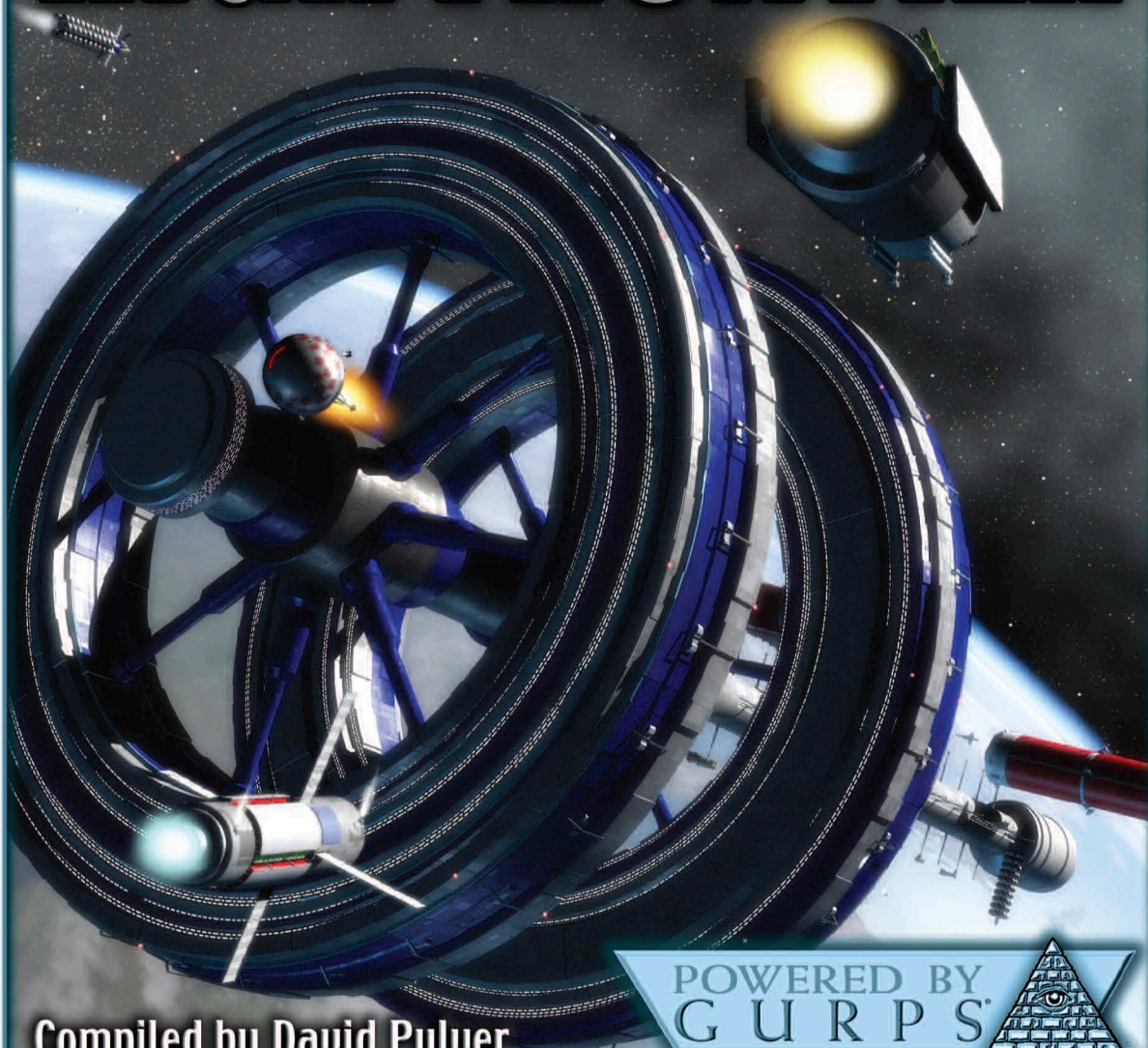


TRANSHUMAN SPACE

HIGH FRONTIER™



Compiled by David Pulver

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GURPS



STEVE JACKSON GAMES

"One giant leap for mankind . . ."

In the year 2100, Earth-Lunar space is the most densely populated area of the solar system, beyond Earth itself.

Come visit:

- Earth orbit, buzzing with busy space factories and bustling spaceports, all under the watchful eye of rival orbital weapons platforms. But the biggest danger is not the threat of war, but 150 years of space junk, moving at 25,000 miles per hour!
- Lagrange 4, where giant cities in space glitter like jewels in the night, presided over by the massive O'Neill colony Islandia.
- Lagrange 5, the ghetto of the solar system, colonized by dreamers, ideologues and undercapitalized entrepreneurs. Sometimes a dream and a prayer aren't enough.
- The Moon. We're back, and this time with bulldozers. Luna is the solar system's industrial park, with Helium-3 mines that feed the fusion reactors on Earth and more cybershell robots than people. But it's not all machines – the north and south poles are home to the pleasure domes of Moonshadow and thriving transhumanist Luna City. And on Luna's farside, a massive telescope array unravels the mysteries of the cosmos . . .

Transhuman Space is required to use this supplement. **GURPS Basic Set, Third Edition Revised**, and **Compendium I** are also recommended. The ideas in **High Frontier** can be used with any roleplaying system.



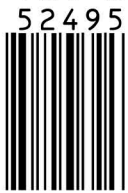
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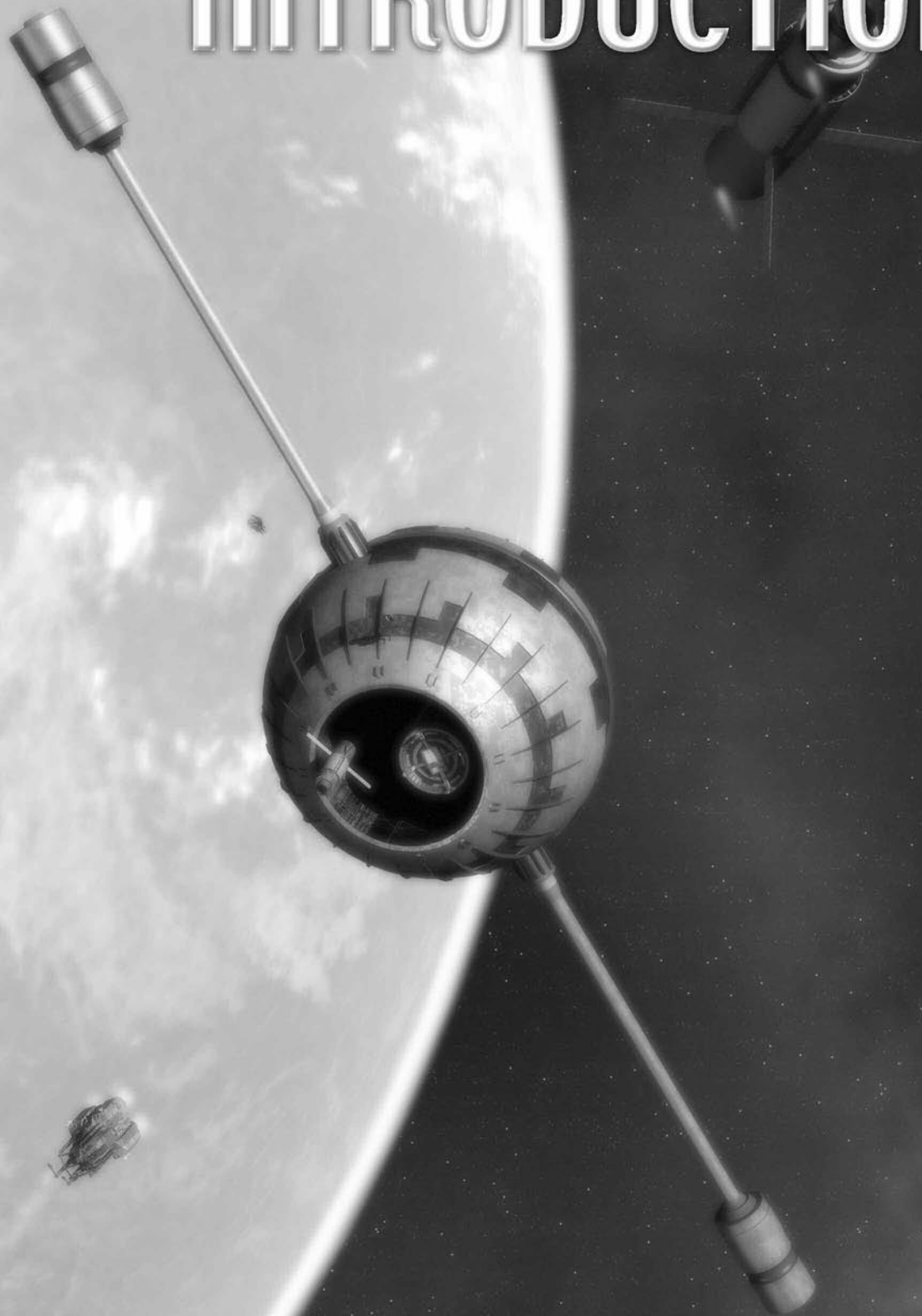
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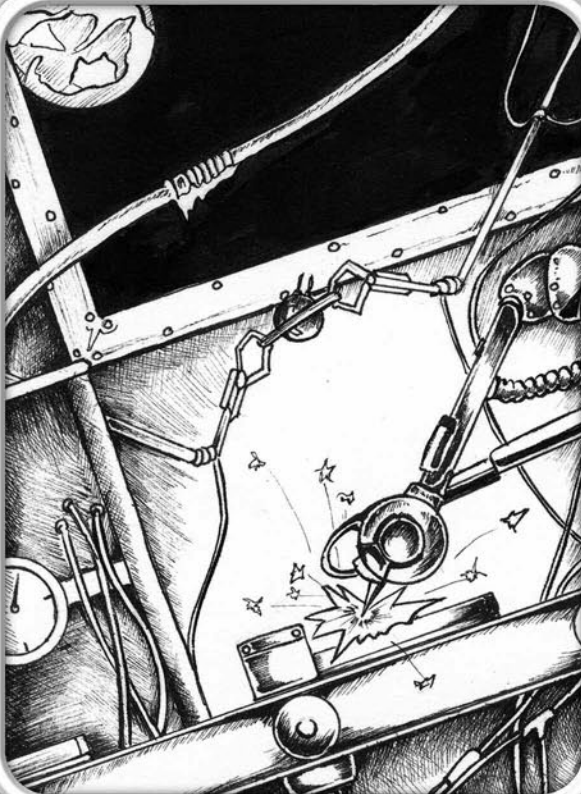
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INTRODUCTION



ABOUT TRANSHUMAN SPACE

The *Transhuman Space* series presents a unique hard-science and high-biotech universe for roleplaying. Set in the Solar System in the year 2100, it is a setting rich in adventure, mystery, and exploration of the possibilities of existence. The core book in the line is *Transhuman Space*, written by the series creator, David Pulver.



In the year 2100, Earth-Lunar space is the most densely populated area of the solar system outside Earth itself.

Earth orbit is buzzing with busy space factories and bustling spaceports, under the watchful eye of rival orbital weapons platforms. But the biggest danger is not the threat of war but the ravages of 150 years of space junk, moving at 17,000 miles per hour!

Further out lie the two Lagrange points: L4, where giant cities in space glitter like jewels in the night, presided over by the massive O'Neill colony Islandia, and L5, the ghetto of the solar system, colonized by dreamers, ideologues, and undercapitalized entrepreneurs.

Finally, there's Luna. Humans returned, and we brought bulldozers. Luna is the solar system's industrial park, with helium-3 mines that feed the fusion reactors

ABOUT GURPS

Steve Jackson Games is committed to full support of the *GURPS* system. Our address is SJ Games, Box 18957, Austin, TX 78760. Please include a self-addressed, stamped envelope (SASE) any time you write us! Resources include:

Pyramid (www.sjgames.com/pyramid/). Our online magazine includes new *GURPS* rules and articles. It also covers *Dungeons and Dragons*, *Traveller*, *World of Darkness*, *Call of Cthulhu*, and many more top games – and other Steve Jackson Games releases like *In Nomine*, *Illuminati*, *Car Wars*, *Toon*, *Ogre Miniatures*, and more. *Pyramid* subscribers also have access to playtest files online!

New supplements and adventures. *GURPS* continues to grow, and we'll be happy to let you know what's new. For a current catalog, send us a legal-sized or 9"×12" SASE – please use two stamps! – or just visit www.warehouse23.com.

Errata. Everyone makes mistakes, including us – but we do our best to fix our errors. Up-to-date errata sheets for all *GURPS* releases, including this book, are available on our website – see below.

Gamer input. We value your comments, for new products as well as updated printings of existing titles!

Internet. Visit us on the World Wide Web at www.sjgames.com for errata, updates, Q&A, and much more. *GURPS* has its own Usenet group, too: rec.games.frp.gurps.

GURPSnet. This e-mail list hosts much of the online discussion of *GURPS*. To join, point your web browser to www.sjgames.com/mailman/listinfo/gurpsnet-l.

The *Transhuman Space: High Frontier* web page is at www.sjgames.com/transhuman/highfrontier/.

PAGE REFERENCES

Rules and statistics in this book are specifically for the *GURPS Basic Set, Third Edition*.

Any page reference that begins with a B refers to the *GURPS Basic Set* – e.g., p. B102 means p. 102 of the *GURPS Basic Set, Third Edition*. Page references that begin with CI indicate *GURPS Compendium I*. Other references are TS for *Transhuman Space*, BIO for *GURPS Bio-Tech*, DB for *Deep Beyond*, FW for *Fifth Wave*, ITW for *In the Well*, SSS for *Spacecraft of the Solar System*, and VE for *GURPS Vehicles*. The abbreviation for *this* book is HF. For a full list of abbreviations, see p. CI181 or the updated web list at www.sjgames.com/gurps/abbrevs.html.

of Earth, and more cybershell robots than people. But it's not all machines: the north and south poles are home to the pleasure domes of Moonshadow and thriving transhumanist Luna City. And on Luna's far side, a massive telescope array unravels the mysteries of the cosmos . . .

