the huge solar electric powerplant up there used the barest wisp of its potential energy to give the swift rigid streamlined airship shaped like an old jet fighter aircraft, whatever energy it needed as the plane headed out over the Atlantic ocean along the equator. Two days later they were circling the first of the two remaining African towers; it too was surrounded by storm clouds at its base as was much of the planet by now. It had been easy to fly over

the cloud-covered ocean at night, guided by the golden sparkling light reflected off of the east-west ring of Cities infilling the Clarke Belt high over them marking the equatorial plane.

The whole planet was almost entirely covered by cloud cover now, reflecting the sun in daytime but keeping heat in at night, so the phototropic plants and bacteria, and the mechanical photo-activated louvers, all were now non-functional under the clouds; they had done their task, and the world's weather was busy in its busy task of equalizing pressures ever unequally re-energized by the Sun as the planet turned, stirring things up a bit too rapidly now in the effort to hurry the ecosystem restoration processes.

The neutral buoyancy system of the aircraft could not quite provide flotation at the 15 mile height of the tower's top, so they used their engines to thrust them to the top, and landed on the floor of the shattered remains of this transportation hub. Suiting up in their modified environmental suits, they brought out another of the rolls of rectenna net, and draped it down the eastward side of the tower, attaching its power cables to the cables coming up from below. Getting back in their aircraft for a bit of shielding during target acquisition by a SPS off to the east up in GEO, John linked to the SPS via the Holoterminal, locked its power beam onto the newly unfurled rectenna, and noted a reasonable indication of absorbed energy was now happening. Back out of the airplane, they went over to the tower's elevator and requested the elevator car be prepared environmentally, the car at the top there having lost its pressurization and warmth long ago.

Riding the long trip down the 15 mile high tower, they relaxed in its luxurious lounge chairs while munching the lunch they had brought along; the vending machines and restaurants down there would no more be functional than were the ones in the Brazilian tower. But by the time they

arrived down at the base terminal of the tower, this facility was already glowing with its lights on and air conditioners thrumming mightily to pull the temperature down, freshly energized with electrical power from high above. The place was clean and in good condition as it was left sealed -when its function of exodus had been completed; left to await its use upon the return of the population. It had already been a lot longer wait than ever expected; but it had been in a mothballed mode and it had kept. Not much they could do down there for now, after they had applied Paint onto strategic parts of the facility, so they went back up the elevator to the wreckage at the top, and touched up the Paint there; their helmet mounted mini-Holoterminals now allowed them instant light-presence everywhere in the tower that they had Painted, and it all looked in as functional an order as could be managed by them now. On the tower's upper terminal floor, they once again fastened down a pair of maglev pillow blocks with a small electromagnetic synchronous sensing accelerator between them, aligned east-westward and hooked it up to the power coming from the rectenna's power converter panel.

One more tower to go; but they had cargo capacity for only the equipment for the projects now completed, nor food for more than a few more days. The initial test flight had done well as it was, they thought. Their initial test runs were getting ever better. Back in their sleek aircraft, Donna tried her flying skills, remotely activating the SPS in GEO assigned to track them; power surged in the rectenna system spread over the upper surfaces of their aircraft, the big electric fan motors roared with the air suddenly thrusting through it even at this altitude, and they were pressed back into their seats as the aircraft headed back around toward the South American continent.

Donna was curious about what the jungles looked like in this part of the world, changing rapidly by the raging rainstorms

everywhere. Carefully watching the displays showing altitude and terrain, she dove the speeding plane down into the roiling clouds, the winds buffeting them hard due to the very low mass of the fairly large aircraft. She headed upwind and reduced her airspeed; down below the cloud cover, looking for some large structure where she could land sheltered from the wind. A town appeared, and she found such a warehouse structure, landed. She got out, while John kept the plane's motors and airfoils going, the plane was almost still flying in the remaining wind there even on the ground. Donna gathered a soil sample to send up to the scientists in GEO, and went over to the building and put a stripe of Paint on it to enable virtual monitoring of the spot. Back in their plane, she took off; and soon high above the storms headed westward into the twilight proceeding ahead of them twice as fast as they were going. Now their Holoterminal included two places included in its virtual omnipresence world, which would be guides when they returned this way headed toward the remaining tower on the coast of Kenya. Shifting to autopilot into the nighttime sky over the clouded ocean below them, they sacked out snuggled together; it had been a busy day.

Dawn the next morning they were already past the Brazilian coastal tower's location, racing above the clouds high above the steamy rainstorm washed jungle remains down there. The new type aircraft had performed quite well, and so they sent a request for the components of another one be started up in GEO and be delivered down to them; meanwhile, they would be fabricating another fiber-reinforced icy igloo hangar for it. Landing the airplane in front of its igloo hangar, taxied over to the pulley; John hopped out and locked the front landing gear onto the pulley and started it drawing the plane inside the hangar. The wind seemed to have increased in intensity here too, they noted, as they walked over to the tunnel's entrance.

Much virtual conferencing was going on there with the staff up in GEO, since the increasing stormy winds were causing deflections of the SolidKESTS, sending ripples up the hoop structure that were being experienced at the terminal up there, half way around the world, far above Indonesia. There was both increased urgency and increased difficulty in converting to a conventional KESTS type structure with its ability to use internal differential lateral braking to put structural stresses on, to compensate for varying wind loads.

Chapter 23 The pirates return

Before any KESTS could be used in getting useful numbers of people home, the Circular KESTS had to be revived. It too needed to be a process of emplacing a seed structure, then using it to carry the load of material building up its girth and strength. For now, the contemplated towers could only link passengers to the South American and African continents, but that would be a great help as otherwise the people would just pile up here on Cayembe Peak, not a very hospitable environment and not that much room anyway. People would have to be efficiently gotten far elsewhere and quickly after arrival, and efficient transportation, all electrically powered. There remained the third still standing tower from the original Circular KESTS transportation structure; it was next in line for starting to bring back to life.

John, Donna, and a couple originally from the Kenya area of Africa where the next destination was, Environmental Engineers, all were mated couples who were to go to these isolated places alone for awhile. The pairing up, like John and Donna, had proven very effective in teamwork activity. The cargo hold was loaded with the maglev pillow blocks, accelerator, roll of rectenna grid, food and the essential mini-terrariums of various combinations of flora and fauna with which to seed the land anew, around the tower. The four donned their special environmental suits and climbed into the SPS-beam powered aircraft, the pulley belt pulled them out of the igloo hangar, the beam was locked onto the plane's rectenna from the SPS in GEO, power was poured into the big electric motors driving the turbofans in the nacelles and the fighter-plane-shaped rigid airship bolted off the airstrip like a frog going after a bug in the air. It took less than a minute to clear the turbulent storm clouds and then they were high above the clouds, racing along the equator eastward.

The next morning they were a third of the way around the planet, zeroing in on the thin spire stretching far above the storm clouds on the coast of Kenya. Again using their turbofan engines to drive them far above their maximum buoyancy altitude up to the top of the tower, they circled the top and discovered this one had only one side of the original transparent dome torn out when the Circular KESTS was destroyed. Flying into the broken opening, they landed their plane. John hopped out first and tied the aircraft down to some part of the wreckage that seemed immovable, lest their aircraft be blown away by some unexpected wind. Joined by Donna and the Environmental Engineer team on the former great transportation embarkation floor, they examined the remains, more than they had seen before. Part of the remaining environmental shell section included a maintenance storage area, still intact. Even before unfurling the rectenna to gather power for the tower, John and Donna eagerly opened this storage area, and began to apply Paint to everything they found in there, instantly linking the objects into the HoloPresence omnipresence, especially eagerly being analyzed by the engineers and scientists up in the Clarke Belt Cities, for clues as to how the original system had worked.

Then the rectenna was unfurled down the eastward side of the tower, its power converters conductors unrolled over to the nearest power panel, and electrically connected into the tower's electrical power system. Requesting the assigned SPS in GEO off toward the eastward direction up in GEO to start beaming a little of its microwave energy into the rectenna, the lights on the top of the power sprang back to life, the elevator cars began to warm up and pressurize their interior, and the airlocks' pumps similarly began to pressurize too. The tower was again coming back to life, at least the structural and elevator parts of it. John watched the panel readouts, having now figured out what they probably meant, and when readings had stabilized, the four entered the

elevator car sitting up there, and began the long 15 mile ride down the outside of the tower, time for lunch in the luxurious but empty dining facilities on the elevator car.

The interior of the huge terminal complex at the base of the tower was about the same as the previous two they had visited, except the artwork reflected the African heritage. A mini-museum displayed handicrafts of the Kenyans over several hundred years, and included replicas of the various bones of human ancestors which had been dug out of the stone in that area of Africa. In this area of the world, nature had been such as to enable those early ancestors of the crew of four recent arrivals, to survive and flourish. People later had goofed when their urges to control and consume irresponsibly went berserk and had nearly destroyed all of nature; now people were going to do their best to restore it, starting with the little terrariums' diverse creatures that had been brought down on the elevator too. The pair of Environmental Engineers opened the entranceway to the outdoors, ones their parents had walked through going the other way long ago; but the scene they saw was surely different from what their parents had seen. Reeling back from the lashing rainstorm battering the outside, the couple sought out an entrance more to the leeward side of the terminal, exited there, and drove stakes to anchor their inflatable home and lab, and another similar dome connected to it, which would house the boxes of specimens and the equipment to nurture them until needed to seed the world out there once again. They would live and work outside there, yet it was nice to know that the shelter of the old great transportation hub was available nearby. And the two were home, never to go back into space, and glad of it.

John and Donna finished painting strategic parts of this transportation structure and terminal, as they had done also to the other two; and bidding their two companions goodbye, they went back up the elevator to the top and soon were off

in their speedy airship, headed back to their home, mission accomplished.

Midday the next day they were approaching the coast of Brazil, and Donna was using the HoloTerminal in the airplane to check in on how the environmental re-establishment process was going on down at the base of the Brazilian tower, when her virtual presence virtually observed a calamity she had long feared, an attack by the Pirate Polygamist bull-men, jumped the two women of the Environmental Engineer team, as the women were out planting seedlings of the jungle trees that had once thrived here, placing them in the sheltering root structure of the dead hulks of the former jungle trees at the perimeter of the tower's complex. Donna witnessed it as one of the women suddenly went unconscious, and the other woman quickly looking over to see the woman's helmet flying off and the figure crumpling, then she too went suddenly unconscious.

Donna accessed the Holopresence of the environmental suits of the two women, and found that they were being carried through the rainstorm and jungle ruins; but that which was carrying them was not visible, as it was not painted. But Donna knew, could sense, the enormous psychic power of the huge men who were involved. It was the kind of her father, the Pirate Polygamists who had caused the great ruin of this planet. She had long doubted that they had all died off in the last stages of the ecosystem's collapse, but had seen no sign of them before. The PP's were incredibly expert in concealing their presence.

Quickly advising John and then the people back at the base at Cayembe of the unfolding events, she quickly dove their airplane toward the coast where the base of the tower stood, and the kidnapping was clearly still in progress. Yet the HoloPainted environmental suits which she could experience through the Paint impregnated into its materials, was all dark

and crumpled, having been stripped off the two women and was now being carried along in some kind of dark tote bag. The plane arrived in the raging storm to pause at the edge of the jungle ruins where the two women had vanished; John piloted the plane to hold its position as the storm winds attempted to hurl it around like a balloon while Donna peered out into the dim light down under the storm clouds. Donna spotted the overturned containers of specimens that were to have been carefully placed in the terrain to see if it would take root in the present weather conditions, but although they circled around they could see nothing else. She noted that the helmets had been taken too, was all they could learn, and John pointed out that the roar of their turbofans would be giving their presence away to anybody in the area, and the huge PPs were expert stalkers and chameleon-like in their ability to hide and observe, and would no doubt be aware of their aircraft's presence and quite possibly could damage it if given a chance.

Giving up the hunt, they rose and headed up above the storm, and continued on their way toward their home base, extending their virtual condolences to the two husbands of the kidnapped women, who were left alone to continue the efforts to re-plant the local ecosystem.

As the sun was setting to the west, it still lit up the former Elite's landing pad where John and Donna had their environmental dome home as they straggled into it from the storm outside, and removed and cleaned their environmental suits, and exhaustedly sacked out, long needed rest.

In the night, Donna suddenly woke up. Something was wrong. What was it? Alerting John, she activated their Holoterminal and soon found that the two helmets of the environmental suits that had been stolen along with the two women who had been wearing them, were occupied. But not occupied by their owners. She also noticed a different kind

of Presence there in the room with them ... two of the PPs clearly had put the helmets on, and were playing with them; their innate psychic powers which had led them to conquer a world and nearly exterminate life on the planet was quickly assimilating just what the helmets were and what they could do. Donna advised the Clarke Belt City virtual bulletin board that from now on there would be a pair of virtual spies present everywhere; to be careful. Then suddenly she was overwhelmed by a “sleepiness” feeling, a hallmark of being personally psychically intruded upon.