1

EARTH ORBIT



*"Welcome aboard GaiaStar trans-orbital flight 047, boosting from Charles de Gaulle-3 at Paris to Von Braun Station in LEO. Our spacecraft is a TAV **Pegasus** transatmospheric vehicle, and I am Ramon Sanchez, your captain. The flight engineer and stewardshell is LAI Chester, who will be attending to your every need.*

"We'll be boosting for LEO in 2 minutes, experiencing a peak acceleration of 3 gravities followed by a sustained period of zero gravity. Please let the seatbelts fasten you in, stow all hand luggage in the overhead

compartments, and relax into the nanogel. Chester will be distributing complimentary anti-SAS nano for all those who need it. Take the red pill if your genotype is prone to space adaptation syndrome.

"Your VIs should all have been interfaced into the onboard channels for this flight; if you are experiencing difficulty, inform Chester. Before we boost, please take a moment to review the safety instructions on VI channel C-4. Thank you for flying GaiaStar."

Earth orbit is the busiest region of space in the solar system. It's a bustling, frantic place, the first or last step on any journey to or from the mother planet. Millions of installations circle the Earth: commercial satellites, battle stations, aerospace ports, orbital factories, solar power satellites, and countless tons of space junk.

It's also the ultimate high ground for any battles fought on Earth, and the heavily armed space defense platforms and watchful spy satellites of powers great and small circle the globe, perpetually on guard, warily eyeing each other and the blue planet below. Less than two decades ago, the Pacific War began in orbit, triggering a conflict whose effects can still be felt today. Now, new tensions have arisen over the Olympus Project, a gigantic space elevator linking Earth and a terminus in geostationary orbit.

ORBITS

Earth orbit is customarily divided into a number of populated orbital zones:

Low Earth Orbit (LEO) is any orbit up to 1,240 miles above Earth.

High Earth Orbit (HEO) is any orbit between LEO and GEO.

Geostationary Earth Orbit (GEO) is an orbit that is exactly 22,236 miles up.

Very High Earth Orbit (VEO) is any orbit beyond GEO. It includes some orbits that circle both Earth and Luna.

An orbit is the circular or elliptical path followed by an object in space moving under the influence of gravity, e.g., the Earth around the sun, or an artificial satellite around the Earth.

To enter orbit around Earth, an object must be high and fast enough that when it falls, the pull of gravity will cause it to fall *around* the curve of the planet. If it was launched from the ground, getting an object into low orbit requires achieving an altitude of over 125 miles and a speed of about 17,600 mph – a delta-v of about 4.9 miles per second (mps). Achieving an even higher orbit requires a bit more delta-v – roughly +1 mps more to reach a high orbit, +1.5 mps more to reach geosynchronous orbit (see p. 22), or +2.1 mps to escape Earth's gravity altogether and begin a journey into deep space.

The higher the orbital altitude of a spacecraft or satellite, the slower it will be moving. Objects in low orbit circle the Earth rapidly, while those that are in higher orbits move more slowly. A satellite 22,000 miles up will be orbiting the Earth at a speed of about 1.9 mps, or about 7,000 mph – about the same speed as the rotation of the Earth.

ORBITAL VELOCITY TABLE

Altitude	Speed	Period
150 miles	4.78 mps	90 minutes
300 miles	4.73 mps	94 minutes
400 miles	4.68 mps	97.5 minutes
500 miles	4.62 mps	101 minutes
800 miles	4.48 mps	111 minutes
1,000 miles	4.39 mps	118.2 minutes
1,500 miles	4.19 mps	136 minutes
1,600 miles	4.15 mps	140 minutes
2,000 miles	4 mps	155 minutes
3,000 miles	3.7 mps	196 minutes
4,500 miles	3.36 mps	263 minutes
5,000 miles	3.27 mps	286 minutes
7,000 miles	2.96 mps	387 minutes
10,000 miles	2.74 mps	555 minutes
15,000 miles	2.24 mps	878 minutes
22,223 miles	1.9 mps	1,440 minutes

This table shows the orbital velocity (in miles per second) and the period (the time it takes to make one complete orbit around Earth) for an object at various altitudes.

EARTH TO ORBIT

23:01: *We're in space! Captain Sanchez just said we're making the final approach burn for rendezvous with Von Braun Station. Liftoff was **not** fun and seemed to take forever, and Jason started crying until I told him I was recording him. It's kind of eased off now. I just saw Chester (that's the steward-cybershell) who says we're maneuvering into an equatorial orbit with a period of 94 minutes, speed of 7.6 km/s and altitude of 482 km. (If you're under age, they download all this junk to your kindercomp. It's not like I memorized it.).*

23:04: *I'm weightless! My hair came loose and is floating all over the place. Of course, they won't let us get up and enjoy it "in case disorientation triggers space adaptation syndrome." Like we haven't taken anti-spacesick nano? We're stuck in the Von Braun docking queue for the next 20 minutes, but the killjoy stewardshell told everyone – **especially** minors – to strap in, secure personal items, and focus on their VIs. Like, I'm **finally** in space, now they want me to zone out and watch vid? Not a chance.*

23:09: *So it was **my** fault that I didn't watch Jason when he was supposed to have taken his nano? He is such a NAI-brain. That is **so** unfair, but now I'm back in my seat and Mom made the stewardshell lock the restraints. I am so vrified I could scream.*

If I were a Duncanite I wouldn't have to put up with this stuff – they treat you as an adult when you're 13! When we get to Von Braun, maybe I'll find a Gypsy Angel ship and stow away. Or I could trade Jason for passage. Maybe they'd make him into a bioshell.

23:12: *The Pegasus' external vid's been showing Earth, and since I'm a prisoner here anyway, I've been watching. It's not **totally** boring – we're orbiting fast enough you can watch the continents race by (except when the clouds cover them up). A few minutes ago I saw Africa come into view, and then I watched this huge cyclone that looked like a giant pinwheel. It might be in the Indian Ocean, but it's not like I care, though my stupid kindercomp keeps trying to splash augmented reality over it and make me identify different countries. Grandma is about 100 years old and when she was a girl you only had to learn stuff a few hours a day and didn't have some kindercomp bossing you 24/7.*

23:15: *I was so vriffed I forgot to say why Mom locked me down. I'd unhooked my belt to float free, which was really five, and I floated upside down and made faces at Jason and dared him to unhook. Doing a handstand in zero-G isn't like in gym: there's no sense of your blood rushing to your head. But when I started floating and spinning, Jason got all goldfish-faced and upchucked all over! Mom and the stewardshell threw a fit, and then a squadron of cleaning microbots popped out of the wall and started skimming about, chasing his vomit. I couldn't help laughing, but then a big gob floated toward me! I waved my arms and blew **really** hard, and it started shimmering and pulsing, and split in two – each gob heading off in opposite directions. Then my kindercomp started giving me this really boring lecture about conservation of momentum, so I used my hack and shut it off, but Mom noticed and her VI ran a scan and disabled it.*

23:17: *The emergency acceleration alarm just went off! Captain Sanchez said we're making a quick evasion burn. A chunk of space junk is on course toward us, part of some old nanosoc SDP that got blasted during the war. Consolidated Space Defense is going to take care of it, and she's like, "Expect an unscheduled fireworks show some 20 kilometers off the port bow, ladies and gentlemen." This is so five!*

– Personal diary of Vivian Lacroix (age 12)
December 30, 2099

Heavy cargoes going from Earth to orbit usually lift out of one of Earth's large spaceports aboard heavy laser-lift vehicles. Quito, Sanya, Cape Canaveral, Kourou, and Shriharikota Island spaceports all have their own powerful laser-lift launchers that offer cargo (and also economy passenger service) from Earth to major LEO and HEO stations like Von Braun, Columbia, and Taiko Station. The two most common HLVs are the *Ariane 55-LL* and the *Zhongzhi*.

Smaller regional spaceports (see p. TS32 for a list of these) do not provide heavy laser-lift service, but do offer Earth-to-LEO flights using spaceplane TAVs such as the *Pegasus* (p. TS192). Some of these ports also have less powerful laser-lift launchers to boost small light lift vehicles like the *Enterprise* LLV to transport microsatellite payloads into orbit. TAV service is also available from most large airports with suitably long runways, e.g., Beijing or Paris. The same airports also offer regular intercontinental suborbital flights using hypersonic TAVs such as the *Molniya* ballistic ramjet (p. SSS6).

Orbital Telepresence

An alternative to going up the well is to use telepresence (see p. TS144), but note that at 10,000+ miles up, the light-lag penalty will apply to actions requiring split-second timing. Also, communication with any satellite or station out of line of sight (see *The Horizon*, p. 27) must rely on relays; this roundabout path may further increase the distance involved, resulting in greater light-lag penalties.

SATELLITES

There are over two million artificial objects orbiting the Earth. The vast majority of satellites are uninhabited cybershells controlled by dumb computers or NAIs.

Many modern satellites are also maneuverable spacecraft, with a low-powered propulsion system and small reserve of "station-keeping" reaction mass. This provides a limited ability to avoid collisions, maneuver operationally (a spy satellite may alter its orbit to ensure it gets a good look at an interesting area, for example), and, in the case of LEO satellites, to mitigate orbital decay, prolonging their life. Satellites that exhaust their reserves of reaction mass may be refueled by other spacecraft.

Groups of satellites working together are called constellations. They are usually spaced out along a specific orbital path to ensure global or near-global coverage at all times. The lower the orbit, the more satellites are required to achieve this. At geostationary orbit, three satellites will provide near-global coverage; in high orbits, 8-12 are usually needed; in low orbits, 50-100 satellites may be required. Some applications require three or four times as many satellites – navigation constellations in high orbit may use two dozen satellites, so no fewer than three or four will be overhead at any one time for triangulation purposes.

Advancements in electronics, such as MEMS and nanotechnology, allow small, cheaply launched satellites, often working in networked clusters, to do the same jobs that required much larger satellites a century before. Most satellites launched since the early 21st century have been small microsats, nanosats, or picosats (see *Satellite Classification*, below). Small numbers of picosat or nanosat systems are very affordable – in 2100, it's not uncommon for mid-size businesses, colleges, schools, and individuals to own satellites.

Big macrosats are far more expensive to launch, and mostly used in situations where a single large object is vital, e.g., a full-sized unmanned lab, an orbital weapon system, or a high altitude (high HEO or GEO) satellite that requires a larger and more powerful sensor or communications system due to its greater distance from the Earth.

The following types of satellites are commonly in use:

Satellite Classification

Uninhabited satellites are often categorized by mass:

Picosat: 0.001 tons or less (under 2 lbs.).

Nanosat: 0.01 tons or less (2-20 lbs.).

Microsat: 0.1 ton or less (20-200 lbs. or less).

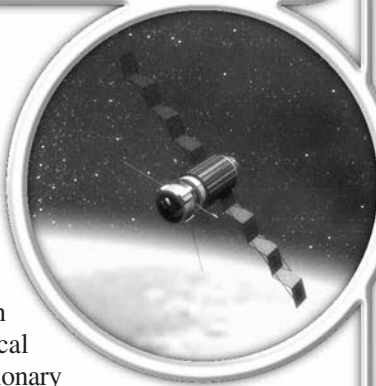
Macrosat: Over 0.1 ton (200 lbs. or more).

Picosats and nanosats tend to be cheap, single-function devices, while microsats and macrosats often (but not always) perform multiple functions.

Communication Satellites

A comsat acts as a transmission and/or relay point for signals from surface or space stations. The traditional comsat is a macrosat in either a highly elliptical Earth orbit or a geostationary orbit to allow lengthy or continuous coverage over the same point on Earth. In fact, a constellation of three geostationary comsats can provide near-global broadcast coverage for radio and television transmission.

However, most modern comsats are not large broadcast macrosats at GEO. Instead, they are networked constellations of microsats or nanosats in low orbit that support distributed cellular communication systems. This low orbital altitude means they can easily communicate with virtual interfaces and other small devices. There are several such constellations in LEO, some civilian, others government- or military-owned.



ORBITAL PATHS

Orbits are usually ellipses (ovals) rather than circles; *apogee* is the point in an elliptical satellite orbit that is farthest from the surface of the Earth, while *perigee* is the closest approach. Some important types of orbits are:

Equatorial Orbit: This is an orbit inclined at roughly 0 degrees, meaning that it circles the globe following the equator.

Geostationary Orbit: A satellite in an equatorial orbit that is also geosynchronous (22,236 miles up) will “hover” over the same spot on Earth, because its orbital velocity – about 7,000 mph – is identical to the velocity at which the Earth turns at the equator. This is called “geostationary orbit,” or GEO for short. A single geostationary satellite can see 42% of the earth’s surface, and three GEO satellites placed around the equator can cover the entire surface of the Earth between 81° S and 81° N. As a result, a geostationary orbit is particularly useful for certain applications, like communication and weather satellites. It’s also a necessity for a space elevator (p. 23). As GEO is a narrow band at a particular altitude, it can easily get crowded – not so much physically, but in terms of electromagnetic interference from different communication systems. International and commercial agreements limit what satellites and stations can occupy geostationary orbit.

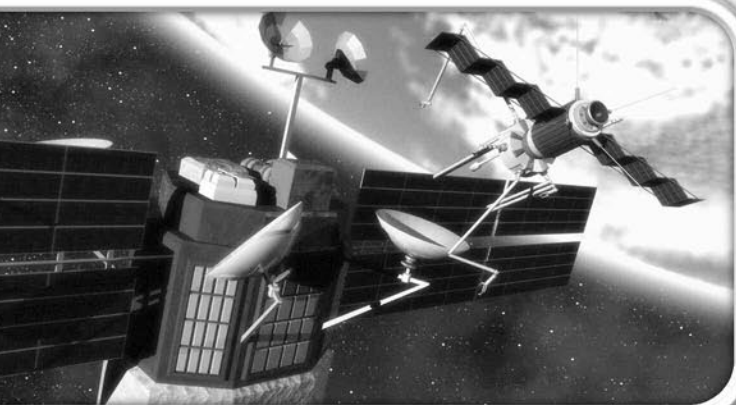
Polar Orbit: This is a “north-south” rather than the more familiar “east-west” orbit. Circling from pole to pole with the Earth turning beneath it, the satellite will eventually see the entire Earth, but not all at once. Polar orbits are preferred for imaging intelligence satellites (p. 10). One disadvantage of polar orbits is that they spend more time passing through both Van Allen radiation belts (p. 15). This makes polar orbits unsuitable for lightly built, unshielded space stations unless the inhabitants are radiation-tolerant.

Sun-Synchronous Orbit: This orbit is a special type of polar orbit. As with a polar orbit, the satellite crosses from the north to the south pole, with Earth rotating beneath it, but the orbit is oriented so the satellite always passes over the same part of the Earth at roughly the same local time each day. This is useful for certain applications, such as weather forecasting and communication relay satellites.

Highly Elliptical Earth Orbit (HEEO): These are orbits with very large eccentricities, typically varying from below 2,000 miles to above 20,000 miles. Objects in these orbits will be moving very quickly at perigee, but much slower at apogee. The orbit can be chosen so that the lengthy period that will be spent at apogee coincides with the satellite’s passage over a particular region. This makes HEEO a useful alternative to GEO, and one that is not limited to equatorial orbit.

Electronic Intelligence (ELINT) Satellites

These satellites, nicknamed “ferrets,” listen in on radio and radar signals. They are mostly operated by government and military intelligence agencies. While almost all radio signals are encrypted, a great deal of information can be learned from analysis, i.e., where messages originate, how long they are, when they are sent, etc.



Imagery Intelligence (IMINT) Satellites

IMINT satellites use electronic sensors – PESA, radar, or ladar (p. TS177) – to observe objects on the Earth’s surface (and in orbit). A satellite in low orbit will be able to observe a “track” of ground or ocean a few hundred miles wide with each orbit.

A typical IMINT satellite is placed in LEO in polar orbits at altitudes of 100-600 miles. It is used for general intelligence gathering and military surveillance, target acquisition, and damage assessment. A single satellite in low orbit can usually only see an object for a brief time – typically about 10-30 minutes – before its orbital path takes it over the horizon. Moreover, for part of its track, the satellite will be looking down at an angle rather than from overhead, which limits its effectiveness. Often, there’s only a “window” of 3-4 minutes in which a single satellite can get a good view.

As a result, most imagery intelligence satellites are found in large constellations of 50-100 individual microsats or clusters of nanosats. The latter consist of several tiny satellites orbiting within a few miles of one another, networked together to form a giant synthetic aperture “virtual antenna” with greater resolution. Such clusters can’t mount high-power radars or ladars, but can “degrade gracefully” in the event of damage and be quickly brought up to strength or even augmented by just adding more satellites.

Atmospheric distortion limits the best resolution of most IMINT satellites or clusters in LEO to about 3-6 inches. This won’t identify specific faces (nor read an old-style car license plate) but can track individual

vehicles or someone wearing distinctive clothes.

Government spy agencies use the latest AIs and macroframes to interpret imagery and movement, and *might* just recognize a face if conditions were perfect. But the satellites are looking down, and unless someone is looking up, they’ll only see the top of a head . . .

Different sensors have their own strengths and weaknesses.

PESAs using visual and infrared sensors provide the most information, but cannot see through clouds or under thick vegetation. Infrared sensors cannot show flat detail and can be fooled by IR cloaking; different visual and multiple infrared frequencies are often combined into “hyper-spectral” imagery that combines the best of both worlds.

Radars can see through clouds and even penetrate a few feet underground (to spot buried bunkers and the like), but do not show colors and require more power. Radars are usually restricted to microsats and larger satellites, rather than the large diffuse nanosat clusters. Radar also makes it clear someone is watching, as it’s an active sensor.

Ladars provide sharper detail than radars, but use much narrower beams (you have to know more or less exactly where to look first) and are foiled by clouds or thick smoke. They can also be used to analyze atmospheric particles produced by chemical clouds, smokestacks, fires, etc. For example, scanning the smoke from a burning factory might make it possible to learn what was produced there.

Navigation Satellites

These are the descendants of the original satellite navigation systems like Navstar and Galileo. Usually just called “GPS” systems, they transmit signals that can be detected by anyone with a GPS receiver, which today is found in most wearable computers and cybershells. GPS receivers use data from four satellites to determine the receiver’s exact three-dimensional position; navigation satellites use multi-satellite constellations to ensure that at least this many satellites are in view at any one time. There are several navigation satellite constellations in orbit. Those in high orbits (typically about 11,000 miles) use about two dozen microsats each; those in LEO use more satellites in lower orbits.

Power Satellites

Powersats are very large macrosats installed in GEO that collect solar power, then beam it down in the form of microwaves to Earth-based collection grids or to other satellites. They offer a source of “free” energy, but – as the solar powersat-dependent Transpacific Alliance discovered – are highly vulnerable in the event of war. No TSA powersats survived the Pacific War, and few are used today, as some activists see them as a sinister means of transforming “clean” solar energy into sinister microwave rays.

Research Satellites

A huge variety of scientific satellites exist in various orbits. Most collect data on a narrow range of phenomena to send back to their sponsors. Some are specialized remote sensing satellites that monitor surface, atmospheric or radiation conditions, such as the ozone layer or the Earth's magnetosphere. Others actually contain experimental payloads.

Some space telescopes are in Earth orbit, many of them amateur systems, as serious astronomical research is now done on the far side of Luna (p. 69) and in deep space, well away from the ever-increasing levels of light and radio interference in Earth orbit.

Remote-Sensing Satellites

These are civilian imaging intelligence satellites (p. 10), most of them operated by commercial space-imaging firms. They're typically cheaper and lower-resolution than dedicated IMINT constellations, but while they can't always track people or vehicles, ecologists can study environmental changes, farmers can monitor the health and productivity of crops, urban planners can track sprawl and traffic patterns, and so on.

Accessing commercial satellite imagery costs about \$10-100 per square mile depending on resolution; exclusive use in real time may cost 10-100 times as much. As an alternative there's a lot of free real-time imagery on the Web from various public sources; the GM may allow a successful Computer Operations or Intelligence Analysis roll (modifiers up to the GM) to locate a free site (or pirated feed) showing imagery along a desired ground track.

Service Satellites

Small, unmanned "garages" for servicing satellites are scattered through LEO, HEO, and GEO. They are normally microsats or macrosats. They store extra reaction mass and spare parts while acting as a base for mobile service nanosats or space cyberswarms that can be dispatched to perform repairs and maintenance. Most are either controlled by their own internal LAIs or teleoperated, and are owned by space contractors who specialize in orbital repair and maintenance, but military forces and large space-based corporations like Columbia Aerospace will have their own private service satellites as well.

Space Defense Platforms

An "SDP" is an orbital battle station – some unmanned, others manned. The earliest ones were built to intercept ballistic missiles.

Today, they also act as bases for AKVs and other spacecraft, and those in LEO can also strike ground, air, or naval targets. The threat of ground-based lasers and a simple need to avoid orbital congestion means that even the largest powers usually have only a few dozen SDPs at LEO. During peacetime, most are in higher orbits. SDPs are always designed with maneuver capability, but unlike SDVs, they are usually very slow. A few SDPs are camouflaged to externally resemble large civilian macrosats or space stations, such as commsats, powersats, or scientific satellites.

Weather Satellites

In the 20th century, satellites helped monitor and predict weather. Today, they also control it. This science is still in its infancy – see *Under Pressure* for more details on weather control.

SERVICE NANOSAT

100 POINTS

Attribute Modifiers: ST -8 [-70]; HT +1 [10].

Advantages: 360-Degree Vision [25]; Absolute Direction [5]; DR 8 [24]; Extra Arms (2 arms) (No Physical Attack, Short) [4]; Flight (Space acceleration, 0.01 G, +10%; One use, -40%; Requires low gravity, 0 G, -50%) [10]; Machine Body [37]; Micromanipulators 1 [15]; Microscopic Vision 10 [40]; PD 2 [50]; Polarized Eyes [5]; Radiation Tolerance 5 [10]; Radio Speech (Laser and radio, +40%) [35]; Vacuum Support [40].

Disadvantages: Deafness [-20]; Dependency (Maintenance, common, monthly) [-5]; Fragile [-20]; Inconvenient Size (Small) [-15]; Mistaken Identity [-5]; No Sense of Smell/Taste [-5]; Reduced Hit Points -8 [-40]; Reduced Move (Running) -2 [-10]; Short Arms [-10]; Social Stigma (Valuable Property) [-10].

Features: Complexity 5-7 small computer.

Date: 2060. **Cost:** \$10,000 + computer.

A small cybershell spacecraft designed to repair and refuel satellites. It is often carried by Vacuum Cleaner spacecraft and service satellites. A typical example is the MEXSAT Querubín, from PICOMEX. It has a roughly cylindrical body, with a sensor-studded head, two solar panel "wings," six spindly limbs, four of them equipped with manipulators, and a nose-mounted refueling probe. It uses ion drive or pulsed plasma thrusters for propulsion, but can only fly in microgravity. As part of its service mission, it can carry a few pounds of reaction mass in an auxiliary internal tank and transfer this to or from another satellite. Most picosats or nanosats require only tiny amounts of fuel for station-keeping purposes. 20 lbs., 2' long.

Variants: Military "sabotage nanosat" versions used for covert operations exist, equipped with stealth systems and chameleon surfaces. Add Chameleon-3 (Infrared, +50%; Radar, +50%) [42]; increases cost to 142 points.. (\$20,000, 24 lbs.).

ORBITAL STATIONS

There are about 400 permanently manned stations in Earth orbit. The most impressive are the great wheel-shaped space stations which spin to produce Mars or Earth-normal artificial gravity: Von Braun, Taiko Station, its rival Columbia Station, and a few others, each of which support a transient population of a thousand or more individuals.

Next in size are the 50 or so large orbital factories, research stations, industrial parks, and space hotels, which have a several dozen to a few hundred inhabitants. Many have bioroid or cybershell crews, with only a few humans. They're big enough to be spun for a degree of artificial gravity. Some of them are "mixed-use" facilities that support a half-dozen to a dozen different corporate or private tenants.

Finally, there are hundreds of "soda can" habitats that house a few dozen people at most. Some are built from discarded heavy lift boosters and fuel tanks left over from the early first half of the century; others were fabricated in space. Most are labs, orbital workshacks, and satellite-servicing stations. They range from fairly new facilities run by prosperous Fourth and Fifth Wave corporations to decrepit structures dating back to the 2020s and 2030s. Sometimes a few of these "soda can" stations are tethered together to form a small "orbital village." Many older stations are in poor repair, but despite their unreliable life support and failing power systems, they are still inhabited. Typically, these aging work shacks are acquired by orbital developers and sublet to undercapitalized nanotech start-ups, shady engineering firms, or ambitious Third Wave nations who want cheap space facilities.

Living quarters in these facilities are capsule hotel or barracks-style, much like life on an offshore oil rig back in the 20th century. Most weren't designed for family life, but despite the wishes of most owners, families and children occasionally arrive anyway. It's an odd place to grow up, and orbit-born kids raised in places like this often bounce between several such facilities as their parents drift from job to job and station to station.

Nobody is sure exactly what's going on in all these small stations; national jurisdiction is often held by "flag of convenience" states who ask few questions. Discovering who a tenant or owner is may involve navigating a very convoluted paper trail that can extend back for decades. Few of these stations have the ability to maneuver, so they will pose a significant hazard for space elevator construction. Buying out these "space ghettos" and deorbiting them or towing them to L5 is an ongoing priority of the Olympus Project.

STATION TYPES

Orbital Spaceports are the first (or last) step between Earth and space. Vessels lifting off Earth usually rendezvous with a LEO spaceport to refuel. Sometimes the vessel will then head elsewhere in space; more often it returns to Earth, leaving its payload to be transshipped aboard Orbital Transfer Vehicles to other locations. Large orbital spaceports resemble terrestrial airports, with attached spaceyard, recreation area, microgravity industrial park, and even shopping facilities. They often have internal docking space for vessels up to the size of a *Pegasus* TAV or *Kageshima* OTV; larger craft dock outside.

Service and Salvage Stations: These are small space-dock/spaceyard facilities. Often privately owned, they are the headquarters of companies performing maintenance, towing, orbit correction, rescue, refit, or salvage operations for stations and satellites. Retrofitting obsolete satellites with upgraded components is a major business.

Space Factories: These manufacture vacuum- and microgravity-engineered products like drugs, exotic alloys, microbot components, perfectly spherical ball bearings, and high-purity protein crystals.

Space Hotels: Vacations in orbit were among the first commercial ventures in the history of manned space flight – for the adventure, and to go somewhere people never could before, but mostly for

The Orbital Population

About 20,000 humans, parahumans, and bioroids are permanent residents in Earth orbit. Roughly 25% of this population are microgravity-adapted humans, parahumans or bioroids – floaters, Tennin, or ZR-5s, for example. The others run the gamut of human, parahuman, and bioroid races (plus a few hundred uplifted animals). Only about 10% of the orbital population was born there – most come from Earth or the various Lagrange stations.

The transient population is much higher. 300,000+ humans, parahumans, and bioroids (85% of them from Earth) will be present in Earth orbit at any given time, either working (often in month-long shifts), visiting for business or pleasure, or passing through on their way to or from Luna, L4 or L5, or interplanetary destinations such as Mars or Titan.

These numbers (and the listed station populations given elsewhere in this chapter) are for biosapients – humans, parahumans, bioroids, and even uplifted animals. About half a million satellites are inhabited by various NAIs. The stations in Earth orbit also typically have three times as many cybershells (80% NAI, 18% LAI, and 2% SAI or ghost; some AIs may be shadows) as their listed biosapient populations.



the lure of experiencing microgravity. Today, the hotel industry also provides small groups of luxury rooms at major spaceports, though the biggest facilities include a more traditional full-service hotel. These larger facilities frequently specialize in conventions and trade shows. Typical rates are about \$1,000/night.

Space Industrial Parks: These are mixed-use facilities that rent space to a variety of clients. The main tenants are usually corporate space labs and factories, but some parks also house government or university research facilities, art studios, or even private residences. A park may also lease space to various businesses that cater to the needs of the workers, e.g., cafeterias, clinics, general stores, 3D printer franchises, or bars.