John gave her strong coffee but Donna remained in a dull and confused state of mind, quickly getting depressed and almost uncommunicative. She was able to haltingly tell John that what was probably happening was that the PPs were using the helmets to amplify their psychic tool and were now intensely interrogating her subconscious mind's vast knowledge of what they were doing here.

So John quickly alerted the two men remaining at the camp at the base of the Brazilian tower, that they probably were in extreme danger and that the likely assaulters were now accessing the Holoterminal ominipresense system and would soon know all about them and their capabilities there.

So the men quickly hauled their precious terrariums and equipment inside the tower's terminal, one of the men keeping lookout while the other dragged stuff in. The parking strip around the tower afforded a view even in the rain, would give them a chance to scurry inside if they saw them being invaded while they hauled stuff in. They longingly looked out to the edge of the cleared area, where the tumbled pair of specimen carriers lay where the assaulters had left them; but for now, they chose to leave them there. One could do only what one could do to help bring a world back to life.

Chapter 24 Pirate's dreams overwhelm

Awareness of the intrusion risk spread rapidly throughout the 7 billion people living up in the Clarke Belt City ring. The potential of having a pair of “virtual spies” anywhere in their midst was mildly alarming, especially aware that those PPs were the cause of their having to now live far from their homes down on the Earth surface, and had caused the destruction of the world's ecosystem and of the KESTS which they had needed to return home. Memories of the nature of the Pirate Polygamists came flooding in, how those PPs had bred themselves to be extra huge, muscular, handsome, smart, and craving to ever control others and be “winners” which seemed a game that enabled them to justify any assault they did on men who did not have the same basic progenitor father from which the PPs sprang. But some things they could not control, including their own craving to control others using their extraordinary cunning and belief that all men other than their kind were mere relics waiting to become extinct, and all women who were potentially breedable, belonged to the PPs, theirs for the grabbing one way or another. They could not control their teamwork predatory instincts, and had no built-in instinct to nurture the world which gave them and all other things life. Enormous loose cannons on the ship of civilization, and when they synchronized their movements they crunched it all and sank the ship in their joy of triumphant winnings. And now some of them were again loosed upon humanity, even now in their virtual midst. How to create a defense against something that can sneak into your conscious thinking and subconscious data set, able to know your intentions before your conscious mind does? And can make trip-ups in your pre-conscious checklists?

The scientists of the Cities took it on as an interesting project. Couldn't the PPs be made aware that the City folk

were working to restore their world shared by the PPs, and ought to be left alone to do that job .... nope, the PPs had innate belief that they were the only ones who were going to own and live on the Earth; if the PPs did not own the world, then no one would live there. Could the PPs be convinced to again take on super management positions, like they once had done, easing in to take over control of all the major corporations, to become fabulously wealthy elite, yet still enable the general goals of restoration of the world ecosystem and return from exodus? One advantage was that there were now billions of virtual ordinary people but only a relatively few of the virtual spies hidden among them. The strength of the Cities was that everybody had equal access to all knowledge and equal authority to get anything done, modulated by equal knowledge of the responsibilities needed fulfilling and who was nearest able to do whatever was needed; but now the spies equally had access to that same vast knowledge; and the PPs nature used knowledge for a quite different purpose.

The City folk's egos were rewarded by the blossoming of civilization as a whole, to which they had full access. The PPs mode was quite different in that their egos were rewarded by the more they were able to assault and rip off others; that mode had worked fine throughout history so long as they were in a land of plenty, mega-hunter-gather types predatory on all around themselves. It was almost certain the PPs would now invade to get more of the environmental suit helmets; and no woman would be safe out planting new lifeforms among the remains of the once-great but now dead jungles. Probably men not safe out there either, but differently, at risk of their environmental suit helmets being taken and they themselves thrown into the PP's digestion tanks, eliminating their former wives' reproductive options while also adding to the soup table.

The teams left in Africa were put on the alert; it was not

known if the PPs had extended to there, but apparently were focused on the remaining towers being likely places for people to show up at.

But the return from exodus project was not entirely at a standstill. They still were able to do lifeform introduction up in the fairly extreme environment around Cayembe Peak in Ecuador. They still were able to continue the expansion of the KESTS rebuilding to GEO. They still were able to proceed with the reconstruction of a Circular KESTS linking the towers. But they now needed to somehow protect the towers from the assaults of the PPs. The small contingent of armed staff at Cayembe there from the beginning, now were put on alert, and soon were joined by another half dozen. The Clarke Belt people were peaceable by nature; there was no need to assault others to get what was needed. Consequently they were not well prepared to deal with saboteurs, assaulters of any type, let alone ones that were physically very strong, tantalizingly-attractive to women, and cunningly predatory to an extent unimaginable by the Clarke City folk. Clearly, the PPs had not completely killed themselves off, and were making a comeback; and surely would thrive in the rejuvenating world that the Clarke Belt City folk had now started to grow back. Foxes in the henhouse, and even taking up residence there. It looked like the Age of Good Times was over; kneel down and worship the PPs, the Big Boys Were Back. The memories of worldwide enslavement by the TANFL and Ownma mega-corporations had not faded completely.

Disgusted with that variety of mankind that had warped so much for maximum reproductive success at the expense of all others, the City folk got to thinking, partly on their virtual collective mind level, their new strength and perhaps advantage in struggle again with their old tyrannical masters. Immediately they established a new reflex among themselves, to input a brief specific message to the virtual

network whenever one felt suddenly sleepy, bedtime or not; they hoped there would be trends deviating from normal sleep patterns that might prove to be a data source about what intrusions in people's subconscious was going on.

There continued to be much that had to be done ASAP despite the increased risk of invasion and sabotage by the PPs. John and Donna were now needed to be essential virtual pilots in the stringing of the seed Circular-KESTS weaving the three towers together. However, the two were still struggling to adapt to her subconscious mind being psychically invaded by the PPs using the stolen helmets' Holoterminals. And through their closeness each night, even John was recognizing traces of similar invasion and remote tinkering with his pre-conscious goal checklists. They both had learned to move with slowness, paying extra attention to what they were actually doing; that way they still could get some things done each day. But fly the circular KESTS mission? Even one little treacherous jerk by the unseen PP's remote-activated mischief would doom it all, maybe destroy some of the work they had already done to prepare the towers.

The scientists up in the Clarke Belt City ring had been silent for a long time. Then they broadcast that their monitoring and analysis of the “sleepiness” phenomenon showed that both there was a characteristic pattern of activation of specific parts of the brain when it was happening, and that they had found an apparent purpose in the pattern of whom the PPs were psychically remote monitoring and jerking at critical times. So they established an image of the brain activation pattern indicating probable intrusion by one of the PP invaders, and automatically introducing equal and opposite stimulation of those brain areas in the targeted person.

John watched for any effect on Donna, starting at the

moment of this effort to fend off the remote invasions; she was the most heavily hit so far. Donna appeared confused, distracted, as she proceeded with her daily routine slowly and consciously; something was different but exactly what she did not yet know. Two wrongs don't necessarily make a right. Also there was a time lag of a few hundred milliseconds before the pattern was detected and the correction pattern's signal applied by the Holoterminal, and in that time things could still go wrong.

Part of the remote assault was clearly focused on the sublingual energies, and soon the computer analysis was able to voice outloud the word-thoughts that were of the person being invaded, no doubt the same word-thoughts of "thinking to oneself" but being overheard remotely. So some of the doings of the PPs was being replicated electronically by the developing technology of the Clarke Belt scientists. And thereby were able to also observe the slipped-in words from the remote manipulator, as a bit different from the real intentions of the individual being assaulted remotely, thus implying something about what the intentions of the unseen assaulter were. It was like the proverbial "Freudian slips" of psychological lore; but deliberately contrived by the remote tricksters, using stimulation of the same parts of the brain patterns.

To direct the specific corrections to the individual being assaulted, the scientists had to identify the holoterminal which the person was using. And that same thing led also back to the two helmets that had been stolen, and to the ones who were now wearing them. Their unusual brain patterns were recorded and analyzed, and then linked to the similar patterns in whoever that was then being accessed by the person amplifying their psychic tools in the mischief. Donna's assaulters were thus spotted within the vast HoloPresence; an experiment was made just for a fraction of a second, and it indeed appeared that it successfully

cancelled out the interruptions intended in the remote assaulter. Probably it would be spotted if done much; but it was readied for a use in a critical time to help Donna.

The second SPS-beam powered high speed neutral buoyancy airship was now assembled, so John and Donna decided to test fly it and also check out how well they could still fly while being pestered by the remote assaults from the PPs, as partly balanced by the scientist's technique of pattern-cancellation. They suited up in their high-altitude environmental suits and Holoterminal helmets, some emergency supplies, and soon were in the plane being pulled out of its fiber-reinforced igloo hangar, out where the millimeter-wave beam from GEO could safely reach the rectennas on the upper surface of the airplane. The big turbofans roared to life and the plane was off the runway rising fast, headed into and soon beyond up above the storm clouds. John was being the primary pilot and Donna was just following along with his actions that were controlling the aircraft's path. Heading eastward toward the Brazilian tower, Donna was being introspective as much as she could, and noticed some differences between the quality of the psychic assaults and the counteracting pattern appearing a few hundred milliseconds later. The correction was an omnipresence signal routed to the specific identity of a holoterminal, Donna's helmet in this case, but the psychic version was directional, linked to a person's DNA sample or other unique identity qualities that the intruders had somehow acquired. In her case, she shared some of their genes; her father had been one of the PPs. And that DNA commonality was making it too easy for the intruders to form her identification, and lock onto her presence. But she intended to somehow use it all in her favor, although she was worried that her super-ego, derived from the PPs genetics, would lead her to do something she would regret later. Easy does it, she thought to herself.

It was a few hours' flight to the tower, and Donna found the experiences were not changing much and so her thoughts began to wander, to places not gone before. She began to long for the companionship of her harem kinfolk; all females, joined together at age three when they were taken from their mothers and traded for girls produced by any of the other BullMen that kept harems for producing their offspring. None of the children knew who were their mothers, only their fathers were known, and which Bull-man PP was the owner of the harem she was growing up in and would produce babies for him as soon as her body was able to start doing that. The Harem was fairly self-sufficient; the Harem's keeper provided the resources they needed, and the women did all else. Most of them had some or a lot of their genes derived from the PPs', and their egos were just as big as the PP men, so there often were conflicts and power struggles among the women too. Donna was only a first generation derivation of the PPs so was a bit on the gentler side. She felt nostalgia for the comforting support of her Harem's family; this current adventurous life was not so easy.

John pulled her out of this reverie to tell her that she had been drifting off; and that they were approaching the site of the Brazilian coastal tower, and asked her if she could sense any difference in her experience from the way it was back home. Yes, she reported, here was some nostalgia, and something else... it was an aspect of directionality, a switch that happened about when they had passed the tower moments before. She asked to take the controls, and John cautiously gave them to her. Donna cruised the plane around the tower, in widening circles; the sense of directionality had its greatest sensation when they passed over the coast about 15 kilometers from the tower. Consulting on the old maps, it was at the site of a one-time great aquarium tourist attraction; that seemed odd. But it was within travel distance on foot to the tower, easily traveled by the hulking predators of muscle and bone the PPs had bred themselves to be.

“Fish!” Donna suddenly exclaimed. “The PPs are using the aquarium facilities to grow fish for food, that is how they are surviving so well over here. The aquarium waters are separate and controlled environs for a huge seaquarium, free from the invasions of jellyfish that was a key destruction of sea life worldwide elsewhere.” Such fish that were surviving there would be precious for helping restore the ocean's diversity, surely; a real treasure if they could access it. But to get some of those fish from a place ruled by the PPs would surely be like the proverbial “bearding the lion.”

Chapter 25 Amazons and Donna

“Let's go get some of those fish and water samples from the part of the seaquarium that is exposed to the air.” Donna urged. “We have netting that we could use from our cargo hold to snare some fish, and some containers we can empty to put some fish and water in, and take them back to send up to the Clarke Belt City scientists.” John was feeling uneasy about that; but also feeling a bit sleepy after the long flight here; and he always had been a pushover for his mate. Their aircraft was able to float in the air and surely would float on water too; they could land in the water, throw netting out for some fish, scoop up a pail of water and be gone in moments with their treasure.

Circling the giant seaquarium, they found the large pool open to the air, and set down on it. John threw the net out, pulled it in and it was heavier than before; he had some fish. Donna had the pail of water scooped up and into the cargo hold, when suddenly a huge net was thrown over their aircraft. John slammed the door shut and threw the motors into full throttle, but the nets pulled one wing over and the nacelle on that side dipped into water, and the prop suddenly stopped as the propellor was thrashing in water, not air. They were not going anywhere, at least not right now. Fish, they realized, had been the bait to pull them in.

Opening the doors, indicating surrender so as to lessen the likelihood of damage to their precious vehicle, the net finished dragging them to the edge of the big tank of seawater. Huge warriors surrounded them, carrying long spears that were tipped with steel bayonets. A dozen spears raised to spear them, the net was pulled off, and John and Donna eased out of their cockpit onto the pool's deck, arms raised up, showing they were unarmed. John looked into those ferocious faces, noting the easy affect of those

accustomed to rule without question with overwhelming obvious strength. And slowly John noticed something else... Amazons. They were Amazon women, all of them, like the legendary tales of warrior women tribes in the South American jungles. Only these definitely were of the huge muscular physique of the TANFL rulers that had claimed this world for awhile, clearly not extinct after all.

John and Donna were prodded too sharply by the spear tips, herded down the broad stairway that had once thronged with admiring tourists, now lined on each side of spear-carrying Amazon-like warrior women clothed in decorated armor made of skins of alligators and sharks, best they could tell. John felt quite intimidated, his 5 and half feet height quite dwarfed; none of the warriors were less than 7 feet tall nor weighed less than 200 pounds, all muscle and bone, wearing smirks on their faces. The fabled smirks of the TANFL management told of how those folks craved in-your-face one-on-one conflict, it was largely how they established their hierarchy, along with birthright. These women were clearly made of the same stuff. Odd that they had not seen their men yet; but then the Harems had always operated largely autonomously, visited by the owner bull-man PP only for quick breeding activity. Herded into a room clearly set up as an improvised jail, shared with the two women who had been kidnapped from the Environmental Engineer teams at the Brazilian tower base weeks ago, conversation soon brought them up to date on the situation.

Back when the ecosystem was collapsing completely, obvious even to the BullMen management of the former TANFL Corporation's Elite, conflicts had arisen, the winners throwing the carcasses of the losers into their digestion tanks, sustaining them for awhile more. But one of the Harems decided that this seaquarium had a good supply of more interesting food, and could probably be sustained, so they took the place over. There were battles with women

from another Harem in the vicinity when food was getting scarce; the defense was held and the surviving members of the other Harem became part of the group, marking their original membership by their differences in attire. Yet all had been of similar parentage, generally a homogenous whole, identified at this stage of life by the specific BullMan who owned them and bred with them.

Their owner had not come back from the conflicts, however, and had never even come to the site. It was possible that he did not know of its existence, reflected the Harem; they had autonomously found and set this place up, as they had always done, their enormously powerful owner of course never losing them before. But in this case, they had moved. Whatever, they were staying alive; defending against all comers. Of particular concern was the strange tower about 15 km away, which seemed to go far up in the sky; it was sealed well, one of the relics of the former civilization before TANFL and Ownma elite asserted their rightful place as owners of the world. So they made it a routine of checking in around it every week, just to see if any of the former humans returned there; and a few did. They had been watching them secretly for several days, then decided to snatch a couple of those strange looking human-shaped things with their bubble-heads. Carried here unconscious the two women had their environmental suits removed and it was discovered by the Harem that inside the odd clothing and head-covering bubble were a pair of women, tiny versions of themselves. These indeed were some of the former peons, probably attempting to make a comeback here on Earth. They would come looking for their lost people. Meantime someone had played with one of the environmental suit helmets, and discovered that very odd thoughts began to happen. Another warrior tried on the other helmet and found that happened too, and also that it amplified their natural psychic abilities enormously. After a few days of playing with the helmets, they had discovered someone with similar energy to theirs,

but far away ... it was Donna. Doing their own version of virtual exploration, they watched the proceedings at Cayembe Peak, and the flights of John and Donna; they realized that their fish farm here in the seaquarium could be used as bait for these folk who seemed addicted to acquiring samples of lower life forms, clearly looking for new kinds of food.

The door opened and a trio of the spear-wielding pseudo-Amazons came in. One was wearing the helmet of an environmental suit. She locked eyes with Donna's for a long moment, the Amazon's face wearing a haughty sneer as she said “Donna Bulguarde. You have been gone a long time from this Harem. You had gone to serve as bombpilot years ago. None such have come back before. You have a lot more to tell us, besides that which your subconscious has already shown us.”

Meanwhile, up in the Clarke Belt Cities, a zillion tourists and scientists had virtually accompanied John and Donna on this trip, once again. And now they were locked in on the Paint of the airplane and of the environmental suits the two explorers wore, and now many were also virtually locked into the helmet worn by this Amazon queen. The events were now getting the attention through the news networks up there and on Cayembe Peak; it was all exciting as well as dismaying. Soon nearly all the seven billion city folk up there were virtually present at the proceedings in the makeshift jail house down at the Brazilian seaquarium. The two other warriors came over and used their bayonet-tipped spears to prod John and Donna with a haughty smirk, drawing a little blood while holding out a hand gestured for the helmets to be given them. Soon the environmental suit helmets were on the heads of the other two warriors; and with the briefest sneers they turned and left the four to be alone in the jail cell. John quickly removed a small tool from his suit and tucked it away among the furniture of the room; even if they were

deprived of the rest of their environmental suits, like the other two captives had been, it would be a homing beacon to possibly interested folk up in GEO. And there were lots of interested folk up in GEO, nearly all 7 billion of them right now. Amazon women yet, wow!

A third SPS-beam-powered aircraft was urgently begun in fabrication; it would be armed in case they had conflict with the captured other aircraft ... but, armed with what, spears? None of the folks in GEO had any urge for conflict with other people, it was a strange topic. They tried, however; and were imagining two such aircraft in dogfights with their occupants leaning out and trying to spear the other plane; the thin composite carbon fiber skin was tough but most likely a hard jab with a sharp bayonet on a long spear would puncture the buoyancy tanks comprising most of the plane; and down it would sink, its hydrogen escaping through the rent. However, no such plane would even take off and fly except as blown by the wind, without the tracking beam of an SPS in GEO delivering the energy beam to make it go.

And the Amazons would know that by now, surely. And they were hereditary members of an elite whose brains were genetically selected wired for ferreting out and using every aspect of a situation and using it to overwhelm any quarry. Minutes later the door slammed open, and one of the helmeted Amazons stalked in, gesturing with her spear. “Amazons! I have been examining your world via your helmet, and they are calling us Amazons! We are the Harem Bulguarde, tell them that! Not Amazons!” and stalked out. John and Donna just looked at each other; there was not going to be much privacy going on in this conflict. Worse yet, without their helmet Holoterminals, they themselves would not be able to know much of what was happening. It suddenly was a very lonely world, deprived of their membership in the vast Omnipresence of HoloPainted items, blinded from seeing what was really happening in their

world.

They had just finished a meal of fish, alligator, seaweed and some tiny crunchy crustaceans, when three of the warrior women trooped in wearing helmets, one carrying the fourth environmental helmet. Placing the helmet on the spear's tip, it was waved in front of Donna, and told her to put it on. “So you are fond of John here, are you. Well, we are keeping him here, just to make sure you behave. You are going to take us in that airplane to Cayembe Peak headquarters, which we will take over and resume our command of this planet we own, from there. We own this world; and your kind is not going to take it away from us, ever. You will restore it back to life for us, and all 7 billion of you will resume your status as our peon slaves from now on.”

Donna paused only briefly, some old part of herself coming back online from her past life as a HaremMate among these people who were mere little kids back then; holding the helmet in one hand she replied “If you would be welcomed back by your slaves, you would do well to bring them gifts of live fish, seaweed, and crustaceans from your vast supply in the seaquarium. Let's go.”

Putting her helmet back on, she welcomed back the Linkage to the HoloPresence world parallel to the physical world she had temporarily been stranded in for awhile. They proceeded out to the platform on the edge of the seaquarium, where the aircraft lay, one wing dipping its engine nacelle still in the water. She checked the condition of the fish in the bucket in the cargo hold, still swimming around. She handed an empty bucket to one of her captors and said it was for living specimens of seaweed and crustaceans. A moment passed of eyes locked together, then the warrior took the bucket using the bayonet end of her spear, and went out with it; and came back in with it filled with the requested munchies. All seated, Donna verbalized a message to resume energy transmission

to the airplane's rectenna; the motor of the still water-free turbofan hummed to life, with air blown across the airfoil control surfaces she tilted the other wing up out of the water, watching the water run out of the wetted nacelle. Then she sent power to that turbofan's electric motor too, and they were airborne. She felt a reminder small jab from the sharp point of a bayonet speartip from one of her passengers in the back; but no words were exchanged, none were needed.

The hours of flying high above the storm clouds was getting almost hypnotized attention from her three passengers, having never been off the ground before. They had grown weary of the sight, however, by midday when Donna started her descent back into the clouds. The rigid airship, streamlined as it was, jerked and bumped around as it passed through the turbulent clouds and into the rainstorm; she prolonged the descent as much as she dare, while observing her three airsick passengers who were still managing to look utterly dominant despite the queasiness. Finally reaching the airstrip and the pulley to move the aircraft into its sheltering hangar, lacking John to hop out and hook the front landing gear to the pulley rope, she gingerly used her engines and control surfaces to nudge the landing gear to lock into place; then sent the command to activate the pulley's motor, so they were pulled into the igloo hangar.

“We have arrived; are you ready to take command here?” Donna said to her still airsick passengers who still were managing to look pompous despite that little handicap. Opening the plane's doors, and hopping out, she sealed her environmental suit's helmet to the rest of the suit in the cold blast of wind. Her three spear-carrying captors got out too, and began marching Donna ahead of them with the command to take them to their new headquarters building. As they left the shelter of the hangar the icy cold wind driven rain lashed at them; Donna was in her environmental suit, but her three captors wore only the helmet part, and were

only acclimated to the relatively warm lands far below. Donna walked them along a circuitous route up to the construction shed office structure; led her three warriors into it, and introduced them to the base foreman who was filing in for John in their absence, by saying “Here are the new rulers of the world. You are to leave your seat of command and give it over to this new management team I have brought here.”

The acting foreman gaped at her a moment as if she were nuts; then looked over at the three scowling spear-wielding shivering seven foot tall women who had come in with her, wearing some really weird clothing that did not conceal their tremendous musculature; then Donna snapped “Do it!” with just a trace of anger in her voice, and the man scampered out of the shack. It wasn't quitting time yet; but he needed a break, things were getting a bit too weird around here just now, and this seemed like a good excuse. Not much was happening right now anyway.

Chapter 26 Stringing a seed CircularKESTS

Donna wasn't sure how this was all going to work; but she set the acting forman up with an office at home, there being a scarcity of spare dwellings. With John being out of the picture for now, the acting foreman would take instructions from Donna, and Donna would take instructions from the three Harem warriors who were occupying the foreman's construction shack, the nearest thing at Cayembe Peak to a management facility. Since Donna was genetically of the Harems, she was given the position of middle management; top management demanded a daily report that all things were going well, received from middle management.

Donna had the pail of water and fish whisked up to the Clarke Belt City ring's biogenetic diversity scientists, before the new rulers decided to have them for lunch. In fact, lunches were going to be a problem; so she prepared three of the lunches commonly eaten here, largely quail, quinoa and pureed cockroach flavored with a few spicy herbs. The Earth had a long way to go before there would be much to be harvested off her again. The three new rulers of the world greeted Donna a bit more friendly when she came in bearing gifts of food, advising them that the people up above had accepted the gifts of fish and crustaceans with thanks, and offered the local cousine in return, since there was a lot more of it, which made sense to the three now-hungry warriors. Donna described the quail burgers as the equivalent of the fish except they ran around on the ground instead of swimming in water as the fish did; and the pureed cockroach as being the land form of crustaceans, and quinoa as vaguely something like the seaweed. The spicy flavorings were an instant success with the warriors.

Discussion of management principles began; and soon Donna realized that the new rulers of the Earth here, had no

ability to comprehend the functioning of a fully enlightened and informed holistically aware people functioning autonomously; and in fact, since their owner BullMan did the management part before, they really did not know much of anything about management at all. Except that they were now Top Management and to be treated as such; and to be provided the best that high position could obtain. And they wanted those progress reports delivered promptly every day, and each would show progress or severe punishment would immediately follow.

Donna pointed out that now that the Harem Bulguarde was now established in their rightful place of rulership here, there was no further purpose in keeping the captives over at the seaquarium; that those imprisoned people were key personnel in the flow of progress of the project, and their loss was already handicapping progress. Donna was told they would evaluate this and provide direction tomorrow; and that Donna should immediately provide bedding for them for the night.

Donna had to search for suitable stuff; none of the cots used here would be long enough nor sturdy enough for the huge warriors. Finally she brought over all of she and John's bedding, along with the few thermal blankets that were in emergency spares; the new masters of the Earth would have to sleep on the floor. Delivering these warm cushiony things, the warriors informed her that sleeping on the floor was the only place they had ever slept; that way a warrior kept connected to the earth.

That night Donna slept on the bare cot in the inflated dome home on the former helicopter pad, no John nor thermal blanket to keep her warm. It was a long night, but she was exhausted and finally fell asleep.