Space Labs: These are the most common facilities in orbit. Some are operated by governments or universities, but most are run by corporate R&D firms (or divisions of larger companies) that find microgravity and/or hard vacuum useful for their research projects, or which are engaged in processes too hazardous to perform on Earth.

Spaceyards: These are facilities for constructing spacecraft, stations, and satellites. Specialized techniques such as vacuum-vapor deposition are used.

Space Defense Platforms: The trend is toward unmanned SDPs, but some nations, notably China, have a few permanently inhabited bases in the sky.

ORBITAL CONSTRUCTION PROJECTS

At any given time in Earth orbit, several stations are being built, rebuilt, towed elsewhere, or dismantled, providing work for thousands of orbital engineers. Some of the microgravity workers are cybershells, some are professionals working for various space development companies, and some are migrant spaceworkers, called “mangliu.” Some of them are even Duncanites from the Main Belt, traveling from one major microgravity project to the next.

Temporary housing facilities and supply depots known as “construction shacks” are usually built

next to major projects to house workers and supplies on site. Some construction shacks are small, but others are sizable stations in their own right, housing hundreds of people. Some construction shacks are dismantled or towed away after a project is finished; others are modified into industrial parks, fuel depots, or the like.

FLAGS OF CONVENIENCE

“Fine job with the intel on that orbiting xox-box, Colonel. The Bureau figured those xoxnappers were in Lazarus Station. Now we’ve got the data to prove it.”

“Thank you, sir. Do we have a timeline for Silent Thunder?”

“State is meeting the Panamanian ambassador at 0900 hours. With your evidence, they won’t fight us on this, and Lazarus Station’s registry will be revoked the next day. What have we got in place?”

*“Sir, the 21st Space Wing have inserted a Delta Force team disguised as a Vacuum Cleaner crew. They’re in a **Steptoe**, working in a close orbit to Lazarus. When we’re ready, they’ll deploy on a boarding pod, and go in hard and fast.”*

“Hmm. What about swarms? That thing with the Royal Marines in the asteroids . . .”

“Someone got careless, sir. Don’t worry: Delta are trained to handle swarms. In any case, we’ve an agent inside. Delgado confirmed the xoxers only have small-arms.”

“Delgado?”

“SIA, sir. One of our best officers.”

“I’m aware of that, Colonel. I thought she was dead. The antimatter explosion on Mercury . . .”

“Yes sir. We had a sapient shadow in storage. It’s a good emulation – sometimes I don’t think she realizes it’s not her inside that bioshell.”

Stations and spacecraft in Earth-Lunar space must have a registered owner – a person or organization. The owner's citizenship, or for a business or other organization, its incorporation or registry, determines what laws apply aboard the station or spacecraft. If the owner of a station is a Chinese citizen or China-based corporation, Chinese law applies there, since the station is legally part of China. It's the same principle that applies to ships on the high seas, or spacecraft operating in deep space.

However, most nations levy taxes and impose various regulatory standards governing things like worker safety, use of hazardous materials, and – particularly in the European Union – sapient's rights. Moreover, great powers have the capability to enforce these laws on spacecraft and stations, and send inspectors or police to back that up.

The Pacific War

More than any other event, this conflict colors the current situation in orbit. The war confirmed China's preeminence on both Earth and in orbital space, tested military space control doctrine, and ended up reducing the TSA's presence in orbit to a bare minimum.

The war also scared everyone, by producing vast clouds of space debris that nearly caused more destruction than the weapons that were fired in anger. Only a concerted effort by neutral corporations, Vacuum Cleaner salvage teams, and military forces prevented total catastrophe.

The economic fallout from the Pacific War and its immediate aftermath also upset the orbital economy, forcing some firms out of business, disrupting tourism and travel, and creating new openings for others, such as the Olympus Project. Organized crime syndicates have also moved into some of these gaps, buying up several bankrupt stations for their own purposes.

Another result of the war was the creation of the first groups of orbital displaced persons – space workers evacuated from damaged or occupied stations, whose bankrupt firms lacked the resources to rehire them, or send them back where they came from. A few hundred of these were TSA citizens who were living or working on neutral stations and ended up stranded for the duration of the conflict, only to find they had no homes left to return to. Most of these displaced persons, whether they were economic or political refugees, were eventually repatriated, made their way to L5, or were hired by other firms, but some still live as squatters in various abandoned stations.

Since the Pacific War, tacit understandings between China, the European Union, the Pacific Rim Alliance, and the United States have led to new doctrines aimed at limiting damage from any further engagements in Earth orbit. How well they'll work is unknown.

Not everyone likes close government oversight, however, whether for reasons philosophical or practical. A market has developed for those who are willing to pay to escape it. In 2100, certain countries – some of them not even spacefaring powers themselves – have extended a system long used on commercial ships and oil rigs to apply to space stations, spacecraft, and satellites. They charge annual fees to owners in exchange for allowing their registry as a so-called "flag of convenience." Thus, a vessel or colony run by a British owner might instead be registered in Ecuador (and legally be Ecuadorian territory). Furthermore, most flag of convenience states, to better attract foreign fee-paying owners, have laws that exempt such stations from many of their own domestic laws, taxes, and regulations.

Flags of convenience are not just popular with legitimate operators who want to avoid taxes or stifling regulations. They're also a haven for various criminal organizations with footholds in space. A growing number of TSA-operated spacecraft and stations also register under foreign flags of convenience, as a means of getting around trading sanctions and harassment from China and other anti-nanosocialist nations.

Most flag of convenience states will take action if it can be *proved* that a station, satellite, or vessel is violating international law, harboring criminals or terrorists, or otherwise engaged in unacceptable behavior. Some may send inspectors (often just hired mercenaries or deputized Vacuum Cleaner salvage teams) to check the allegations out and/or require a clean up. Or they may simply revoke the registry, which amounts to washing their hands of the problem and leaving it up to others to deal with.

Spacefaring great powers like China, the European Union, or the United States, when hunting international criminals, terrorists, or regime-opponents, sometimes use diplomatic pressure on flag of convenience states to get them to revoke registrations. Then they follow up with a police or military assault on the station in question . . . sometimes mere moments after the revocation has been received by the unfortunate target.

Not all corporate or privately-owned stations use flags of convenience. There are many advantages to being registered with a "legitimate" spacefaring nation. For one thing, insurance is often cheaper, as brokers know that the station must meet higher standards for maintenance and occupational safety. For

another, the aegis of a government with a military, rescue, and police presence in space is a useful safety net, especially in a crisis. During the orbital battles of the Pacific War, China's space force took great care to avoid accidentally damaging stations registered to nations with space forces that could shoot back. Some stations lacking powerful protectors suffered accidental damage.

The most popular flags of convenience for space stations in Earth-Lunar space are Ecuador, Islandia, Liechtenstein, Königsberg, Montreal, Panama, and Russia. Islandia and Liechtenstein tend to have low corporate taxes but a fairly good record of inspecting stations to ensure compliance with occupational safety or sapient's rights regulations; the others tend to be more casual about this as long as fees are paid on time. Russia (and Islandia) do have small space forces of their own, but tend not to be overly intrusive.

LOW EARTH ORBIT (LEO)

Low orbits are those whose apogee and perigee are both no higher than 1,240 miles. This region has the largest population of artificial satellites and space stations. This is simply because much less energy is required to launch an object from Earth into LEO.

In low orbit, Earth's atmosphere, though functionally a vacuum, is still thick enough that it produces a tiny amount of friction on orbiting satellites and spacecraft. The lower the orbit, the more quickly an object's orbit will decay due to this air friction. At altitudes of about 100-125 miles, a satellite's orbit will decay within a few days; at 200 miles, it will take a couple of months; at 400-500 miles it will may take several years, and so on. The lowest reaches of LEO are populated mostly by relatively cheap, disposable satellites, or those capable of correcting their own orbits via thrusters.

Orbiting only a few hundred miles up makes it easy to make detailed observations of the Earth, perform upper atmosphere sampling, or transmit radio signals without large antennas or high power levels at either the satellite or ground station. However, its low altitude means a satellite in LEO can only be in line of sight of a few hundred miles of Earth's surface at any given time, and its high speed means it passes over this area in a few minutes. If coverage of larger areas is important, "constellations" of dozens or even hundreds of satellites must be used, so one will always be within range of a given point.

The largest object in LEO is the European Union's Von Braun Station (p. 18).

VAN ALLEN BELTS

The Earth is surrounded by a pair of torus-shaped fields called the Van Allen radiation belts. A function of the Earth's magnetic field, they store and trap charged particles produced by the solar wind and the interaction of cosmic rays and Earth's atmosphere.

The highest energies are found in the *inner radiation belt*, where lengthy unprotected exposure can cause radiation sickness or damage electronic systems. Most of the inner belt extends on average some 400 to 4,000 miles above the Earth at the equator, but it's aligned with the magnetic axis of the Earth, which is tilted away from the axis of Earth's rotation. As a result, while the belt can start some 800-900 miles above the surface on one side of Earth, off the coast of Brazil is the "South Atlantic Anomaly" where radiation is especially intense at an altitude of only 150-200 miles.

The *outer radiation belt* is a more tenuous belt found at higher altitudes. Most of it stretches from about 15,000 to 23,000 miles up above the equator, although the radiation belt curves downward toward each pole. Its radiation is mostly in the form of lower-energy ions and electrons produced by the solar wind, and is less hazardous than the inner belt.

Fortunately, due to the geometry of the radiation belts, stations or satellites in low orbit typically only pass through hazardous regions for fairly short periods (20-25 minutes) each day, which is safe as long as occupants don't go outside at the wrong time (like when they're passing through the South Atlantic Anomaly). On average, exposure in the inner radiation belt is about 4 rads/day of beta radiation; see p. TS59. For people in space stations, cell repair nano that is routinely taken against cosmic radiation exposure (p. TS59) is sufficient to repair any damage sustained by Van Allen radiation.

Similarly, the standard shielding built into most *Transhuman Space*-era electronics is usually enough to protect electronics against Van Allen belt radiation exposure. Occasionally, radiation-induced malfunctions in electronics sometimes occur, especially in tiny picosats and other small objects like microbot swarms. This is an accepted part of regular wear-and-tear, and handled by routine maintenance.

STATIONS AND SATELLITES IN LEO

Here are a few examples of different types of orbital stations and satellites. These only scratch the surface – GMs should feel free to create others as necessary.

Notable LEO Satellite Constellations

LOGOSAT: A 80-satellite commsat constellation serving customers of the global news agency Teralogos (p. FW64). Some of the satellites may also be imaging intelligence satellites.

Longwang: Two giant weather control macrosats in highly eccentric orbits that regularly take them over the eastern Pacific. Run by China's National Satellite Meteorological Center, but possibly under PLAN-SF control.

Mithra: A string of 27 state-of-the-art IMINT satellites in low polar orbits, it provides imagery for European Union intelligence agencies like German's BND (p. FW38).

Ortrac: A 256-nanosat constellation that provides communication services to track v-tagged packages, cybershells, and robotic vehicles.

Sirius: Fifty remote sensing microsats in low polar orbit. They are owned by Orion Security (the security division of Orion Industries, p. FW79), who sell the imagery to a variety of commercial clients.

Tantalum Claw: A U.S. "ferret" spy satellite constellation consisting of 72 nanosat clusters that form large virtual antennas. Operated by the National Technical Intelligence Bureau (p. FW38).

Xarxasat: A LEO commsat network that provides relays for personal communicators and cybershell lasercoms. Operated by Xarxa Enllaç SL, the Catalonia-based telecom giant (p. FW63).

Auremond Orbital Hotel

The historical Auremond Orbital is an extravagant example of folly in action. Work on it started in 2034; it was completed in 2047, one of the first space hotels to be constructed and perhaps the last major structure built primarily from materials lifted into orbit from Earth. The design lacks spin gravity, which somewhat limits its appeal.

Physically, Auremond Orbital is a 150' long "soda can" cylinder with large solar panels, with eight 75'-long modules attached, four per side. The guests are accommodated in the external housing modules. (Two *Enterprise*-class stations with 8 housing modules; p. 136.) It can accommodate 160 guests and a staff of 40.

Despite charging as much as \$100,000 a night for rooms (in the 2040s: now \$800 a night), the hotel became a trendy destination for Earth's wealthiest citizens, particularly thanks to its wedding chapel and microgravity

honeymoon suites. However, the small and cramped Auremond suffered for its own innovation: the first of its kind, it was eclipsed by newer and larger space hotels like the Tartessos (p. 18) or the Columbia Hilton in Columbia Station.

The hotel has changed hands five times, as each new owner attempts to find a way to make it profitable. In the 2070s it was sold to a Thai investment group. During the Pacific War, the Auremond was seized and briefly occupied by Chinese space troopers. For the duration of the war and two years after, it served as an internment camp for 170 TSA civilian orbital personnel and travelers whose vessels or stations surrendered to PLAN-SF forces. Although it was returned after the war, its owners lacked the funds to repair the damage it had sustained, and they resold it to Nikolai Nakaunicina, a mysterious Russian orbital developer, who began restoring it. It reopened in 2091.

Today, the hotel turns a modest profit. The original staff (those who survived the War) was fired by Nakaunicina; the present staff is entirely cybershells. The Auremond offers few amenities, but its décor, dating back to the 2040s, has been carefully restored, and now seems more antique than tawdry; indeed, the dining room and lobby contain several historical relics dating back to the first four decades of 21st-century orbital settlement, plus a collection of salvaged relics from the War – the centerpieces are an old (but operational) PLAN marine battlesuit and the hulk of a TSA-built AKV. The kitchen offers an eclectic mix of Thai and Russian orbital cuisine. Nakaunicina occupies a suite of seven rooms in the hotel, but is almost never seen in public.

The Auremond is cheaper than many places in orbit, and its air of history combined with Nakaunicina's own eccentricities (and immense wealth) have given the place a certain air of mystery – in fact, it is scheduled to host a mystery writers' convention next month. It's quite popular with visiting Duncanites, Pacific War orbital combat veterans, and Vacuum Cleaners, and many colorful characters can be found staying there.

Russian territory, CR 3.