The next morning she arrived at the construction shack a bit

bleary-eyed, and again requested that the captives be freed so that essential progress could be resumed. The two women were needed by their husbands to resume the replanting of the living biosystem around the base of the Brazilian tower; and John was needed here as chief pilot for the highly risky and difficult but essential stringing of the seed Circular KESTS. The three warriors were quite adept at power plays, however, and before Donna had quite finished her request, she was told to go empty out the cargo hold of her airplane, then fly it direct to the seaquarium's pond as before, pick up the three slave-humans along with as much fish, crustaceans, and seaweed that they could lift in the cargo space. She was then to drop the two women off at the base of the tower, then she, John and the fish would come directly here. They had determined how long that would take, knowing how long the trip had taken to get here yesterday, and demanded that the fish and John be presented before them in precisely the minimum time all that would take. Dismissing Donna, the three warriors resumed their playing with the environmental helmets, familiarizing themselves more with the civilization ongoing, so as to more efficiently rule it. Donna noticed the dinner plates had not been more than sampled; apparently the fare here was not good enough. Hence, the fish. Except that there were no seaquarium here in which to grow fish; and even if such water were present, it would soon freeze over.

Taking time only to freshen up and grab some nutrition and water for the trip, Donna patiently wandered the circuitous route to the hangar, aware now that the warriors were timing everything, and were going to use that as a measure of efficiency; apparently using the principle that if there were no slack time, there would be no time for mischief to happen along the way. Simple, but effective management even if callously a bit brutal.

In the hangar, she wasted no time in buckling in, getting the airship pulley-drawn outside and activating the SPS energy

millimeter beam from GEO to lock in on the plane's rectenna. Soon she was hurtling up through the turbulent cloud cover, yet again at the lower slope as used when bringing her captors here. If they could maintain the fudge factor, it might come in handy some time in dealing with the demands of inconsiderate masters.

When she landed in the pond at the Seaquarium, half expecting to be re-captured and detained, instead she found that the helmet amplification was enabling the three warriors at Cayembe to communicate psychically with their Harem at the seaquarium. So she was met at the poolside by John and the two women Engineers who were readied to go, along with a huge cargo of fish and other supplies familiar to the Harem's members here. No time was being wasted; there were three huge hungry folks waiting at Cayembe. With only one helmet between them, Donna continued as pilot while John simply rode along; a quick stop at the base of the tower to drop off the women into the eager arms of their husbands and quickly led back into the tower, Donna was already accelerating high into the cloud cover. Donna used the hours of flight to fill John in on what had been happening; John was still bleeding a little from a few bayonet pokes given him for reminders of who was boss as he was prodded out onto the poolside to wait for Donna's plane arrival; so he kind of understood the transpiring events.

Landing at the Cayembe runway, they first got John a replacement helmet for his environmental suit, then they did their best to solve the food storage problem by getting a bit more swimming room for a few fish by putting the majority of fish on the abundant ice everywhere outside, and hauled as much of the water-filled pails into their inflated dome home as they could, so as to keep it warm enough for their live survival for awhile. Same for the seaweed and crustaceans; fortunately they had not sent any alligators along too. And before stopping to rest, Donna carried a

generous portion of the fish etc over to the construction shack, realizing that these fish had not been properly prepared for dinner. The three famished warriors inside barely mentioned that they were quite capable of preparing their food, unclipping the bayonets from their spears, and with the wave of a blade gestured Donna to leave; they were through with her services for now.

Donna and John had no thermal blankets that night, but they had each other; and so they did not notice the cold that much, until early the next morning. They awoke cold and aware that their place smelled like the seaquarium, from the aroma of the pails of fish and other sea critters they had there for meals for their new rulers. Deciding that wearing their environmental protection suits even inside their home was desirable for now, they had just gotten warmed back up by the electric heaters in the suits when Donna heard via her helmet the commands from the new management, to bring them some fish for breakfast, immediately.

While she was gone carrying some wiggly fish over to the construction shack, John used their main Holoterminal to contact the scientists up in GEO, and went thorough a description of the various critters that were in the pails there, comparing them against the specimens sent up previously, so as to see if there were any new kinds here. A half dozen sounded different, so John separated out a few of each, and placed them out for shipment on the next gondola up to GEO, along with a request that when the gondola returns, to bring down replacement bedding for he and Donna, and a generous supply of possibly similar useful items for the new Management folks in the construction shed.

And by the day's end, John had been given another request, to have sent down three environmental suits sized to fit the Amazons... no, the Harem Bulguarde rulers of the world, that is. The three hulking female warriors had gone out stalking

around checking on the doings of their new bunch of peons, wearing their fearsome clothing of fish and alligator skins and carrying their long spears; but it took little time for them to realize that they would be able to maintain a more proper dominating affect by wearing environmental suits instead of shivering while haughtily glaring around at peons doing work.

John also received a half dozen requests for emergency repairs to environmental suits; couldn't he do something about their visitors' urge to jab everyone with the sharp points of their spears?

While they had been detained over on the Eastern coast of Brazil, the spool of carbon fiber embedded with magnetized armature domains, had arrived on a gondola, and awaited the first test run to see what it took to create a seed Circular KESTS laid through three existing tower tops that spanned only a quarter way around the globe. Three points define a circle, true; but this was a very lopsided set of three points. They spent a couple days mounting the spool in one of the high speed airships; and for supplying provisions for survival for awhile in case of not making it back per schedule. If the seed KESTS could be emplaced by an airship instead of a rocket propulsion system like the SolidKESTS were started from, there would be a lot of advantages such as more time to make adjustments for error. The probability of complete success the first go at it was considered very low; it was mostly to be a learning experience.

Early the next morning, after Donna had taken the last of the wiggly live fish to their captors for breakfast, and arranged for others to take frozen fish to them next time, John and Donna flew the modified airship off the parking spot in front of their igloo hangar and circled up through the turbulent cloud cover, and headed west, soon far out over the Pacific Ocean. There they again did a half turn and headed eastward

again. The de-spooling was then initiated, the nearly invisible diameter carbon fiber thread trailing behind then at about half their airspeed, so the whole thread was being towed along with an airspeed of 350 km/h. The big turbofans were running at high power, partly to maintain airfoil flying altitude of about the height of the tower tops, their buoyancy not being enough to float at that high an altitude. The very thin fiber trailing behind them almost floated itself, and the overall towing friction drag in the air was not noticeable, at least yet.

They had a whole world to fly around. Although they had no fuel level to worry about, being powered by the series of SPS in GEO as they went around the world, they themselves would need nourishment and rest. And a few times they would need to do precise maneuvers as they passed each of the three tower tops.

They had been in the air four hours by the time the Brazilian tower was looming ahead. This was the first critical test coming up. They switched to precision auto-piloting mode using the Holoterminal field involving both the position of the fiber being de-spooled, and the southward open maglev pillow block clamps poised on the tower top. Targeting their position vector as close as possible they switched to autopilot precision mode for the last 30 seconds, tensed to abort if it looked like they were going to impact the tower. John aborted at the last instant, it looked like they would have touched grazing the tower as they sped past; a quick evaluation showed that they would have cleared by a centimeter; the autopilot had been working OK. But they continued on eastward at full speed toward the African continent, across the vast Atlantic Ocean. Twelve hours later they were approaching the Zaire tower; refreshed by coffee and some in-place physical exercises, John again flew the thread-trailing airship with turbofans roaring to maintain altitude straight at the top of the tower, then switched to

autopilot, and resisted the intense urge to abort the pass again; then they were past the tower and it was far behind in an instant, and the instruments showed that the automatic clamps had activated and the thread was now being pulled through its pair of pillow blocks with the accelerator in between them, which had also locked to the pattern of magnetization along the thread and was adding its energy input to the thread's kinetic energy, taking all the load of pulling the fiber that lay to the west of it from then on. Freed of towing friction, the plane's speed increased perceptibly only on instruments. Four hours later they repeated the maneuver as they sped across the top of the Kenyan tower. Then they settled in for flying mostly on autopilot for the next day and a half headed eastward.

They passed again high over Cayembe almost unnoticed; and a few hours later they again made a pass at the top of the Brazilian coastal tower; still tensed at the apparent impending impact John more intensely watched the instruments of the autopilot's readout of error corrections, then they were past the tower and the sequence of maglev clamps locked onto the thread and the accelerator began its pull on the part of the thread that spanned 3/4 the way around the world.

The plane continued once again out across the Atlantic Ocean, now thinking of chasing the tail of the thread far ahead. This was dull tedious work as compared to the virtual rocket piloting they had done before, they were discovering.

A half day later they were approaching the Zaire tower's top, its clamps now opened again, the end of the carbon fiber thread having pulled past it already. Once again the precision autopilot placed the thread being de-spooled behind them through the re-opened maglev pillow blocks; they re-locked and the Zaire tower's accelerator took over the job of pulling on the thread portion spanning across the Atlantic Ocean. A

few hours later, another critical new action was to be tested as they were now flying several meters above the trailing end of the carbon fiber, having finally caught up with its tail. As they approached the Kenyan tower's top, they directed its clamps to pop open as they laid the still de-spooling thread through their open jaws, then the pillow block jaws snapped shut again, now guiding two strands of thread instead of one. The magnetic fields of the two strand sections passing together through the accelerator quickly shifted phase to be locked in step with that of the accelerator. Then another function of the process was tested as the airship did a complete loop around the essentially invisible thread ahead as they sped past it at twice its velocity, then they activated the carbon ion welder to flood the thin air behind with carbon ions, a small percentage of which bonded between the two fibers and in an instant the automatic cutter severed the airship's spool from the loop now established continuously all the way around the planet.

They dropped down to a lower altitude where the airship could establish neutral buoyancy, the turbofans dropped to a more normal effort and noise level, and the Holopresence sensors began to show the performance of the thread, as the three tower top accelerators gradually eased the velocity of the thread loop ever higher. The part of the loop spanning from Kenya to Brazil was ever so slowly drifting downward in the middle. The radial velocity of the carbon fiber thread loop continued to increase as driven by the synchronous tower top accelerators, yet not so much that the part of the loop across the Pacific Ocean would drop more than a km in altitude. As the velocity of the loop increased, so did the energy input increase to overcome the miniscule but accumulative drag of the fiber within the air; the loop slid past the velocity of sound with no trouble, the path everywhere having been cleared by the part of the thread ahead of any other part of the thread. Mach 3 passed, then Mach 5.

John and Donna finally reached the Ecuadorean coast and soon landed at the Cayembe airstrip, put their plane in its hangar, and wearily made their way into their home dome. Donna flopped on the bed, asleep in a moment where she fell; John fought to stay awake as he activated their Holoterminal and resumed the monitoring of the progress of the accelerators as they increased the speed of the thread encircling the planet across the top of the three towers. The carbon fiber had reached meteoric velocities long ago, yet slipping in the wake of itself, only brownian molecules actually contacted the speedy fiber. John swilled some more stimulants, and fading consciousness still monitoring the progress of the experiment, he watched until the microscopic girth ring around the planet was completing its spin around the planet every 75 minutes; the part of the loop spanning from Kenya to Brazil was now finally rising toward tower altitude since it was now going faster than orbital velocity at that altitude, and so centrifugal force was stretching it outward away from the planet more than gravitational force was pulling it toward the planet; the experiment was declared a success. John shut down the Holoterminal and flopped on the bed beside Donna, also asleep almost at the touch of the bed. There still were no blankets on the bed; but in the warmth of their environmental suits, it made no difference.

Waking up still wearing their environmental suits the next morning, had gotten to be somewhat routine lately, but finding themselves in their suits in bed in their pressure dome home was a bit strange. Then, the awareness of still no thermal blankets available. Donna was first up and went into their home's Holoterminal to check on the progress of the gondola bringing their blankets among other things; it would be another morning when they would wake up in normality as the gondola was on its way down, but still quite high on the KESTS. It was clear they needed to get a real KESTS built and working as soon as possible so transportation could

be speeded up. The original KESTS through the tunnel here had continuous two-way travel of spacecraft along itself, and a trip from ground to GEO took only five and a half hours.

Then she remembered the Circular KESTS microscopic version they had apparently successfully sewn on their last adventure trip, and quickly shifted the Holoterminal's attention to see how it was doing. The Circular single carbon fiber was humming along nicely, its resonant vibratory modes around its circumference were of low amplitude, as there was enough lateral damping by the thin air it slid through to prevent much oscillation amplitude. It looked like it was working; she wondered what would be their next trip. The odor of the buckets of saltwater aquariums teeming with seaweed and crustacea in their home was still not very welcome before breakfast. And thinking of breakfast, had the new rulers of the world been fed their fish yet this morning?

They both participated in the progress evaluation virtual conference later that morning. Key points that the experiment had determined were that such a seed Circular SolidKESTS could be initially emplaced by an aircraft flying at subsonic speeds; that the synchronous accelerators were able to lock in on the relatively slow moving continuous armature formed by the alternating magnetic polarities of the steel particles embedded in the thread of carbon nanotubes; that the earth-encircling loop of thread could be welded to the other end of itself; that it's sag in unsupported areas was overcome enough by the flow through the thin air that was within the 1 km altitude drop they thought tolerable during emplacement; that the speed could be smoothly increased by the tower top accelerators all the way up to operational speed which was above orbital velocity at that altitude; that the excess speed above orbital velocity expressed as outward, upward relative to the earth's mass, stretch, stiffening the circular shape; that the inevitable transients oscillating and vibrating around the huge circular perimeter were mostly

damped out by the air molecules of the thin air at that altitude.