Al-Khwarizmi Station

This large orbital station is operated by the government of Kuwait for the Islamic Caliphate. Al-Khwarizmi is part government research station, part spaceport, and part industrial park, renting space to various Caliphate corporations.

The station is a spacious 250' long cylinder designed for long-term habitation (*Cynosure*-class station, p. 137). Current population is 150. Kuwait territory, CR 5.

Ingelheim Station

This elderly LEO industrial park was built by System Technologies, AG (p. TS96) in the 2050s, then leased to 17 different commercial orbital factories and labs, all of them engaged in vacuum or microgravity-enabled

activities, chiefly cutting-edge bio- and nanotechnology. One of the biggest tenants is Baumann Krankenpfledge AG (p. FW69), which has its main nanodrug laboratory on the station. Some quite sensitive research is ongoing here; after a case of industrial espionage in 2082, it has upgraded security.

The station is a 250'-long cylinder (*Cynosure*-class station, p. 137), with 24 smaller 75'-long workshacks (18 lab, 6 housing) clamped onto it. It's a microgravity environment with a population of 350 people.

Ingelheim was damaged during the Pacific War (from stray combat debris). 200 people were injured, and 86 were killed; under pressure from the E.U., the Chinese government eventually compensated the victims. Ingelheim has since been repaired, and System Technologies assures its tenants that its space defenses are now state of the art.

German territory, CR 6.

Jorge Chavez Station

This combination space dock and laboratory was constructed by a consortium of Peruvian companies that wanted to perform industrial research in microgravity. Built in 2092, it's one of the few manned stations constructed by a TSA nation since the Pacific War. Peru has stated that no military research is taking place here, and has occasionally allowed foreign inspectors onto the station to confirm this.

The station is a 300' long truss-bar with 10 modules clamped onto it (*Omnistar*-class station, 8 lab, 3 housing, 1 defense, p. 138) attached to it. Jorge Chavez Station has a resident population of 50 people (including 20 scientists). Peruvian territory, CR 4.

Jorge Chavez is a civilian facility, but has a very alert internal security team (due to fears of possible Chinese sabotage). Chavez Station also sometimes entertains foreign visitors, usually scientists from other TSA nations or those with infosocialist sympathies.

Lammergeyer Station

This is the headquarters of the Space Debris Removal (SDR) corporation (see p. 34). It has a population of 40 people, and an extensive space dock facility. It's a 150' long "soda can" cylinder with four 75' modules attached (*Enterprise*-class station, with one housing, one service, and one defense module, p. 136). There are usually a couple of *Steptoe*-class DRVs (p. 138) docked here for refueling or servicing. It is of Islandia registry, CR 3.

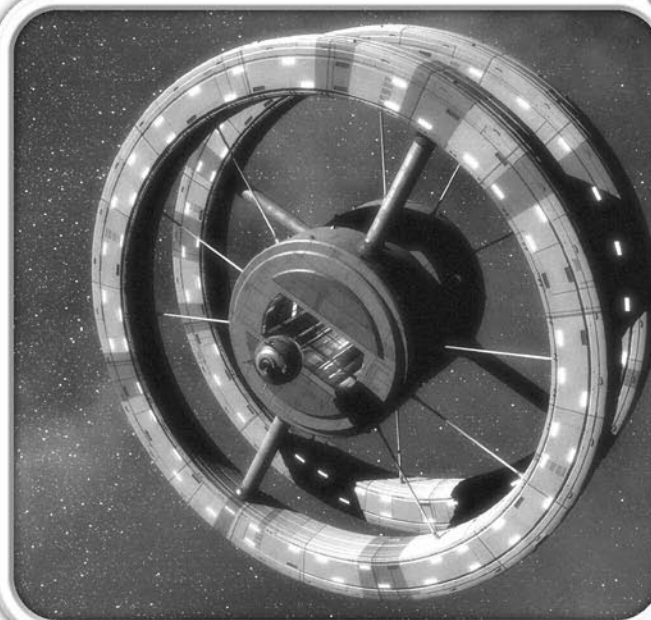
Morgenstern Station

This aging microgravity laboratory station is located 250 miles up in LEO. Originally a lab complex built by Biotech Euphrates and run under a Panamanian flag, the station was evacuated following damage sustained in the Pacific War, then resold in 2085 to a Liechtenstein developer, who leased it to a Mexican research firm, Industria Bio Reactores (IBR). After a toxic vat spill contaminated the facility and ate all the plastic in the

station, the company did a (partial) cleanup, then sublet the space to several Argentine and Ecuadorian nanotech startups.

Some of these laboratories still operate here, but others have moved or fallen on hard times, often further subletting areas of the station to newer tenants that provide on-site services having nothing to do with the original bio-nanotech R&D the station was built for. These include a food court, some Peruvian mushroom pharmers, a used cybershell dealership, a fuel station, a battered bioroid shelter run by the BBF (p. TS106), and a digital creationist church. Many of the current tenants have been living there for over a decade, and more than half of their employees are "floaters" born in microgravity.

Recently, the original Liechtenstein developer, Orbital Investments, was purchased by Systems Technologies AG, who a year ago sent eviction notices. A few of the current tenants have pulled up stakes, but the rest have ignored the notice. System Technologies is considering hiring mercenaries to clear the station, but wish to do so with minimal force to avoid public outcry. Morgenstern Station is still under Liechtenstein registry, has a population of 700, and is CR 1.



Obsidian Station

The space development branch of the French industrial conglomerate CIT/Provençale (p. FW57) operates this microgravity station. The main business is precision nanofabrication of micro-electrical mechanical system components. Obsidian is a 300-foot truss with 10 modules attached to it (*Omnistar*-class station, with 8 lab and 2 housing modules, p. 138). It has a population of 60. French territory, CR 4.

Srinivasan Station

This Indian spaceport and industrial park is operated by Bangalore Aerospace and leased to various bio-engineering and nanotech companies. It consists of four *Omnistar*-class stations joined together (forming a cross shape), with 40 attached housing and lab modules. It's a lively, fairly chaotic place, with a mix of Vacuum Cleaner, satellite-servicing, and R&D tenants, a restaurant/motel for travelers, and even small Buddhist and Hindu temples. In 2097, one service company imported Tennin-adapted monkey-plus uplifts (p. FW120) from Avatar Klusterkorp. They're all over the station now, and seem to do better in space than on Earth. Population 320 (including 40 Monkeys-Plus). Indian territory, CR 3.

Shou-Xing Station

This mid-sized Xiao Chu laboratory station houses the corporation's life-extension biomod research laboratories working on rejuvenation nanotechnology. The new "Project Xian" is currently beginning trials using human volunteers. The station is a 250' long cylinder (*Cynosure*-class space habitat, p. 137) with a population of 120. Chinese territory, CR 5.

Station Légère Industrielle

An older mid-sized industrial park in LEO, this station was built by the French government in the 2060s and leased to several commercial and state-associated businesses, then later sold to a private company based in Montreal.

The station consists of two 150' soda-can cylinders joined together, each with four smaller 75' cylinders attached (2 *Enterprise*-class stations with 8 housing, 7 lab, 1 science module, p. 136). It has a population of 200 people.

It is now home to a couple of import/export businesses, a satellite service company, a Vacuum Cleaner salvage company (Albert & Haraldt, p. 36), a zero-G dance troupe, an orbital catering firm, and a secretive amateur radio astronomer who has covered the station with large dish antennae, supposedly for privately-funded SETI research.

There are several rumors concerning "the astronomer," who some suspect of ties to the Trojan Mafia, perhaps beaming illicit programs (or ghosts!) back and forth into the Deep Beyond. Montreal registry, CR 2.

Taishan Station

This aging microgravity station (300 miles up) is a Space Defense Platform that also serves as dockyard, repair, and advanced training center for China's aerospace forces. Many Chinese military spacers (including some from the PLA Air Force as well as PLAN-SF) have visited Taishan for basic training in everything from vacc suit

operations to celestial navigation. The base also services PLA military and intelligence satellites.

Taishan Station is a 125'-diameter steel sphere, bristling with weapons and AKV bays (*Shanzi*-class Space Defense Platform, p. 137). It houses 200 military personnel, including a 50-soldier PLAN-SF space infantry division platoon, plus 100 civilians who work at the space dock.

Taishan was severely damaged during the Pacific War (primarily from ground-based laser fire). It has since been repaired, but PLAN-SF has doubts about its survivability in a future conflict, so most of its command, control, and logistics functions are duplicated on several smaller stations in higher orbit. Chinese territory, CR 6.

Tartessos Low-Earth Orbit Luxury Resort

Opened in LEO in 2088, this is one of the more luxurious orbital hotels. It caters to a mixed clientele of vacationing terrestrials and on-leave spacers who don't want to return to Earth.

Tartessos is a conventional design, with two residential pods rotating to provide 1/3 G in the hotel rooms, dining room, bars, and kitchens (eating and cooking in microgravity is not especially fun), plus a central non-rotating section with a large zero-G gymnasium, sports center, and "swimming pool" – a large chamber partly filled with floating blobs of water, for aquatic play. (Swimmers have miniscuba masks in case they get trapped in a blob of water, but aquamorph and cybershell lifeguards are always alert to rescue someone if needed.) There are also private playrooms for those wishing to spend a few nights in weightless conditions.

The station's starkly monochromatic fittings and furnishings – all black reactive nanocomposite and silver-gray asteroid-mined platinum – are exquisitely comfortable but tastefully understated, a deliberate decision that is intended to emphasize the magnificence of the view of Earth below, one shown off to best effect by the transparent diamondoid floor of the ballroom and dining room. There is an impressive art gallery, with a collection of some of the finest paintings and sculptures by the first three generations of extraterrestrial artists. Susie Xu's sonic sculpture *Storm on Jupiter* (currently valued at over \$12 million) is the centerpiece of the exhibit.

Tartessos has 300 luxury guest rooms with a typical population, including staff, of about 500. The staff is a mix of humans and cybershells. For the last two years, Tartessos has been managed by Arganthionios, a very personable SAI. The ownership is Greek, but the station is legally registered to Liechtenstein. It is CR 5.

Von Braun Station

The European Union's Von Braun Station is a large wheel-shaped station in LEO (200 miles up). It was begun in 2057, and spins rather rapidly to produce Earth-like

LIVING IN MICROGRAVITY

Many space stations rotate to provide some degree of gravity – but it's easier to build a non-rotating station. It's also useful, as a lot of industrial processes rely on microgravity – that and hard vacuum is why labs and factories are in orbit, after all.

Zero- and microgravity movement is covered on p. TS56. Space stations have plenty of handholds, often supplemented by motorized pulley tracks. Handholds are common on walls and furniture to assist in movement. The natural posture for moving about in microgravity is a fetus-like posture nicknamed the “simian hunch.” It's possible to kick off and drift, but easy to become disoriented.

While some things are easier to do in orbit, many other tasks are more difficult. Any motion produces an equal and opposite motion, which has implications for everything from fastening a nut to making love. Weight is gone, but inertia remains. A person could slowly push a steel girder that masses a couple of tons, but after it starts to move, it takes the same effort to slow it down, and anyone in its path who couldn't move out of the way could easily be crushed before they could slow it down. Perhaps most important, in weightless conditions everything floats, unless it is glued, fastened, or nailed down.

Spacecraft and station designs compensate for microgravity in various ways, to make it easier for people to adjust. For example, one wall per room (not always the same one) is usually designated a “ceiling,” with lights on it, and another as the “floor.” Of course, people can bump into things, so rooms often have floor-to-ceiling padding or carpets.

What furniture is used is bolted onto the nominal “floor.” Unless a station is also capable of significant thrust, chairs are usually not bothered with; it's easy enough just to float. Tables are still used, though; they (and the floors) have bars so people can hook their feet (or tails) to remain in place.

One of the hardest things to get used to in microgravity is eating and drinking. Like everything else, food and drink has to be confined, or else it will drift off. This is messy, potentially unhygienic, and even dangerous – floating food particles can gum up vital equipment, block

visibility, or cause choking. Most meals are served on deep trays rather than plates, designed to fasten to tables. Even the tiniest culinary details have to be thought through. For example, flaky pastries, crumbly bread, and powdered condiments like pepper are never served, as they form messy clouds or fly up noses. On the other hand, spicy liquid condiments like ketchup and mustard are common, provided they're sticky enough to stay attached to food.

Liquids don't flow “properly” in weightless conditions, so all drinking and soup containers are sealed; straws are popular. There are no open water faucets or cups. Carbonated beverages are also avoided, as in microgravity they tend to cause flatulence.

In orbit, there's no natural sense of morning, night, dawn, or dusk. While virtuality can partly compensate, it still throws time sense out of whack. Some people find sleeping in microgravity very comfortable, but other people have trouble “nodding off” due to the lack of gravity pull on the head. “Sleep restraint systems” – various ties and/or bags – secure sleepers to avoid accidents. Some people prefer to sleep free, but air currents from ventilation systems may cause them to drift and bump them into something, resulting in bruises. In cramped spacecraft and stations like many in LEO, there are no individual bed rooms, and “bunk rooms” consist of a row of sleeping bags fastened to any handy surface. Sleep spots are located in line with a ventilator fan: people trying to sleep in badly-ventilated areas can end up surrounded by a bubble of their own exhaled carbon dioxide, causing them to wake gasping for air with an awful headache.

Washing can be difficult without the proper facilities; even then, it takes practice to get the hang of it. Small workshack stations often use a sponge bath or cleaning microbots. In a station, you can't rinse properly – you end up pushing blobs of water around. Spilled water does not fall, it rises; and if you spill it you have to go and get it. Plumbing cannot rely on gravity, and instead uses multiple fans and pumps. Showers are built to vacuum away excess water. Toilets work the same way, using a continuous air suction to ensure waste products don't escape.

gravity. It serves as the European Union – and much of the world's – premier gateway to space.

Von Braun consists of a 2,000'-diameter torus with a 750' tall cylinder hub (see *Von Braun*-class space wheel, p. 140). As usual, the central hub contains space port and microgravity lab facilities, while the wheel houses residential and hotel space.