The process of emplacement in a direction opposite to the Earth's rotational direction gave maximum relative velocity to the Earth, and thus to the accelerators on the tower tops for the effort involved, since the equator was already moving at 1600 km/h. Could it have been done when the aircraft was flying in the same direction that the Earth was moving? So that was the next experiment, to do the same thing except do it in reverse direction, and somehow managing to not ever sever the existing microscopic girth thread that would still be sliding through the first set of accelerators. For this experiment, to give a bit more room for error in position as they laid the thread through the second pair of open jaws of the maglev bearing pillow blocks and the accelerator between them, a boom would be deployed beneath the aircraft, its angled strut terminating a meter below the bottom of the fuselage of the airship. The thread being pulled sideways off the spool carried by the aircraft would be guided down along the strut then a 15 degree bend back to the horizontal relative to the planet.

It took all of the next week to bring down the modifications for the aircraft and the second spool of carbon microfiber embedded with steel particles magnetized in alternating directions, and get it all ready to go in the airship. Checks of the turbofans bearings and electric motors in the nacelles mounted in each wing checked still fine with little wear found; some of the bonding between the rectenna netting appeared to be a bit bubbled from overheating at some time, but there was no way to repair it short of replacing the whole airplane wing itself. Plenty of food and drink were put onboard, and this time a small microwave oven was installed, run by direct feed from the energy being beamed down from the SPS in GEO. A lot of power was delivered to the aircraft when flying at near sonic speeds even in that thin

air at 24 km altitude, which also needed extra energy to utilize the inflated wing airfoil to support part of the weight of the vehicle, not being able to completely reach neutral buoyancy up there.

The exercise was also giving the Solar Power Satellite system up in the Clarke Belt quite a workout. Although the amount of energy beamed down was a tiny fraction of what they were built to produce, the need to track a rapidly moving object down there, plus tighten the energy beam much smaller than would be done in normal power delivery for commercial power grid input use; and in addition to that, each SPS be set to switch off exactly when the next SPS took over the powering of the aircraft as it moved around the planet, were not things the SPS system had initially been designed to do. However, it was working well enough to have some people looking into using a series of smaller SPS in GEO built specifically to electrically power moving objects down there, including intercontinental aircraft, freighters crossing the ocean, and trains hauling freight across the continents.

Pulling down the huge amount of carbon in the atmosphere would get done quicker to viable levels, if major transportation could be done electrically as derived from the solar electric power gathered by SPS all around GEO; why not deliver the electrical power directly to big moving users of energy, instead of pumping it through wires to point of use, or charging up batteries, all with attendant losses in overall efficiency. So the technological spinoff from these experiments looked quite helpful for the near future's application needs, as well as looking capable of serving the immediate upcoming needs to rebuild the major corridor for getting returning people back to their home nations as efficiently as possible.

Chapter 27 Towers linked once again

The results of the first experiment were favorable enough that people were extrapolating way into the future; yet many experiments remained for reality-testing. Their airship modified with the retractable strut, the fresh spool of carbon nanotube thread installed in the cargo hold, and provisions loaded, John and Donna were again being towed out of the igloo hangar; then acquired by the powerful SPS millimeter-wavelength energy beam from GEO, air turbines in wing nacelles roaring into life, they were again headed up into the storm clouds. This time they headed eastward for an hour first, then turned around and began to pay out the carbon fiber thread behind them as they headed westward. This time they were stringing it out freely for three quarters of the way around the world before the first pass would be made across the top of a tower; they were flying several hundred meters below the existing thread. Flying mostly on autopilot for the next day and a half, they took turns in the main Holoterminal the airship carried; the other person limited to just the Holopresence enabled by the helmet Holoterminals. The autopilot was constantly fed anticipated wind conditions and up and down draft data, laying the new thread as close to the existing one as possible without risking getting wind-blown up into the earlier thread, which was now stretched by its centrifugal force as it spun around the planet, and was relatively impervious to deflection by winds up here.

As they approached the Kenyan tower, they both were at the cockpit controls, as John began the first maneuver, shifting to the side if the tower on which the second set of maglev open clamps were on; then shifting back over in line but now above the tower, the autopilot lowered the fiber's guide strut and made the last instant guidance to lay the thread across the top of the clamps and accelerator as they flew over the top of the tower at 800 km/h; in a few seconds the signal was

received that the pillow blocks had closed upon the fiber, so John again shifted to the side of the original thread's position, then easing down under it again after a few kilometers out from the tower. Autopilot back on fully, they took a break; they would do that again in a few hours as they approached the Zaire tower. So far, it looked like it all was working.

They repeated the maneuver at the Zaire tower and then headed out across the vast Atlantic Ocean, and both of them got some sleep as the well-informed autopilot kept them flying adequately below the initial thread's position. They did the same maneuver across the top of the Brazilian tower's top, and then began the long race to catch its own tail, coming around the planet. They passed the tail of the thread before it had cleared the Kenyan accelerator; they did the maneuver laying the thread across the freshly re-opened maglev pillow blocks, but this time they then activated a carbon ion spray which was mounted on the tower's top which welded the two fibers together as they exited the second pillow block, initiated as soon as the accelerator signaled that the magnetic polarities between the two armature threads were in sufficiently close alignment. Signal was sent to the airship; Donna activated the thread cutter, severing their spool of thread and retracted the thread guide strut. John then flew to the side and dropped a couple of kilometers too, out of any possible contact with the still sagging second thread they had just emplaced around the planet. Donna did the piloting for awhile, making sure the autopilot was doing well in the new flight path, while John went into the Holoterminal and monitored the progress of the speed up of the new circle of armature thread. It was speeding up now, still way too slow to be having any significant centrifugal force lift, and it was all below the initial one. The speed up continued, while the airship continued westward the remaining quarter way around the planet, across ocean and the unseen Brazil beneath the clouds and kilometers away from the Brazilian tower when they

passed it. By the time they came in for a landing at the Cayembe airstrip, the second fiber had also reached above orbital velocity and had stretched itself taught.

They had just turned in for a long overdue long sleep at home when the alarm sounded. John hurried into the Holoterminal, and found that there was a problem unfolding. The difference in drop times until the welding of the circle had made the two fiber circles into slightly different circumferences, so one was more taught than the other, and the ripples from transients ringing along the two fibers were thus different. The vibrations in places were approaching zero clearance between the two hurtling threads going in opposite directions, and there were only the three towers to provide position re-initialization. It was a long way between Kenya and Brazil, the long way around. Generally winds deflected both much the same, but resonances were building up at times, and they were not always in phase between the two taught threads. Then indication that the two had actually been superimposed together; yet, it did not fall; the boundary layer of air molecules had provided adequate bearing function surface to keep the two from direct physical contact. John said let it be for now; he headed to bed.

They awoke in the morning snuggled under thermal blankets, for the first time in weeks. A refreshing breakfast enjoyed of fried quail eggs and fried quinoa patties sauced by spicy pureed cockroach, ignoring the mild seaside aroma of the crowded crustaceans and seaweed bucket aquariums, getting a bit thinned out now. Feeling rejuvenated it was time to get on with the next phase of the experiment. Loading the remaining carbon fiber into their cargo hold, and re-supplying provisions, back into their high altitude environmental suits they soon were again over the clouds headed to the Brazilian tower's top. A few hours later they were unloading the two spools of carbon fiber armature thread onto the tower's former terminal hub's floor. Carefully

rolling one spool over close to one of the maglev pillow blocks, neither he nor Donna could see any sign of any fiber there; but their Holoterminal helmets let them see that there were high velocity fibers streaking in and out of those pillow block bearings, going a bit faster than orbital velocity inside the boundary layer each fiber had made in the thin air. Not to be touched.

Yet the next experiment would involve them being touched, in a way. Could such a seed structure be used to scale itself up? One of the spools of fiber was placed between the accelerator and the exit pillow block; the carbon ion emitter was checked to verify it was fully filled and powered; but any attempt to get the end of the spooled fiber to contact the speedy fiber failed. So the alternate experiment was begun: they activated the carbon ion deposition that had been used for fusing two fibers together, but this time it was just left running, adding ions to the fiber. In the Holoterminal's microscopic awareness of what was happening, the build up of carbon from the ions onto the hurtling fiber was putting the ions into proper place, except there were gaps, it was an uneven layer being added. So they installed a tube from the accelerator's output all the way to the edge of the exit maglev pillow bearing, applied frigid liquid oxygen to the inside of tube and on the inside it froze out the air, creating a partial vacuum inside the tube, and into there the carbon ions were injected onto the fiber, and they took. They waited the 70 minutes while the process continued, and observed the starting point go past again, now a few molecules thicker. It was working, yet the deposition rate would take eternity to build up to the desired girth. And how to get the necessary steel particles embedded and properly magnetized had yet to be figured out. But, they were learning things.

And people up there in the Clarke Belt Cities were getting antsy to get down to Earth. They saw some of their fellows at work down there; the temperature at the equator had dropped

two degrees and at the poles 4 degrees; soon there would be a need for lots of people to get down there and plant new life all over the place, a worldwide national park tended by every person on Earth. The vast majority of people going down at first would be Environmental Engineers and Technicians; the conditions were not already stable enough that farmer methods would work. An adequate transportation system just had to get going as soon as possible. But it was no way near ready yet, nor did they really have a solid concept for how to get it completely done. But they were learning good stuff. Ion deposition units were set to working continuously on all three of the towers, but it was a slow process and eventually would reduce the ability of the initial embedded steel magnetized sections to function as the armature for the more non-magnetic carbon fiber's massive substrate.

Donna had been relaxing reading about Old Earth's technological history, and had found the Los Angeles story of the struggles to bring water hundreds of miles from a mountain river, to the growing desert seaport town. Involved in places were large steel pipes, serving as siphons over mountains. At one time, due to major vandalism that the long aquaduct from Owens Valley to Los Angeles was often experiencing, a kinetic suction had collapsed a section of a siphon, and plans were made to fork up hundreds of thousands of dollars for replacement pipe to be put in. But their non-degreed, but very savvy, chief engineer first set up an experiment, where he closed off the output end of the collapsed steel tube, and then opened up the source of input; the force of the mass of water hitting the inside of the collapsed tube re-inflated it, and it was back in service, no replacements needed. The collapsed tower here at Cayembe, like many others around the world, had to be re-created. But could they be patched and re-inflated to get them back up in the air again, she wondered. She got John's imagination going on the idea too; they took a break from the routine and went exploring over where the remains of the Cayembe

Terminal's tower lay across the landscape, a 24 kilometer long fallen pillar across the Cayembe Peak mountainside. Hiking along its fallen length, they could find no rent until they came to the fallen upper platform; here, the platform had split out. And they had the feeling that the fall had not progressed violently, but almost gently. What had the tower been filled with? Air pressure, they had always assumed; but what if it were with water? Pressurizing a sealed water container was quite conceivable. Once filled, very little change in water volume would make large changes in the internal pressure. And like a balloon, it was the internal pressure that had enabled these enormously tall towers to stand. They now had almost constant torrential rains here, like much of the rest of the planet was experiencing. Plenty of water was being delivered to the construction site.

They had the tower's upper floor re-attached and sealed to the tower's pillar; and had a cistern made to catch rainwater, and they set a water pump to pump water into the interior of the collapsed tube, another long term project. Little to lose; this could chug away mindlessly for months over here unnoticed. So they left it chugging away, pouring into what seemed to be a port accessing the bottom section of the hollow inside of the fallen tower.

Returning to their home and its Holoterminal, they discovered that the demand now was to make progress on the KESTS to GEO part of the project. They thought there were too many little projects going at too little speed; but, they needed to make progress on something each day, so that was as good as any for now. They had had plenty of time to sleep on the problem of how to re-create the KESTS to GEO; so it was now time to do some more brainstorming about it.

The original KESTS to GEO was supported by the outward supra-orbital velocity of the vast streams of armature segments and they were endlessly bent inward around by the

maglev tracks in the hard vacuum maintained by the tubing, encircling the Earth, which they supported by their aggregate outward centrifugal force.

The manufacturing and test process of making those armature segments was an infamously difficult thing to do, history related; even though the exact details of how it was done was long lost. The lack of that manufacturing technology, plus the sophisticated sensing and pulsing of the accelerators on each and every armature passing by it, as controlled by the vast servo-position feedback system throughout the transportation structure, was still holding up efforts to re-build that KESTS.

That was why they had been focusing on building the SolidKESTS type technology structures, which utilized continuous armature bands instead of streams of armature segments; the continuous nature of the armature fixed the position of the armature magnetic fields in the armature, simplifying the accelerator activity enormously. But the "solid" continuous form of armature meant that most of the structure was in high tensile stress since the entire armature had to be always going faster than orbital velocity at any altitude, so as to freely maintain its hoop shape without collapsing in the gravitational field of the planet. The high speed armature was nothing to be touched, however, and the gondolas used on the SolidKESTS they had been using went up and down the hoop using modulated drag on maglev bearings looped around the upward-moving side of the SolidKESTS hoop. But only one gondola direction could operate at a time on such a structure, going up or down at any given time. So the transportation capacity was very limited and was relatively slow.

They needed the outer sheath of tubing for the structure, for supporting the maglev tracks for bi-directional travel on the structure, and for structural protection against flying things

bumping into the structure. So, could the SolidKESTS be operated within a protective tube? The weight of the tube would be supported by speeding the SolidKESTS armature inside to much higher velocity, to provide the outward centrifugal force against the tube's mass to balance the weight of the tube being pulled downward by the earth's gravitational field. So how could they emplace a seed structure of that type that could be quickly scaled up to full operating capacity girth?

Chapter 28 From SolidKESTS to real KESTS

Deciding that creating a seed structure of that type of KESTS to GEO merely to see if it would work, was an appropriate goal. Even it it had to be torn down, learning what really happens in such a structure would be preliminary to starting to build a useful larger one. Solid KESTS as an inner armature seemed a lot easier to make than the discrete armature segments version, but if there were a breakage somewhere, even of one of the armatures, it was likely that the tensile stress energy of the fully unleashed armature would wreak havoc on the rest, it containing the entire stored energy of that solidKESTS; the use of armature segments enabled controlled shutdown processes that minimizes the need to cope with wayward armature kinetic energy.

So a design was sought of a standard KESTS sub-hoop that would consist of a SolidKESTS armature sliding in an associated stator maglev track that was made of material as strong as the SolidKESTS used, the two inherently formed to be interlocked along their mutual maglev track so the stator would be capable of restraining a broken armature, its strength taking up the tensile load until a repair could be effected. The function of a KESTS's stator were to provide anchoring of the overall transportation structure to the planetary surface, to provide trajectory definition for its armature(s), to provide support for maglev tracking used by the spacecraft moving up and down the structure, and to provide lateral positional coupling between armatures moving in opposite directions around the overall hoop structure. So that meant that the stator would need to be made of carbon nanotube fiber too. It would need to be manufacturable in the complex cross-sectional shape that would provide tubing's exclusion of air from the interior path of the high velocity armature traveling within itself, coupling to adjacent similar stators, and some to provide anchoring for

the vehicular maglev tracks on the overall outside of bundles of such sub-hoops. As a principle for easier calculating the component structural masses, it had long been a convention to make the mass of the stator be equal to the aggregate mass of the armature, which meant that the velocity of the armature would be a little more than twice its free-flying orbital velocity. Although refined computer modeling surely could have optimized the ratio, this convention had been adopted back in the original KESTS to GEO design, and seemed reasonable to continue it on a SolidKESTS design.

If the maglev track field strength was capable of sustaining separation at more than twice the normal operating velocity of the armature, and the structural material capable of enduring the resulting double tensile stresses, then one such sub-hoop would be capable of supporting the inert weight of a similar sub-hoop until it was put in place and then its own armature would be brought up to speed, thus enabling a scalable structure function.

So, it looked like they had the design principles of a working KESTS to GEO that was scalable up to useful size. But how could the first, seed sub-hoop be put in place? Could the existing raw SolidKESTS be used for that? Possibly a single, one-time-use version which could connect to either kind, could be made. It would need to be small, overall mass equivalent to the three loaded gondolas the existing structure could lift up. Dynamic braking against the upward moving side of the SolidKESTS would lift it up to GEO; then gravity would pull the leading edge down back along the downward side of the SolidKESTS, until it was back at the Cayembe tunnel, where the two ends would be joined to make it a full hoop. Then its armature would be started up so as to make it support its own weight. If this addition could support twice its normal tensile stresses and have its armature run at twice its normal operating speed, it could be used to lift up an equal copy of itself, and the bootstrap construction would be

thus begun.

Then how to dismantle the SolidKESTS, without risking destruction of the new KESTS? Well, it had been built up from a seed version, and so it seemed likely it could be similarly taken down layer by layer. The intention of all KESTS design was that they could be dismantled safely at the end of their operational life, without risking the safety of whatever newer version was taking its place.

It looked like the integrated design had a way to get from here to there. Fabrication was started up in the Clarke Belt City industrial park areas; the resulting components came down on gondolas to the Cayembe tunnel site.

Meantime, John and Donna's expertise was freed for awhile, not being much involved in the physical implementation of this structure. So they took hikes out to check on the progress of their pumping up of the fallen tower nearby. The internal volume of such a tower was immense when upright. This one had flattened its base area when falling, but had held its internal cross-section fairly well upon impact to the ground, suggesting that it was still dynamically pressurized at that instant. Could the inflating interior get the base to support the 24 km long lever arm to tilt up the weight? Not likely. What would actually happen? They were going to find out, about the time it got filled up with water and began to show pressurization.

They found out a lot quicker than that, as the lowest part got filled up with water, they discovered that the tower actually had been made of a series of chambers separated by bulkheads; as the bottom chamber filled up, it ballooned out and began the task of trying to lift the weight of the 24 km of steel tube laying across the mountain side. The internal pressure began to go very high, beyond what the pump could produce, and there was the stalemate. So they tried an

experiment, bringing out a cutting torch they cut through the weld they located between the lowest and next to lowest part of the tower; thus freed, the lower part was able to be pumped back up into shape, a huge diameter cylinder 100 meters tall. Except now there was all the rest of the tower still on the ground. It began to be clear that the empty sections had been somehow lifted up into place, welded to the existing tower part, filled with water to pressurization level, then lifting the next tower section.

They had to take a break from their tower project, since the construction of the new KESTS to GEO experiment needed a lot of carbon for its construction, and the Clarke Belt Cities already were suffering from lack of carbon; that was one of the resource acquisition that had driven the need to build the initial Indonesian SolidKESTS. The material had to be made up in space, the hard vacuum and microgravity was needed for the efficient and rapid manufacture of the bulk material and especially in the extruded forms needed by the interlocking armature and stator configuration, made by the hundreds of thousands of kilometers. A lot of carbon was needed, and for now had to be acquired on Earth and hauled up in gondolas. Lots of carbon.

Where to get the carbon? There still was too much carbon dioxide and methane in the air, fine sources of carbon if it could be gotten out efficiently; but that had been part of the original big problems, no mechanical way to get the carbon out. The straw from the quinoa harvests already was being sent up to the Cities for its carbon collection out of the air. The remains of the jungle held plenty of carbon in the dead trees, and John and Donna were put to the task of using one of the SPS-powered aircraft to go down and cut wood, bringing it up in its cargo hold, and put in the gondolas to go up. This was providing enough carbon to get a pilot manufacturing plant going, itself a learning process. The wood hauled up was put into a mass spectrometer total-

recycler up there to extract the carbon atoms; the hydrogen, oxygen, and minerals were also produced from the wood and had to be stored.

To make it more efficient, a small mass spectrometer total recycler was sent down on a gondola, along with a large rectenna for it. Although the abundant solar power up in GEO that was normally needed to make the total recyclers work, was not available on the Earth's surface; but for this relatively small scale effort, they could beam electrical energy down from SPS in GEO to power a little recycler on the ground. The recycler was set up a ways from the rest of the growing community around the Cayembe tunnel; a dedicated SPS continually poured millimeter energy down to be rectified and drive the recycler's enormous energy appetite, as it pulled in air and spit back out everything but the carbon. Quite inefficient, but it was producing pure carbon as its product, which was efficiently hauled up gondolas to GEO for the manufacture of the carbon nanotube armature and stator assemblies. Some of the oxygen byproduct was fed into the enclosed atmospheres of the living quarters there at Cayembe, helping the breathability up there in the thin and still a bit toxic air up there, brightening people's outlook.

Finally there was enough of the interlocked maglev material, made into the double use form that would also slide along the edge of the existing SolidKESTS sent down on a reel in a gondola. Plenty of carbon had been sent up to GEO by then to build many layers of the new KESTS structure, as well as extra essential food and supplies for those on the ground, in case the experiment caused the destruction of the SolidKESTS link to GEO.

Chapter 29 Spinning precious carbon

The tower re-construction project that John and Donna were focussing on currently, was not going well. They visualized how a tower could be rebuilt, using a spiral staircase going up its exterior, for use by mechanical conveyance of steel "bricks" to be welded up in a spiral to for the outside of the tower, periodically putting in bulkheads sealing below and then pressurizing the interior. But 24 km was a long way to be hauling bricks up and for welders to be setting up the wall steel brick by brick. One such tower could take years to do, and there were hundreds of towers to be put up for the return of people down to earth to their homes again.

Finally Donna suggested that they see how low an altitude a SolidKESTS could be run at. The existing SolidKESTS dropped down all the way to the tunnel here and also had done so on the mountaintop in Indonesia before. Of course, the high velocity ribbon spent only a tiny fraction of its time in the atmosphere. They had plenty of electrical energy to input to such a system to make up for losses from friction sliding through the denser atmosphere, as beamed down from SPS in GEO. It was not the same situation as existed before the Clarke Belt City ring was built, with their vast supply of SPS now up there. How low an altitude could a Circular SolidKESTS operate at continuously? Could one even operate at the altitude here in Cayembe? Or would it have to operate above the storm clouds?

They decided to test that which was easiest to test. Pairs of pillow block bearing and armature accelerator assemblies had been sent down in gondolas when spare room was available, and there were a dozen of them on hand. They requested four large angle brackets designed to support such accelerator assemblies attached to the side of existing towers. For convenience, they would attach one such angle bracket

holding an accelerator assembly, to the edge of the top of their 100 meter high re-inflation attempt at their tower here, which was associated with the Cayembe tunnel site of the former huge terminal complex, which would be easy to connect together for significant usage if all went well.

A week later they had the four large angle brackets on hand; this clearly was a high priority effort per the fabrication shops up in GEO. They used their SPS-powered airship modified a bit for the task, to lift the bracket and accelerator assembly up into position on the east-west edge of the tower's stump, and practiced attaching it there with adhesives, since welding of the thin steel shell while under enormous internal pressure was very unwise. They hooked the accelerator up to power and it was set to go.

Now to do the same thing on the side of the three full-height remaining towers. Putting one of the assemblies in the cargo hold, set to lower by a winch and boom, they packed a lunch and headed for the Brazilian coastal tower. A few hours later they were busy attaching the angle bracket to that tower at the same altitude above sea level as was the top of the 100 meter high tower on top of the Ecuadorean Andes Mountain Cayembe Peak, and checked out what it would take to modify the tower's elevator to have a stop at this altitude. They returned to Cayembe and the next day they returned to the Brazilian tower with cables and a footbridge, and connected the footbridge between the accelerator's pad and the side of the elevator shaft. Torching a doorway into the elevator shaft, they went in and attached power from its cables and now the accelerator here, too, was ready to go. And they had practice at the process; ready to go for the two African continent remaining towers.

Two weeks later they had rested up after the lengthly trips to install and hook up accelerators at the 6 km altitude on the sides of the Zaire and Kenyan towers. Time to sow the seed

SolidKESTS if they could do that. John and Donna each flew separate SPS-powered rigid airships for this task. John would fly ahead and higher, carrying the de-spooling carbon fiber steel-particle-embedded armature thread, while Donna flew behind and to the side about a kilometer. As they approached a tower, John would fly past it thirty meters above the platform on the side of the tower as the tread continued to pay out; Donna would come to a stop at the tower, hovering above the thread, and deploy the thread guide boom, and push the thread down, guiding it right into the open clamps of the pillow blocks. When she saw that the clamps had automatically clamped around the thread, she they would accelerate fast out to catch up with John's airship. Even then it would take her about an hour to catch up with him, flying just below the speed of sound to close the gap.

It was a repeat of the original emplacements of the pair of contra-rotating seed Circular SolidKESTS connecting the towers around the planet, this time at the lower altitude of 6 km. The accelerators speeded the thread armatures up to above orbital velocity at that altitude, stretching them taught in their circles.

Back on the top of the tower stump at Cayembe Peak, home sweet home, they had little time to rest, as they had to set up the carbon deposition tubes so as to begin the scaling up of the threads to usable girths. They were experimenting this time with iron atoms laced into the carbon nanotube fiber, and installed a laser that heated the passing thread to the critical Curie magnetization temperature of the iron, which then took on the magnetic polarity at the site. after it had just come out of the re-accelerator and thus synchronously locked re physical position. Every 8o minutes, the polarity of the applied magnet was reversed, and the laser selected the distance from the accelerator that marked the location of where that polarity of armature would be located, and thus re-magnetized the whole armature, including the newly

deposited iron particles in the thread.

Although the artificially partially evacuated tubing and carbon nanotube formation deposition techniques piled the carbon on, so to speak, it still was a very slow process. Yet, it was being done down here on the ground, using carbon extracted from the air by the small mass spectrometer total recycler on site, powered from SPS in GEO. The carbon did not have to go up for processing in the GEO environment.