Much of the office and laboratory space at the station is used by government and non-profit

agencies, such as the European Space Agency and various scientific institutes. Some is also leased to non-governmental organizations based in the European Union. The station's factory space is devoted mainly to the construction of ESA space probes.

Von Braun has a population of 7,500, but its transient population is closer to 15,000. Many spacecraft stop off at Von Braun for a short time before proceeding to higher orbit. It is CR 5.

High Earth Orbit (HEO)

High Earth Orbit is generally considered to be anywhere from 1,000 to 22,000 miles above the Earth. Manned stations in HEO tend to be 6,000-12,000 miles up, well above the inner Van Allen belt. HEO is often used by navigation satellites and deep space ports. At altitudes of about 9,000 miles or higher, satellites and stations are also out of range of ground-based lasers.

Satellites in high orbit get a good view of the planet, and remain up for centuries without orbital correction due to the lack of significant air drag. They also move more slowly than those in lower orbits, taking more time to pass over any given area of Earth.

SPACE WEATHER

Inside Earth's magnetic field, surrounding the outer Van Allen Belt (p. 15), is a much larger and more diffuse zone called the *ring current*, which extends out well beyond high orbit to some 40,000 miles altitude. It contains low-energy ions and electrons produced by solar wind plasma interacting with Earth's magnetic field. Also associated with Earth's magnetic field is a long "magnetic tail" of ions. This stretches away from the sun on the night side of Earth's magnetosphere for some 32,000 to 880,000 miles.

Magnetic Storms: During increased levels of solar activity (flares, solar coronal ejections, and sunspots), unusually energetic solar wind plasma traveling out from the sun blows ions from Earth's magnetic tail into the ring current. This results in a "geomagnetic storm" – a global disruption in Earth's magnetosphere. The effects last about 12 hours and vary in intensity, but can produce visible aurora, and interfere with unshielded electrical systems in space and, to a lesser extent, on the ground. Modern satellites and spacecraft electronics are designed to be resistant to magnetic storm effects, but shortwave radio signals in space and on the ground may be subject to static or jammed for the duration.

Solar Flares: These are described on p. TS30. Large flares can be hazardous to individuals living in stations lacking storm shelters or heavy shielding. Earth's magnetosphere usually provides a fair degree of protection in Earth orbit, so most ordinary flares are not dangerous. In those instances where a severe flare would be hazardous, weather stations near the sun provide early warning, and individuals will have a few hours to seek shelter; if their own stations lack radiation protection, they'll usually evacuate to a larger orbital facility with appropriate shielding.

The main drawback to high orbit is the distance to and from Earth. It takes more energy to transmit radar, radio, or laser beams to higher orbits; a ground station also requires a bigger antenna. Similarly, a given sensor in high orbit can't see the ground as well as one in low orbit, or has to be bigger and more expensive to do the same job.

Most importantly, it costs more to launch payloads from Earth into HEO. However, this is not as big a factor in 2100, as many satellites installed in high orbit are constructed in orbital space factories, and most of the large stations in HEO were built using resources mined from asteroids or Luna. Nevertheless, high orbit is still less crowded than LEO.

STATIONS AND SATELLITES IN HEO

A few examples of the HEO population are detailed below.

Notable Satellite Constellations

Galileo 5: The current E.U. satellite navigation system, providing GPS services from an orbit 15,000 miles up, using a network of 44 microsats.

GETEPOS: The GenTech Pacifica Ocean Surveyor is a constellation of three large macrosats in HEEO that provide constant surveillance of the Pacific Ocean.

Teralink: A four-satellite commsat constellation in GEO, serving Teralogos customers with direct satellite broadcast.

Chatarang Space University

A prestigious astrophysics laboratory and orbital university operated by Thailand in collaboration with other TSA nations. In the 2080s, its campus grew to include many non-TSA faculty and free-thinkers with nanosocialist sympathies. Although not involved in military research, during the Pacific War, it was targeted (by accident or design) by PLAN-SF warcraft, and a particle beam bombardment killed most of the 92 residents. A heroic operation by ESCA and Vacuum Cleaner teams rescued a few radiation-burned survivors in time to upload them as ghosts. The new Thai government has rebuilt the station with the help of a sizable grant from the Hawking Foundation, and it is now a state-run facility under Thai government control. It's a *Cynosure*-class station, population 101.

Columbia Deep Space Port

This 2,000'-diameter torus-shaped station was built in the 2060s by the U.S. corporation Columbia Aerospace as both a deep space port and corporate HQ. The station is a large space wheel similar to Von Braun Station (p. 15).

Columbia's role as a interplanetary port makes it (and China's Taiko) the most "romantic" locations in Earth orbit: it is here that colonists board the large interplanetary vessels that travel to and from Mercury, Mars, the Belt, Titan, and points beyond.

Columbia is also the HQ of Solar Express (p. TS96), whose distinctive yellow-and-purple courier vessels are a regular sight at space-docks. Triplanetary Lines (p. TS97) also runs OTVs here, shuttling passengers and cargo between Columbia and its headquarters in Islandia. Columbia is also the orbital HQ of NASA and the U.S. Astrographical Survey.

Columbia has a permanent population of 5,800, which often increases to 7,000 when large ships are in port. Visitors can stay in the luxurious 1,200-room Columbia-Hilton Spaceport Hotel. The remaining residential, lab, and office space is used primarily by the 2,000 employees of Columbia Aerospace who live here. The station is CR 3.

Columbia Station Spaceyard

This is a collection of two dozen zero-G dockyards and workshacks orbiting adjacent to Columbia Deep Space Port. At the center is a trio of 300'-diameter *Vulcan*-class space factories (p. 139) which house giant nanofacturing tanks where large nanocomposite and diamondoid assemblies are created. There are also a half-dozen *Omnistar*-class stations (typically one housing or service module plus nine empty cradles used for workpods).

Dozens of vessels are docked outside, many of them only partly completed. Much of the port's business is military, and dozens of USAF personnel are usually here, assisting with design work, testing, or shakedown cruises. It is CR 5.

The station is U.S. territory, and a USAF *Yeager*-class SDP (see *Shanzi*-class, p. 137) orbits nearby. A squadron of *Predator* AKVs are always patrolling nearby or docked at the SDP as well. Sometimes a larger warcraft like an *Angel*-class SDV will be present.

Indaba Station

A 250' long cylindrical space habitat (*Cynosure*-class, p. 137) established by the South Africa Coalition as an orbital research facility, with a population of 500 people.

Indaba is jointly operated by a consortium of universities and companies, including MDB Integrated Systems (p. 26) and Ithemba Biotechnologies (p. TS95). Most of the laboratories are devoted to materials technology, nanotechnology, and biochemistry, and are rented by African universities and corporations from the SAC government. Indaba is often visited by teletourist groups from African schools, and various student intern programs exist to ensure that promising students can study here..

It is South African territory, and CR 4.

Murder in HEO

Indaba Station was the site of a series of bizarre murders of expatriate bioroids in late 2098, killings that were carried out by a swarm of genetically-modified insects. Human Alliance radicals were initially suspected when rashes that appeared on the victim's bodies, apparently triggered by nanosymbionts carried in the insect's poison, formed patterns similar to that organization's logo. In 2099, station security arrested an immigrant Indonesian genetic engineer and TSA refugee named Ulfah Bintang on circumstantial evidence – she knew one of the dead bioroids and had the skill to commit the crime – but the case did not go to trial due to a lack of evidence or motive. No charges were laid; after her release, Bintang threatened to sue the station's security detachment for wrongful arrest, only to disappear two days after leaving police custody. There are no records or witnesses to her ever having left Indaba Station.

Taiko Station

Taiko is a large double-wheeled space station located in HEO (6,200 miles up). Administered by the Chinese government and Mars Interplanetary, it's the largest fully-constructed station in Earth orbit and the busiest interplanetary spaceport.

Taiko consists of a pair of 2,000'-diameter wheel-shaped habitats (treat this as a *Von Braun*-type station, p. 140, but with two wheels). The wheels contain residential, office, and factory space, and rotate around a central 750' tall cylinder containing the space port, a factory, and microgravity laboratories. Taiko has a resident population of 13,600. This swells to 30,000 on any given day if transients passing through but not staying at the station are included. It is not a self-sustaining habitat: it imports the majority of its food (mostly from Islandia).

Construction on Taiko Station was begun in 2059 to support increased traffic by fusion-drive spacecraft traveling between Earth and China's Mars colony. As the population of Mars increased, the station grew in size and importance, evolving from a Chinese to a truly international spaceport. Many non-Chinese colonists, particularly Arabs and Europeans, began their voyage to Mars from Taiko Station.

Taiko Station is primarily a spaceport, but it also contains plenty of manufacturing, office, and residential space. It houses the dockyards and headquarters of Mars Interplanetary, and also Red Arrow, China's largest orbital spacelift company. Many offices and labs are leased by other companies, chief among them Xiao Chu, which uses the station as a center for microgravity bioroid design and production.

Taiko Station is also the base of a brigade of Chinese Space Infantry Division troops, although only a battalion-sized unit will be on the station at any given time. Many are bioroids who consider service to be a signal honor that will eventually lead to citizenship.

Taiko is Chinese territory, and CR 5.

LEAVING EARTH ORBIT

GEO to L1 Lagrange Point: 176,500 miles (0.00218 AU).

GEO to L2 Lagrange Point: 252,000 miles (0.003 AU).

GEO to L3 Lagrange Point: 212,000 miles (0.00256 AU).

GEO to Luna, L4, or L5 Lagrange Point: 212,800 miles (0.00229 AU).

Vandegrift Station

A ring-shaped orbital lab, this facility was built by the Vandegrift company as a materials research facility. In 2093, the company went bankrupt and the lab fell into disuse. It was occupied by migrant microgravity workers for five years, until the biotech firm Terrel-Dieskau leased it from bankruptcy trustees, hired mercenaries to evict the squatters, and remodeled it into a state-of-the-art biotechnology research facility.

In 2099, it was occupied by 27 workers and numerous cybershells and cyberswarms. The station conducted high-security nanotechnology research. Netherlands territory, CR 6.

For more on Vandegrift Station, refer to the adventure *Orbital Decay*.

Vela Station

Orbital satellite factory run by PICOMEX (p. 26) (*Enterprise*-class, 2 lab, 2 housing modules, p. 136). In December, 2099, it was occupied by the 6-16 terrorist group (p. 29), possibly with Guatemalan backing, who have demanded access to Mexican broadcast networks and freedom of radical nanosocialists held by the government. The situation is developing; Mexican Grupo Aerotransportado de Fuerzas Especiales commandos are training with U.S. Delta Forces for an assault. Population 40. Mexican territory, CR 4.

GEOSYNCHRONOUS EARTH ORBIT (GEO)

Geosynchronous orbit is some 22,236 miles above the equator. At that altitude, it takes a satellite a full 24 hours to circle Earth. The busiest geosynchronous orbits are those that are also *geostationary*; see *Orbital Paths*, p. 9.

Geosynchronous satellites have the same advantages and disadvantages that those in HEO possess, magnified by their greater altitude. They have a good view of a wide swath of Earth, but it takes a lot of energy to launch payloads up to GEO.

SATELLITES AND STATIONS IN GEO

While GEO has many communication satellites, it has the smallest numbers of stations . . . but soon it will have one of the biggest.

Notable GEO Constellations

DECASTAR: Three Indian laser communication macrosats in geosynchronous orbit plus four more in HEEQ orbits that connect slinky news and entertainment reporters with their direct-broadcast subscribers. Operated by TNN and Mawari Digital (p. TS95).

Foursight: A 4-macrosat remote-sensing constellation that provides a view of the entire world to monitor disasters and developing "heavy weather." Operated by Esperante Enterprises (p. FW59).

StarCross: A four-satellite evangelical Christian religious broadcasting constellation.

Bifrost Station

This base was put in geostationary orbit over the Pacific in 2057. It was intended to be the foundation for an Earth space elevator, but funding for the project collapsed after the U.S. government dropped out, and only the construction shack was actually built. It was acquired by Nanodynamics, one of the original contractors for the project, in 2072.

Bifrost is a 300' sphere used as a microgravity space-dock and factory, with two attached spin capsules that house non-space adapted workers in Earth-normal gravity (*Vulcan*-class space factory, p. 139). Workers are assigned to Bifrost in week long shifts before returning to Earth, or, more often, to L4 stations like Islandia, Margaret, or New Deseret.

Scaled Composites, a Nanodynamics subsidiary, also uses the station as one of their primary spacecraft manufacturing plants. Small vessels are built inside the station, while larger ones are built one major component at a time and then assembled outside. The station has a population of 400, and is U.S. territory. It is CR 4.

Olympus Station

The largest project currently underway in orbit is Olympus Station, the planned anchor point for the Earth beanstalk (p. 23). It is in geostationary orbit above the city of Nairobi in Africa.

The planned chandelier-like station is now just an open structural frame, but parked next to the station are three *Vulcan*-class space factories (p. 139) for on-site workers and several smaller microgravity facilities, including *Enterprise*- and *Omnistar*-class stations. A

1,200'-diameter asteroid has been maneuvered into orbit to mine for raw materials.

Some of the smaller stations have *Concierge*-class defense modules (p. 137). There are usually a couple of European Union or Japanese military craft nearby, plus a contingent of on-site security forces from EDI. The site currently employs some 1,100 space workers and several times that many cybershells. Many of the workers include veterans of the Mars space elevator project. The station is legally Kenyan territory, and CR 5.

THE OLYMPUS PROJECT

The Olympus Project is an ongoing effort to build a space elevator, or "beanstalk," that extends from Earth's surface into orbit. The structure's center of mass is located in geostationary orbit, with a cable extending 22,236 miles down to a fixed point on the equator. The space elevator orbits Earth in synch with the planet's rotation, and like any other satellite in GEO, it always "hovers" over the same location on the ground.

The Earth beanstalk is intended to be a mass transportation system that uses high-speed elevators to move people and cargo between Earth and space. China has built a similar, but smaller, space elevator on Mars, which became operational in 2083. The Olympus Project is a far more ambitious feat of engineering, due to the higher gravity of Earth. Although its outlines had been envisioned for more than a century, the Earth beanstalk only became practical in the last three decades, due to the difficulty of manufacturing a superstrong cable thousands of miles long that could support its own weight.

The current project is not the first attempt to build an Earth space elevator – an earlier U.S.-funded effort collapsed due to opposition from entrenched space launch and satellite operation interests. The Olympus Project – backed by a different multinational consortium, led by many of the Lagrange and Lunar development companies – began moving forward shortly after the Pacific War ended.

The Olympus Project is funded by a multinational consortium of European Union, Pacific Rim Alliance, and South African space development companies and

TRAFFIC CONTROL

With so many objects and spacecraft in Earth orbit, traffic control is a high priority. Experience with air traffic control in the last century provided a good model from which to build a more elaborate system for orbital use. Standard procedures have been developed which are accepted by all space-going nations, alliances, and corporations.

Traffic control communications are handled by a dedicated system at every orbital port and station. Public access to traffic control channels is severely restricted – again as a security precaution. Likewise, traffic control equipment includes multiple failsafes and redundancies.

Any vessel that arrives within a region administered by a particular traffic control authority is expected to notify that authority as soon as possible. The authority then instructs the vessel on local variances from the standard procedures.

governments. China and the Islamic Caliphate are not formal partners at present, but it's expected they may join in the future. The United States and India have opposed the beanstalk project for a variety of reasons (see *The Olympus Cleanup*, p. 40); so have the TSA nations.

No cable has yet been laid, but construction of both the orbital and ground sites began in 2093, and both are well underway. Once the Earth Beanstalk is fully operational (currently set for 2114), it is expected to drastically reduce the cost of reaching orbit.

Olympus Project projections suggest operating expenses will be as low as \$250-500 per passenger. To recover their capital, the owners plan to charge \$2,500 per person (roughly 10% of a ticket price to LEO at present) and some \$3-\$5,000 per ton of cargo. The investors expect to see a steady increase in volume of orbital traffic as this reduced cost makes it far cheaper for people to visit or emigrate into space; they predict this will lead to expansion of the elevator and further price reductions.



Touchdown: Mount Kenya

The touchdown point of the beanstalk is Mount Kenya near the city of Nairobi (in Kenya, Africa), where a massive construction effort is underway. To reduce the height of cable needed, the beanstalk will be attached to a 10-mile high tower built atop the mountain. The mountaintop itself has been flattened to accept the structure. Also under construction are new airports, rail lines and other facilities to support the spaceport.

The Mag-Lev

Five elevator tracks will extend up the base tower and along the cables, ultimately reaching Olympus Station in GEO. Riding above these tracks will be pressurized magnetic-levitation (mag-lev) elevator cars. Power requirements for the mag-lev are relatively low; when each elevator is descending, it freefalls toward the surface, returning energy to the system. The cable itself can also generate power – see below.

Each mag-lev car will be capable of carrying hundreds of people and/or many tons of cargo. Moving through vacuum for most of the journey, the mag-lev cars are designed to travel at average velocities of 0.7 mps (2,500 mph), and



will be able to reach GEO in approximately nine hours. Later, faster cars and additional cables are planned as additions to the structure.

The Cable

The surface-to-orbit cable is about 23,000 miles long, constructed of braided carbon nanotubes (nanocomposites) about 100 times stronger than steel. The beanstalk cables will be several yards thick in orbit, but taper down to a thinner cable as they near the Nairobi tower. The cables also serve a secondary function: they'll be able to tap the rotation of the Earth's magnetic field to generate power for the elevators and other station needs.

At present, the plan is to create a single thin "precursor" cable to test the structure and haul up building material, then follow with four full-strength cables. Multiple cables will provide redundancy against damage (accidental or otherwise) and allow more elevators to operate. The beanstalk will have facilities permitting car-carriage of satellites and small spacecraft for launch at altitudes below GEO, allowing it to be used to deliver objects to points below GEO. An object that is released from a high enough point part-way up the beanstalk will not fall back to Earth, but will instead end up in a non-GEO orbit.

Olympus Station

The orbital center is Olympus Station, located in GEO. At present, this is a hub of construction activity as the station is being built and huge cable-laying machines are being installed. When finished, Olympus Station is planned to be a spaceport, hotel complex, convention center, and industrial park that will surpass Columbia, Taiko, and Von Braun. In fact, plans envision many of the smaller stations already in GEO or HEO relocating to Olympus Station itself, while some others will move to L4 and L5.

The Countermass: Artsutanov-Pearson Station

To keep the cable structure from tumbling back to Earth, the cable has to extend for a sizable distance into space away from GEO as well. Rather than build a long cable, a somewhat shorter one with a large countermass is planned. This will be a small relocated asteroid on which another port, Artsutanov-Pearson Station, will be built.

The countermass cable will also have a secondary function: using the rotation of the entire space elevator, it will be able to slingshot payloads into deep space.

Mag-lev cars will be used to connect Olympus and Artsutanov-Pearson, which will also house a small space launch facility to benefit from the slingshot effect. The 1/3-mile diameter asteroid that will be used for the station is currently heading toward Earth, using a mass driver for propulsion. It is expected to arrive in 2101.

VERY HIGH EARTH ORBIT (VEO)

VEO is relatively unpopulated. A few scientific satellites in highly elliptical orbits are found here, monitoring space weather phenomena and Earth's magnetosphere.

The Graveyard

The "graveyard," 24,000 miles up (just above GEO), is where Vacuum Cleaners tow space junk they don't consider worth salvaging. The material is tethered together in great bundles (or nets) and marked with reflectors or transponders.

Some of the graveyard junk is sold to scrap dealers who recycle it. The graveyard is also raided by scavengers from poor L5 colonies like Sakharov Station (p. 130).

ORGANIZATIONS IN EARTH ORBIT

Several organizations have significant influence in Earth orbit. They include corporations, government agencies, military forces, and non-governmental organizations.

ORBITAL COMMERCIAL CARRIERS

Several space transportation companies provide cargo and passenger service to and from Earth orbit, or between orbital stations and other locations. Examples include:

Ellison Orbital: An American corporation based on Columbia Station. The company operates a small fleet of orbital transfer vehicles (OTVs) that carry people and cargo between various Earth orbit stations, especially from low to high orbit.

GaiaStar: This European Union aerospace passenger line specializes in TAV flights to and from Earth orbit.

Mars Interplanetary: The solar system's biggest interplanetary shipping carrier. Although it does not operate orbital craft, this Chinese company has contributed greatly to the growth of Taiko Station. Mars Interplanetary provided not only the initial impetus to the station's construction, but also funded its completion. More than a third of the transient population of Taiko Station are passengers that will travel on Mars Interplanetary vessels.

Ntinga Spaceways: This South African spaceline operates regular TAVs and a few light laser lift rockets, carrying cargo and passengers from Cape Town and Nairobi to Von Braun Station and Indaba Station in Earth orbit,

THE GENETIC REGULATORY AGENCY IN ORBIT

The GRA is an intelligence and security agency founded by the European Union, Russia, and Ukraine to monitor and prevent the abuse of human genetic engineering. Most of its work is confined to pure intelligence gathering, relying largely on human intelligence, but augmented with information obtained from spysats and other sources.

Until the last decade, the GRA confined its operations to the planet's surface. The Pacific War changed the situation, as a combination of TSA exiles and criminal groups became more deeply involved in bioroid trafficking and genetic terrorism. Consequently, the GRA finds itself stretched to the limits of its resources. It has only a small number of full-time operatives whose duty is to investigate and enforce genetic engineering protocols. Therefore, it frequently relies upon a combination of local police forces and freelancers to achieve its goals. The latter are certainly not favored by any of the GRA's sponsoring governments, but sometimes there's no other option available. For example, freelance agents were instrumental in uncovering an illegal bioroid growth operation aboard a Russian orbital facility in 2096.

That affair had a very high profile and has secured the image of "genetic bounty hunters" in the popular imagination. In 2099, an InVid based on the incident was released, starring Shammi Nagrajhan in the role of Cami Ocalan, the leader of the freelance band that uncovered the facility. The publicity has put some pressure on the GRA either to train more personnel or expand its freelance program.

as well as chartered flights to other locations. Recently Ntinga has begun selling off some of its transatmospheric vehicles and investing in a new fleet of orbital transfer vehicles, since its executives believe that the coming Earth beanstalk will make the Earth-orbit route unprofitable.

Solar Express (SOLEX): A permanent fixture of life in orbit, and a major tenant on Columbia Station. SOLEX operates a small fleet of cargo-carrying orbital transfer vehicles and transatmospheric vehicles in addition to its deep space craft. SOLEX facilities also employ many microgravity dockworkers (both human, bioroid, and cybershell).

Red Arrow: The largest Chinese carrier, operating a mix of TAVs and heavy lift vehicles. In addition to surface to orbit transport, it also runs a fleet of OTVs based at Taiko Station.

RV Interorbital Ltd.: A major cargo carrier that transports goods between Earth and LEO. Based in the United Kingdom.

Islandia performance . . . at a Lenin's Tomb price! 3D Orbital Solutions can handle all your minifac needs, no matter the size. And we know what it's like to dream big on a small budget – it wasn't that long ago that we were in the same place. So schedule a visit from one of our friendly techreps today! We'll come to you, no matter where you are!

– 3D Orbital Solutions ad in Space Today

SPACE DEVELOPMENT CORPORATIONS

These companies build satellite, spacecraft, and space stations, and often also have extensive investment and property holdings in Earth orbit.

Alvarez Orbital S.A.: A division of Alvarez Motors, this Brazilian company is a major manufacturer of commercial space systems, especially small plasma thrusters used for satellite station keeping.

AVPK Moiseyev: An old Russian aerospace company, it manufactures spacecraft and mass drivers for use in Near Earth Asteroid mining. Its headquarters is in St. Petersburg.

Beijing Academy of Space Technology (BAST): Develops new space systems, especially satellites, laser rockets, and directed-energy weapons.

Columbia Aerospace: This aerospace giant (see p. TS94) has some of the most extensive holdings of any corporation in Earth orbit. A pioneer of orbital laser lift technology and spacecraft design, it also assembled the first space industrial park, *Enterprise-1*. That facility is long gone (broken up and moved to a junkyard in Lagrange 5 in the 2060s), but the company built and largely owns Columbia Station (p. 20), as well as several other orbital factories. It was one of the first corporations to move off world when it moved its headquarters from Quito, Ecuador, to Columbia Station in 2064.

CIT/Provençale: This French industrial conglomerate (see p. FW57) has orbital labs and factories.

European Robotics and Aerospace Corporation (ERAC): A Netherlands-based consortium of satellite and cybershell manufacturers. It is a tenant at Ingelheim Station.

MDB Integrated Systems: A South African company that produces satellites, workshacks, and spacecraft. Its headquarters is in Cape Town.

Nanospazio: An Italian corporation that manufactures very long carbon nanotubes for space

applications. A major subcontractor on the Earth Beanstalk, with many workers currently at the Olympus Station construction site.

NUK: This Japanese company is moving into L4, but still has many labs and factories in Earth orbit (p. TS95).

Picosatellites Mexicanos S.A. (PICOMEX): A large Mexican commercial and defense satellite manufacturing company with a factory in LEO. Also makes low-cost IMINT nanosat constellations used by Mexican and other intelligence and police agencies.

Scaled Composites: This American industrial conglomerate, a subsidiary of Nanodynamics, is a major producer of spacecraft and habitat hulls in orbit, and has a factory in GEO. Its headquarters is in Albuquerque.

Skytrain Industries: A consortium of European, Japanese, and Korean mag-lev rail manufacturers. They produce intrastation electromagnetic transport systems, and are a contractor for the Olympus Project's mag-lev cars.

System Technologies AG: The largest space development company in the solar system, the Berlin-headquartered transnational has built hundreds of satellites and space stations, and is presently the primary contractor on the Earth Beanstalk. See p. TS96.

3D Orbital Solutions: This Chinese company leases, installs, and services 3D printers and minifac workshops, catering to the needs of small orbital and L5 stations. Its salespersons (mostly social-interface bioroids) are often seen making the rounds of various seedy LEO and L5 stations.

Xarxa Enllaç SL: The Catalonia-based telecom company owns and operates many satellites.

Xiao Chu: China's huge space development company (p. TS96) has offices on Taiko Station and numerous labs and space factories throughout Earth orbit such as Shou-Xing Station (p. 18). On Taiko Station, Xiao Chu's factories are engaged in manufacturing bioroids used by both the Chinese military and many commercial facilities.

FIGHTING IN EARTH ORBIT

Orbital space is the ultimate high ground, of vital importance for any conflict on Earth. In addition to the economic value of orbital ports, labs, and factories, a modern military force is dependent on satellites for communication, early warning, intelligence gathering, reconnaissance, weapons targeting, and navigation. To protect these assets and neutralize those of their adversaries, each of the great powers (and those that *want* to be great powers) deploys an arsenal of orbital bases, combat spacecraft, and space defense platforms.

The only real orbital conflict was the Pacific War of 2084-2085, which pitted China against the Transpacific Socialist Alliance, and saw other spacefaring powers struggling to contain the conflict and defend against the debris that was produced by it. The Pacific War demonstrated that a battle in Earth orbit was everybody's business. Today, the great powers – especially China, the European Union, and the United States – police orbital space to keep the peace, while watching one another like hawks. Any vessels that start a fight in orbit will draw swift intervention from one or more of the great power space forces. Earth orbit is densely populated, and no one wants loose cannons blasting away.

Despite this, it's not uncommon for civilian vessels to mount and even use weapons in space, provided they follow accepted safety protocols. Vacuum Cleaner salvage teams and private or commercial spacecraft are free to use their own weaponry to zap space debris that may threaten manned stations or valuable satellites. Nevertheless, to avoid accidents or misunderstandings, it's common practice to broadcast warnings to nearby stations, vessels, and satellites before any such engagements, and it's also important to make sure that whatever is attacked is completely destroyed.