By the time the two carbon fiber ribbons had grown to a millimeter wide, it had been decided to test the assembly of the interlocked microKESTS scaling technique on them instead of on the SolidKESTS linking Earth and GEO; a failure and destruction on the ground was preferable to breaking their only uplink from ground to GEO at this point. So a reel of the coupler form of sliding armature KESTS was fabricated up in GEO; then brought down and put on the top of the tower stump.

John and Donna were the most experienced in dealing with the high velocity and nearly invisibly tiny carbon fiber ribbons, so once again they were at the front, in fact, everybody else was brought inside the Cayembe tunnel's utility caverns for safety. If the ribbon broke, despite its tiny girth it contained a lot of energy speeding along at 8 km/s. And things happened very quickly at such relative velocities; John and Donna were not expendable but were the most capable and this was a critical experiment to do well.

They mounted the spinning reel adjacent to one of the ribbons on the accelerator deck, aligned with one edge of the millimeter-wide high velocity ribbon. Using a Holoterminal microscopic view and micro-manipulator, they eased the slot of the maglev into one edge of the ribbon; then similarly eased the clamping one on the other side of the ribbon. The new interlocked maglev assembly was itself extremely thin,

as the aggregate weight would need to be supported by the existing SolidKESTS all the way around the planet between the towers at first. The maglev seemed to be working, so they released the brake on the pair of reels and they began to deploy the clamping pair of micro-maglev interlocking prefab ribbon, and the electromagnetic drag began to haul the new ribbon addition out faster and faster until the vibrations began to form a safety limit, as the added ribbon was pulled sideways off the reels. It took about a day at that speed to deploy the 40,000 km of ribbon, and the initial end came back around and was flash welded head to tail and severed from the reels; one layer done. Then the same thing was done on the contra-rotating SolidKESTS. So far, so good.

At this point both the armature and stator were riding around the circle at about the same speed. The next task was to electrodynamically brake one of the stators, while using a new set of accelerators to speed up the interlocked armature by the same amount, so that by the time the stator ground to a halt relative to the planetary ground surface, the associated armature would be going at twice the orbital velocity, about 17 km/s to maintain a bit of outward stretch bias overall. This had to be done slowly to remain below the compression buckling limit of the thin ribbon's maglev bearing tolerance. When both of the contra-rotating ribbons finally had their stators stopped and anchored to the tower, there was no time for celebration; but instead they set up the next set of deployable maglev-interlocked stator-armature reels brought down from GEO on a gondola, and set it to be dragged out against the first set, which had its armature speeded up in proportion to the weight of the added material being draped along itself around the planet, the armature within the first part now being speeded up to 4 times the orbital velocity. Then as the armature of the newly added part got speeded up to carry its own weight, the armature speed of the earlier one was slowed down toward its normal 17 km/s speed. Soon an

automated system of bringing down prefab interlocked maglev ribbon on gondolas from the manufacturing facilities in GEO, over to the scaling input site atop the tower stump, and the further scaling up could be done remotely via HoloPresence for awhile; time to take a break for John and Donna, at long last.

Chapter 30 Mankind returns to Kenya

The scaling up of the 6 km altitude Circular KESTS proceeded well, the stators between the two direction sides of it not only anchored to the four towers but now all along the circumference, forming a surface that seemed a ground reference all the way around the planet at 6 km altitude. So the next layer of interlocked ribbons laid across that one also included an upper layer maglev track. When it was finished across the entire width of the KESTS ribbon, now 3 meters wide, the gondola brought down an experimental vehicle, one that would slide on the maglev track grooves in the top of the Circular KESTS, and inductively brake on either the eastward or westward moving solid KESTS armature fields. It was a streamlined bubble vehicle, which could be remotely controlled via the Holoterminals. The later intention was to have narrower vehicles going both directions around the Circular KESTS; but this vehicle had the whole thing for itself, so it was the full three meters wide. A few inert sacks of rocks were put in to simulate some cargo, and the vehicle was remotely coupled to the eastward-moving Circular KESTS armature field coursing underneath it, sapping a miniscule fraction of its momentum; the accelerators on the towers quickly noticed the phase delay and poured extra energy into the armatures to compensate for the live load, all working. The maglev-tracked vehicle quickly speeded up to where its small wheels were lifted off to then slide on air bearing surface until the velocity got up to 300 km/h where the maglev bearings took over and soon the vehicle was going at its planned cruising speed of 650 km/h. Two and a half days later the vehicle showed up at the Cayembe tower again, this time coming in from the west; it had made their first trip around the world, celebration time. The folks up in GEO sent down a gondola full of champaign for the celebration, but under the bubbly were containers of parts for helping do the same conversion to the SolidKESTS now

linking the Clarke Belt City ring to the ground. Keep the gondola down there, they said. They had plenty of gondolas up in GEO and with luck would never need them again.

The process of assembling the maglev-groove interlocked KESTS to the high velocity existing KESTS ribbon was begun up at the terminal in GEO, high above Indonesia. A good supply of carbon bricks had been brought up in gondolas from the ground, enough to get the structure up to the equivalent capacity of the one now running down there linking the towers. This one was assembled a bit differently, the interlocking maglev micro-tracks designed to kick out any air molecules that approached the space between the two sides of the maglev surfaces, for when it was it was within the atmosphere; thus the maglev track was optimized for operation in hard vacuum all along its path. Its path was about four times the path length of the Circular KESTS, so it took that many times longer per loop, and that many times more construction material to build.

Several sets of maglev and drag interface trollies had been delivered down to Cayembe for use on other kinds of vehicles, some full-width and some for two-way traffic. So one of the swept-back airfoil airships was equipped to ride on one of the full-width trollies, and John and Donna chose to take a mini-vacation in it. Stocking up on nutrition and emergency survival supplies as always, they soon were riding the CircularKESTS eastward; as they approached the Brazilian tower, they requested SPS power to their rectenna; and unlatching from the trolley, which they put in a holding autoposition mode, flew down to the base of the tower, for a visit with the two environmental engineers resident there. Freed from fear of invasion by the Amazons - the name had stuck - the testing of various plots of organism diversity mix was showing results, including some that were just struggling along, plus a couple that were thriving and already expanding their perimeter. While there, John and Donna

modified the elevator so as to have a “floor” at the 6 km level where the new Circular KESTS now linked around the world, so now there was an alternative way to get from the Brazilian tower to the Cayembe tower's stump, besides use of aircraft. John and Donna flew their airship back up to dock onto the maglev trolley that had been holding position for them, the orbiting Solar Power Satellite was released from duty powering their aircraft, and they resumed their journey, now headed out eastward across the Atlantic Ocean. They made similar pitstops at the Zaire and Kenyan towers to similarly finish converting the elevator to have a usable “floor” to stop at, linking to the 6 km altitude KESTS.

Then they continued their around-the-world vacation, eastward out across the Indian Ocean until leaving the KESTS to fly down to deliver a package of supplies to the folks at the former Indonesian site; then they began an arial search for remains of the giant towers which surely had been across these island nations. They found one in Sumatra across from Singapore, no doubt the major Asian link for the exodus to GEO; they also found a tower remnant deep in Borneo, and another in the interior of Indonesia. These were all near sea level, however, no easy way to re-build a tower that high yet had been devised. Then they continued on their journey around the equator, crossing the Pacific Ocean, half way around the planet, just water below. The original Circular KESTS had thus only linked at sites around half the planet. Probably the Asians had used the trans-pacific direction, leaving the trans-atlantic for the rest of the folks. The buffeting by storm winds were deflecting the KESTS quite a bit; they wondered if a tower could be built on some small islands out in the Pacific which were close to the equator; but then they realized that there were no hordes of people there who needed a ride up or down. Yet it seemed like a useful thought, a tower linking some vast oceanic floating research facility anchored to the tower's island, a major facility for the rejuvenation of the ocean. Such a tower

ought to add more stability to this part of the Circular KESTS, anyway. And finally they arrived from the west, glad to get back to their nice home at Cayembe, a rest from their “vacation” trip around the world.

The testing of the same technique of the interlocked maglev microribbon KESTS ribbons was found to work in the varying gravitational field between the earth surface and GEO, the continuous “solid” armature taking up the slack through its tensile stress, and concurrent deformation at the higher altitudes, from the more elliptical shape of the original form of discontinuous armature KESTS. Scaling up was going well, going both directions along the contra-rotating sides; a month and a half later they sent a remote controlled maglev vehicle down to Cayembe, on around and back up without stopping, and the GEO terminal folks celebrated with the cargo of champaign that had thus been delivered to themselves.

Although their new KESTS to Earth could not support the huge mass of a fully loaded spacecraft of the type used to bring the population up here, of which there were hundreds of the spacecraft mothballed up in GEO, they copied the design in miniature, to be used when the new KESTS would be scaled up enough to carry it, expected in a couple more weeks. This spacecraft would slide down the maglev tracks, braking against the upward-moving high velocity SolidKESTS parts of the structure, to ease them down to the Earth's surface. They were working on the form of lowering which was originally used, which was to synchronize the pushing of the armatures on the downward side, making them go a little faster, adding the descent energy back into the system, much more efficient; but for now, just the more primitive dynamic braking against the upward armatures would get the process going.

The miniature captive spacecraft would carry ten adults and

an equal amount of inert cargo. It followed a path that sped up rapidly at the upper areas so as to pass through the radiation belts as fast as possible, then used the electrodynamic braking at a little over one gee until arriving at Cayembe tunnel. The first load consisted of environmental engineers who had their homes located near the Kenyan tower, taking along their weight in household treasures; with added supplies given them at Cayembe, they then rode the CircularKESTS eastward a quarter of the way around the planet, to the Kenyan tower, where they rode the elevator down to the ground level. The first group of the de-exodus had arrived on their home soil.

John and Donna had flown their SPS-powered airship nearby, accompanying the Kenyans on their KESTS ride back to Kenya, in case there was unforeseen problems. They also were there to scout for them on their way to see what their long-abandoned homes looked like. Environmental suits were still advisable on the surface there; it was only a couple hours' walk from the base of the tower to their homes, was part of why they were selected for this initial trip back. They found their homes had suffered the neglect of almost two decades of standing unoccupied, even though somewhat mothballed for a much shorter intended time. Boarded-up windows were still intact; unshuttered windows often had been blown out by the storms, and the interior was damaged in those areas. John and Donna helped set them up with rectenna power separate from the municipal electric power system, which was of course not operating. A SPS overhead in GEO would beam down a trickle of its electrical power to energize their homes; the same SPS was there to provide even many gigawatts to power the whole city when it was ready to use the energy.

The tram on the CircularKESTS headed eastward again, unloaded now; for the near future, it was decided to use the three-meter wide vehicles which took up the whole maglev

track width, which meant traffic could go only one way. And for safety, it was decided that the only stop would be at Kenya, unless careful scheduling would prevent a Kenya-bound vehicle from colliding with one parked at the Brazilian tower or Zaire tower. A similar down one side and up the other side scheduling was adopted for use of the KESTS between Cayembe and the GEO terminal transportation; at least there were no intermediate possible stops along the way along that path.

The next several captive spacecraft traveling from the Clarke Belt City ring GEO terminal down to Cayembe and then to Kenya carried electrical engineers and their families, specialists in setting up rectenna-sourced electrical power to the municipal power grid, in place of the original fossil fueled power generating plants. This would be the model city for the new type of SPS-electrically-powered civilization's re-growth. A second and then a third captive spacecraft was fabricated and began hauling people down to Cayembe terminal faster than the one existing maglev vehicle could carry them to Kenya, so several of the original lander gliders were modified so as to serve to carry four people at a time along the CircularKESTS to Kenya. John and Donna could carry two passengers in their airship, along with a lot of cargo, so they also helped with the movement of people and supplies from Cayembe to Kenya.

When they had what was considered a viable sustainable population there in Kenya, in case of disaster in next steps, they finished the mini-de-exodus to Kenya for now, with a population there of 3,000 people and a rectenna-supplied electrical power system providing abundant electrical power to enliven their homes and light industry shops, mainly supporting the environmental engineering and the beginnings of outdoor agriculture in addition to some dome-enclosed agricultural areas for the immediate future's nutritional needs. They were also supplied with the equivalent of the

"digestion tank" technology for use if things went sour re more natural sources of nutrition.

Similar precautions were made for nutritional survival at Cayembe, while more importantly a large staff for the transportation hub's re-creation were brought down the KESTS along with a stash of three months food and supplies for them.

It was time to shut down the transportation structures to resume scaling them up toward operational girth. The next would use interlocked maglev ribbons ten times those used so far, as the structures could easily carry more now during each layer's emplacement, before they in turn being powered up to support themselves plus some payload. But there was always risk when making such a big change; the spools were also ten times as large, getting quite unwieldy to move around and into place at the terminal. Enough reels of an intermediate size maglev ribbon were sent down to the ground for scaling up the Circular KESTS there, and also to scale up the existing three-tower top seed circular SolidKESTS to be of useful girth, able to at least link the three towers still standing and linking South America to Africa thereby, as an alternate path. Then the GEO to Earth surface KESTS downlink was shut down for scaling up; when the last of the Kenyans had been delivered from Cayembe along with their supplies, the 6 km high circle was also taken out of service to be scaled up to increase its carrying capacity tenfold, if all worked out OK.

A parallel effort was mostly done by John and Donna, now experts in the initial scaling up from a seed KESTS. They also were able to fly their airship up to the top of the tower, and to any of the three towers if need be; but for now they lifted spools of KESTS ribbon from the 6 km deck of the Brazilian tower elevator to the tower top, and began the de-spooling of the microKESTS ribbon from there.

When the first new layer of the KESTS to GEO was added on, the original pair of SolidKESTS were slowly brought to a stop, their deadweight now being negligible in comparison to the girth of the present girth structure, dead weight being considered much preferable to them being a potential loose cannon deep inside the crucial transportation structure. Those original SolidKESTS had served their purpose, and had done it well; and now were cocooned deep within the structure they had enabled built. Similar advise was sent down to the people working on the 6 km high Circular KESTS; and the 24 km high version was to be grown from seed only enough to support the first of the interlocked KESTS ribbons, and to be shut down as soon as the added interlocked ribbons were able to support their own scaling up.

The creative scientists and engineers up in the Clarke Belt City ring were now put to the task of figuring out how to re-build the 24 km high towers, up where the vehicles could travel much faster. Although they had not been able to figure out how the original makers of the discontinuous armature mass stream KESTS to GEO had built the KESTS that had enabled the exodus up here, they had figured out an alternate way to do it, and that seemed to be working. Now although they also had not figured out exactly how the 24 km high towers were assembled, could they figure out a variation that they could build? The principle of using high internal pressure inside a steel shell tower, inflated like a balloon, supported by the kinetic energy stored within itself. In a way, the KESTS also supported itself by the kinetic energy stored within itself, too; but that was a directed focused form of stored energy expressing as outward centrifugal force, in opposition to the inward force of gravity on the mass. The towers were just using omnidirectional energy storage. If they could even create towers that would only last long enough for the return from exodus, maybe that would be adequate; maybe something that used energy beamed down

from SPS in GEO, currently in abundant oversupply. Could they create some directional form of energy storage in a tall tower, since the majority of force was needed in the vertical orientation. KESTS needed the mass of a planet so as to bend itself around the planet to form the closed loop, thus was unsuited for this task. Enormous magnetic mass stream benders were conceivable at the base and top of tower, and be powered by energy beamed down from SPS in GEO; but they lacked the resources to build such unwieldy benders. The principle of a vertical fountain supporting a weight balancing up at the top of the fountain, had long been known and suggested over the decades, so they re-explored those possibilities, this time with plenty of electrical energy available.

They also explored other means for getting the task of getting people back in their homes down below. Probably 5 billion people needed to be moved; the last poll indicated that 2 billion people wanted to stay up here in the Clarke Belt City ring, considering it a better life than they would have down where they came from. Five billion people moved within 15 years, not do-able by re-entry vehicles, nor by aircraft from Cayembe.

Or could they? A SPS in GEO could track an aircraft's rectenna, delivering even terrawatts of electrical energy if needed, no problem with propulsion energy, and no fuel to be carried along. Streamlined neutral buoyancy SPS-powered inflated rigid airships ought to be constructable to quite a large size, largely strengthened by the pressure of hydrogen stored inside, aircraft-shaped balloons, gigantic versions of the aircraft being flown by John and Donna. It would be better to build such large components down on Earth, so it was decided to build a combination SPS-beam-powered carbon extractor from the air, as integrated with a carbon nanotube fabric maker inside a large pumped-down chamber. All quite energy-inefficient, but for now they had far more

energy delivery capability than was needed until the cities were re-populated.

By the time the KESTS from GEO had been scaled up to its next useful level, some vehicles were ready to ride it down. These were carbon nanotube woven fabric gigantic balloon aircraft, with rectennas built into their upper surface, The first captive vehicle descending to Earth was one such vehicle, essentially a trolley that would drop off its crushed fabric cargo to Cayembe then the trolley would return up the other side of the KESTS.

John and Donna were there to watch the unloading of the huge wad of black fabric off the trolley, then see the unloaded trolley head back up to GEO, out the other side of the tunnel. The crumpled up huge knot of fabric was hauled over to a hydrogen generator decomposing water, powered by SPS beamed power so abundant. The huge wad of crumpled black fabric slowly began to unfurl itself as it was inflated with the hydrogen; it was solidly anchored to the ground. By the time it had gotten mostly inflated and looking like the largest vehicle ever seen, the big electrical motors and turbofan assemblies had arrived down the KESTS, and were mounted inside the nacelles in the stubby swept back wings. Pressure tanks were installed inside, and pumps to compress hydrogen to squish it inside the tanks so as to maintain neutral buoyancy at any operating altitude and a wide range of payload weight.

Its cockpit was fitted with a Holoterminal that had priority access to the airfoil warping servomechanisms as well as the hydrogen pumps and release valve; and soon John and Donna were in their high altitude environmental suits carrying nutrition and emergency equipment into the cockpit, and they requested a SPS to track the airship's rectenna grid all over the upper surface of the airship, activate the beam, and the huge airship bolted up and away, essentially no

payload to lift. They flew it to above the tower's altitude, then let the engines develop some of their energy to the turbofans, and the low mass vehicle was moving at a thousand km/h.

Flying the speedy behemoth back to Cayembe, they found that another delivery had arrived down the KESTS, a canister that was sized to fit up inside the airship; inside the canister were a thousand seats plus a lot of luggage space. An equivalent mass dummy load was placed in the canister, and it was tucked inside the belly of the giant airship, and Donna took the first turn at flying it this time, revving up the turbofans and adjusting buoyancy, and they were off the ground. This time it was not as agile as a feather as before, but it still was soon cruising 12 km up at 800 km/h. They returned home, and waited for a thousand more Kenyans to come down the KESTS to Cayembe, and they and their luggage and nutritional supplies for a month for them, were loaded into the canister; and away they flew. Seven hours later they arrived at the city near the Kenyan tower, and the passengers disembarked, and the supplies were unloaded. Then they headed back to Ecuador at higher altitude and faster, having no load.

Progress was being made, but how many of these airships would it take to move 5 billion people over a 15 year period or less? That would be 333 million a year; given an average time of 4 days per round trip, 90 trips per airship per year, a thousand people per trip, 90,000 people per year per airship, about 1.5 million people moved per airship in 15 years. Over 3 thousand airships. Now that would be straining the SPS in GEO capability to power the airships via tracking beams. Yet these airships could deliver far north and south of the equator, thus no infrastructure needed to go between the towers to homes that might be in, say New York City.

The KESTS now could deliver 250 passengers a day to the

ground, along with 500 kg belongings per person. The existing airship could ferry them to anywhere on the globe and return for another 1000 passengers in that time. Strategies were formed as to where to set down a thousand environmental specialists, electrical specialists, including their families, all to disembark in one place. People were selected from among those most eager to return to home down below, enough to operate it all for three months; a serious start at preparations for the return of the masses to their homes, 21,000 people back on the ground in the next 3 months.

The returning captive spacecraft coming up the KESTS would be carrying carbon bricks for making the next scale up of the KESTS to Earth, increasing its girth and carrying capacity by another factor of ten. In the next three months following that construction, they would deliver 200,000 people to their home towns. But in that 3 months, they would build a hundred captive spacecraft to be in continuous movement down and around the KESTS, two round trips per day, with efficient loading and unloading. Each vehicle carried only 100 people with their household goods, but 200 vehicle trips per day overall, that was 20,000 people a day. And that is going to take 80 airships to get them from Cayembe terminal to their home town.

The airship design was being continually evaluated via the Holoterminal observations, and it appeared an equivalent performance airship could be built to carry 3,000 people and their belongings per trip; so the design and fabrication of one such was begun, then delivered in compressed form to Cayembe for further equipping with motors and controls, and filled with hydrogen.

Since the KESTS appeared to be operating well within its capacity to tolerate transient forces, they added another 100 vehicles to the KESTS; then since the KESTS had been

operated at three times normal armature velocity to support the load of scaling up, they decided that operating at twice their normal velocity would be well within the safety factor, thus doubling again the number of captive spacecraft that it could carry. Now operating at 800 passenger trips per day, and 100 people with belongings per KESTS captive spacecraft, they now were delivering 80,000 people a day, all needing airships to take them home. Again they ran at this de-exodus level for three months, delivering 3/4 of a million people in that time to their homes.
It was time to change the size of the interlocked maglev armature-stator ribbons again, this time making them four times larger in girth, and the scale up would be another four times this time; their analysis in detail of the history of the project suggested this could be done with equal risk as they had been running at so far. When it was finished in this scaling up, vehicles were added to take advantage of its increase in carrying capacity of 16; they were now able to lower 80,000 times 16 or over one and a third million people a day. As soon as the ecosystem down there had been revived enough to support them safely in long term health of the world ecosystem, the KESTS was now able to get them down within the 15 years time span.

Now came the biggest task, to teach all those people how to live in responsible harmony with the planetary living ecosystem. They would have to spend much of the first generation after return, just giving the whole planet TLC, every person. It needed to be the way of life from now on; they could do it with the unlimited electrical energy from SPS in GEO, no petrochemicals to waste on energy production.

Tracking SPS energy beams could power the big airships, and surely could power trains and ships similarly. Yet the SPS-powered huge airships looked like they could handle much of the transportation between cities and continents

very efficiently and producing no carbon dioxide in the process. Civilization now could make it long term. If people would continue to function harmoniously. They had been doing it now because all knew they had to pull together to survive; and now to cooperate to get back home and get the planet back to life to support them. And they all had nice living accommodations up in the Clarke Belt City ring, ever plenty of fine nutrition, the situation equalized all people's quality of life up there in the similar rotating city designs. But once down on the planet again with its geographic features enabling separation of people, the forces that had shaped tribalism's territories might eventually happen again.

The Holoterminal technology was far too entertaining and useful in just about all activities, from the daily routine to the most advanced scientific exploration and engineering development, so it would be a new factor in the new life on the Earth surface. However, something needed to be done to enable the omnipresence nature of the Holoterminal functioning, to be able to correlate with spacial position. So they examined the recorded knowledge about a group of instruments that were evenly distributed around the City ring around the planet, which did not seem to have had any function for the people up there, so had become ignored. It was a system created for position determination anywhere on the Earth's surface; and in fact the instruments had been sent up via rocket propulsion before the original KESTS to GEO was started in construction, long ago. They were put in place to soothe the complaints from the users of the GPS type sat-nav users, having laced it even into their handheld telephones in daily use.

So the Earth-encircling satellites were put up into GEO, evenly spaced, 360 of them, and aligned with the geographical grid on the earth, one for every degree of longitude. They were fixed points, unmoving with reference to the surface of the planet; and they operated at several

frequency bands, the highest being visible light. The ground user's instrument electronics no longer needed the complex calculations required by the use of signals from fleets of moving satellites in Low Earth Orbit; the cloud penetrating frequencies used by the GPS satellites similarly worked from GEO, and when the air was clear, the laser light was also usable, enabling position fixing to microscopic levels, as well as ability to determine position by using a non-electronic telescope with precision angle measuring stand. Although these beacons enabled extremely precise longitudinal location, the latitude had to be derived from angle with the horizontal at the receiver's location, requiring the instrument to do an electronic derivation of the horizontal and do the calculation for the display to show. And an area around the poles had to be serviced differently, on a different radio band that used the bending of radio waves to tilt the signals over onto the polar areas; only three of the sat-nav beacons in GEO provided this function, but even with only a direction finder one could locate the longitude at the polar areas. It took a more sophisticated instrument to use the embedded timing signals in the three beacons to derive an approximate latitude determination, and then only good to about 30 meters accuracy.

For most of the planet, however, the GEO-sourced navigation was so very much more useful, accurate, and the instruments needed by the user so much simpler, that people had stopped using the GPS system, obsoleting those satellite uses in LEO. Before that, there was quite a resistance to building KESTS to GEO despite its enormous potential for helping civilization solve its big problems; all satellites below GEO had to be cleared out to avoid eventual collision with the KESTS. So the GEO sat-nav system was put in place and indirectly enabled agreement to build KESTS, by focussing on the position location function on the ground. That GEO Sat-Nav system had been incorporated into the construction of the Clarke Belt City ring, so a project was

begun that made sure those senders of geographic position were still all functioning properly. Another project was started to construct instruments for use on the planetary surface, that combined the HoloPaint with the sat-nav receiver; so anyone in a Holoterminal could now specifically access any such instrument; and by observing its sat-nav derived location, they would know where it was at. Besides the old GPS applications, some of these were built to be place markers on non-moving objects on the planet, marking their locations in the Holopresence system. That way people using the Holoterminals could put their virtual presence anywhere such an instrument was located, for a virtual visit to a place of great natural beauty, or into the depths of a particular flower growing in the Rose Gardens that would soon be again sprouting in parks around the world.

Now that people were again streaming down the KESTS to Earth, flying in SPS-powered airships back to re-enliven their homes around the world, and to be committed to tending the garden Paradise they had in their vision to produce as their planet, they realized that it was indeed all Down To Earth.