Debris isn't the only thing that gets zapped, though. In the 15 years since the end of the Pacific War, several

small-scale orbital skirmishes have occurred in which firepower has been unleashed by powers great or small, usually against terrorists, criminals, or hijackers who've seized spacecraft or satellites. This doesn't trigger intervention if safety protocols are followed; this means taking care to either vaporize a target (usually only possible for objects massing under a ton, like a microsat or a person in a suit) or failing that, to salvage any bits of debris before they can hit something else. Lasers and particle beams are the only weapons tolerated. Coilgun fire (either with KKMP or XLMP munitions) is considered too dangerous for anything short of a general war, due to the risk of unintended collateral damage, either physical or, in the case of XLMP munitions, electromagnetic pulse.

If minor powers (or private citizens) violate any of these "unwritten rules," the result will usually be a rapid and extremely lethal response from ESCA, PLAN-SF, and USAF military forces. If a great power "broke the rules," the result would be an international crisis.

Other Aspects of Orbital Combat

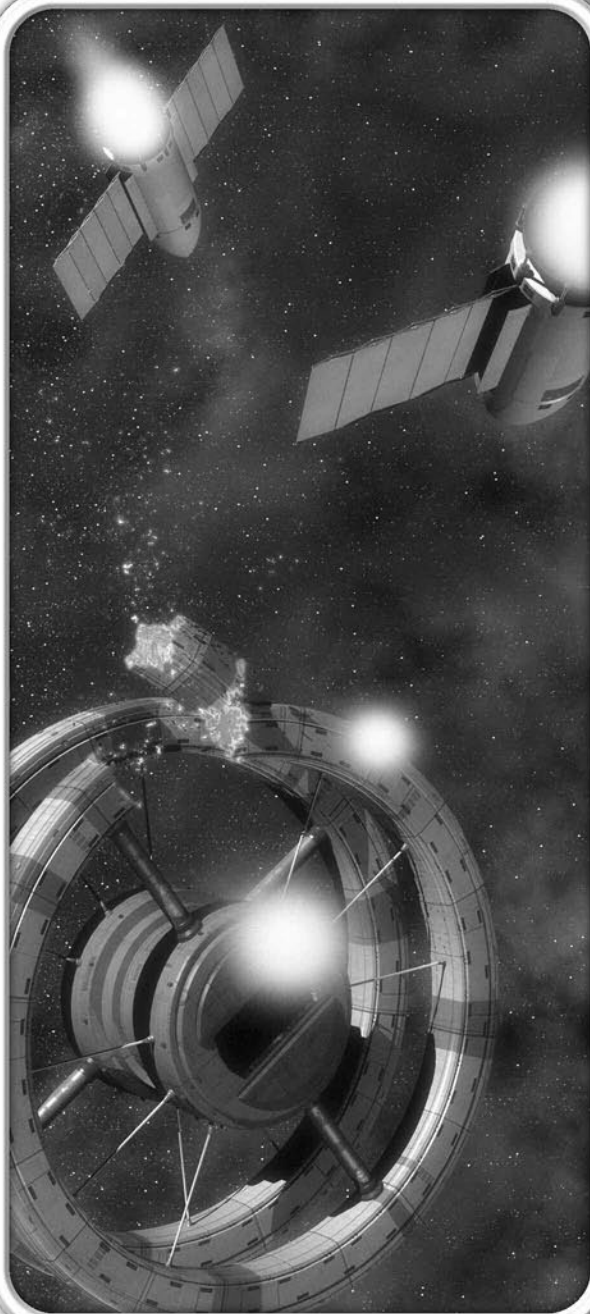
Orbital Maneuvering: In orbit, increased acceleration in a straight line doesn't really make you go faster – you actually go slower, but rise into a higher orbit! The physics of orbital maneuvering can be non-intuitive, but they can also be largely ignored since the space combat system on pp. TS194-201 is fairly abstract. Engagements in Earth orbit are most likely to be "close encounters," although when converging orbits result in very high relative velocities, the GM may wish to use the "distant encounter" rules. In this instance, begin the engagement at a range where vessels appear over the horizon (see below).

Speed Kills: In LEO, orbital velocity is typically about 4-5 miles per second (mps), but what matters in combat is *relative* velocity. If both spacecraft are orbiting the same way around Earth, their relative velocity will usually be minimal, typically 1 mps or less. If orbiting in opposite directions, relative velocity would be added together, and can easily reach 9-10 mps. See the *Orbital Altitude and Velocity Table* on p. 7.

Curvature of the Earth: Objects can disappear below the curvature of the Earth, limiting engagement ranges, especially at low altitudes. See *The Horizon*, p. 27, for the formula.

The Horizon in Orbit

Line of sight in orbit (for sensors, laser fire, or communication) is limited by the curvature of the Earth. The distance to the horizon is $70.55 \sqrt{h}$ (square root of height in miles). To calculate the distance at which two objects at different heights are visible to each other, do the same calculation for the observer's distance to the horizon and the object's distance to the horizon, then add the distances together.



Ground Fire: All of LEO – and HEO to about 8,500 miles – is in range of heavy Earth-based lasers, the “coastal artillery” of 2100. Most major powers install ground-based lasers atop mountains or high hills, with power and control systems buried underground. As these are well-armored (and can be easily camouflaged), important strategic installations are often located in HEO, often 10-12,000 miles up. When spacecraft engage surface installations or vice versa, use the Orbital Strike rules on p. TS203; note that Earth’s atmosphere gives cDR 10 vs. lasers firing into or out of it.

Naval and Airborne Lasers: Heavy lasers that are capable of engaging armored spacecraft in orbit are

too big and power-hungry for most ground vehicles, but are practical on ships and even submarines (which must rise to periscope depth to fire). Airborne lasers on large aircraft or even airships are also used, but these can’t be as heavily armored as ships or spacecraft, and so are highly vulnerable to counter-attack once they’re located. At high altitudes, the atmosphere will provide reduced DR; if an aircraft is flying at high altitudes, the atmosphere may only provide cDR 1-3.

SPACE FORCES IN EARTH ORBIT

All but the very poorest nations have their own military communication, imaging intelligence, and navigation satellite constellations in Earth orbit.

The great powers and emergent great powers – and some other wealthy or militaristic nations – also deploy armed spacecraft. The most common are space defense platforms and AKVs (robot fighters), but all shapes and sizes of vessels may be used. In peacetime, they perform debris interception, rescue missions, police actions, boarding actions, embargo enforcement, counter-terrorism, and so on. In war time, they stand ready to destroy the enemy’s space assets, defend the homeland from attack by space weapons or ballistic missiles, and to perform orbital strikes on surface targets.

The largest forces in Earth orbit include:

Alliance Space Defense (ASD)

The military forces of the Pacific Rim Alliance are largely independent from one another, but due to the importance of space operations, maintain a unified headquarters for orbital operations. This force controls some 50 Australian, Japanese, and Korean SDPs, AKVs, and TAVs. Japan is the only member of the Alliance with significant deep space forces. A few Japanese SDVs are sometimes in Earth orbit in support of ADC, but the majority of Japan’s Space Self-Defense Force (JSSDF) patrols lunar space and the Main Belt in support of Japan’s own interests.

Earth Fleet

The Chinese PLAN-SF’s “home defense” force is dedicated to operations in Earth-Lunar space, and especially Earth orbit. The main forces of Earth Fleet are about 50 SDPs and 75 AKVs (most of the latter based on space stations). PLAN-SF doctrine is to keep SDVs out of LEO, preferring to patrol out beyond Earth orbit, but it does usually have a group (*dadui*) of 3-5 *Riguang* or *Xingzhai*-class SDVs (pp. SSS34-35) at Taiko. Several obsolete, second-line, and training vessels are also based there as a reserve fleet, usable in an emergency. In addition, China also has over 200 *Diaocha*-class TCAV aerospace fighters (p. SSS36). They are controlled by the Air Force rather than PLAN-SF, but can reach orbit to participate in joint operations in LEO.

Standing Space Force Earth Orbit (STANSPACFOREO)

This is the European Space Control Agency (ESCA)'s force dedicated to orbital warfare. The mainstay of the force is 55 *Auskermar* SDPs (p. SSS31). They are usually backed up by a dozen or so SDVs, usually a mix of the LSDV-5 and the *Konigsberg* class (pp. SSS27-28). The SDVs may carry a mix of AKVs or Puma "boarding pods" (p. SSS31) with spaceborne troops.

TSA Orbital Strategic Directorate

The TSA now lacks much in the way of orbital assets to defend; their wartime strategy is to attempt to deny low orbit to the enemy via surface-based lasers. Malaysia and Indonesia do have a couple of SPVs used for operations-other-than-war. A more nebulous threat is the unconfirmed report that some "civilian" macrosats launched by TSA corporations (often under flags of convenience) may be OSD-controlled AKVs or SDPs; whether this is rumor or strategy is another question. If they exist, in wartime they'd be used for first strikes against high-value targets.

USAF Orbital Command

Actual operations in Earth orbit are controlled by a joint-services Orbital Command, which is dominated by personnel, satellites, and TAVs controlled by the USAF's Aerospace Command. The major assets actually in orbit are a network of 60 SDPs owned by the 21st Space Wing, assisted by several spacecraft (two *Angel*-class SDVs and numerous AKVs and smaller vessels) of the 341st Space Wing (at Columbia Station). The army and navy also control various ground-based and ship-based lasers that have sufficient range to intervene in a battle fought in low orbit.

Other Powers

The great powers are fairly comfortable with their degree of orbital firepower, but there is a minor orbital arms race going on among second-tier powers, particularly those in the Pacific, East Asia, and in Central and South America, as the newly-spacefaring powers in these regions seek to protect their own growing orbital assets, and in some cases, achieve space superiority over or parity with a potentially hostile neighbor.



Several nations, including Argentina, Brazil, Canada, India, Iran, Mexico, Pakistan, Russia, Saudi Arabia, and South Africa, have small to medium-sized orbital forces tasked with protecting their own orbital stations and satellites, and/or fighting against regional opponents. These rarely consist of more than a dozen AKVs and SDPs, augmented by a few (mostly unarmed) OTVs and TAVs that are used for orbital transportation.

India, Russia, and South Africa each have 2-3 SDVs. These are often deployed far from Earth, visiting their respective colonies: Russia on Mercury, while South Africa and India have interests in the Belt and, in South Africa's case, Venus.

LAWS AND CUSTOMS IN ORBIT

Stations in orbit are treated like ships at sea. Though not contiguous with the land that makes up the state that possesses them, they are nevertheless within their jurisdiction. (see *Flags of Convenience*, p. 13).

The Revised Outer Space Treaty (p. TS86) and other international regulations (regarding traffic safety, for example, or use of satellite parking "slots" in GEO) are enforced by most spacefaring nations (including flags of convenience). Violators can usually expect a fine of \$50,000 or more imposed by their own government, or if they lack a government, arrest as "international criminals."

6-16

6-16 is an international nanosocialist radical group acting independently of the TSA to strike at "external enemies of global nanosocialism." It is currently focusing on India and Mexico, two regions where radical nanosocialism is on the rise, but the group is named for the date (June 16, 2084) when China launched its orbital assault on the TSA, and considers China its primary enemy. Its leader is exiled Thai cosmologist (and noted poet) Dr. Suwanee Cholasuk, one of the few ghost "survivors" of the Chatarang Space University attack (p. TS23). She has recruited many European and Central American members, and also attempts to recruit disaffected mangliu. Members prefer to create and upload shadows of themselves into hijacked cybershells rather than risk their own lives through direct assault. They tend to have scientific or engineering backgrounds. There is some reason to suspect a covert base on Von Braun, supported by E.U. sympathizers. 6-16 may also have sympathizers at Tsiolkovsky on Luna.

Orbital Department of the People's Armed Police (ODPAP)

A Chinese paramilitary organization (under Ministry of State Security), this is the largest "space cop" police force in Earth orbit, with 400 officers, including some trained for counter-terrorism ops in microgravity, and a supporting squadron of armed OTVs.

ODPAP has jurisdiction on Chinese stations, and also carry out inspections and emergency/rescue duties. They're based at Taiko Station, and are a favorite subject of Chinese dramatic InVids.

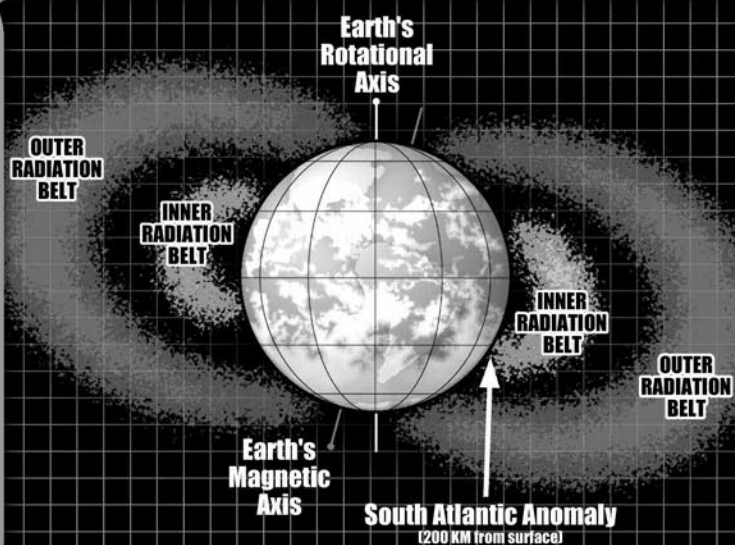
The E.U., U.S., and PRA have no single agency that handles orbital policing to the same extent, but various agencies maintain offices in Earth orbit.

The large orbital ports – Columbia, Taiko, Von Braun – are open to international visitors, but have strict traffic control and docking procedures aimed at reducing the risk of accidents or terrorism. Any suspicious or previously unknown craft will be met and boarded by security or military forces before being allowed to dock. These stations enforce national border controls – visiting Taiko Station, for example, is the same as arriving at an international airport in China, and passengers and cargo will have to pass through Chinese customs.

The majority of customs inspections take place on ground ports rather than in orbit, due to the vulnerability of stations to hazardous materials, terrorism, etc. Thus, someone shipping goods to Taiko Station will usually have been inspected prior to liftoff.

Where this isn't possible, stations will send teams over to search for contraband and hazardous materials. Chemsniffers, bio-enhanced sapient dogs, and microbot hunters all serve the cause of protecting a nation from contraband and controlled goods.

Smaller commercial or military stations handle their own security, and are free to admit or deny entry to uninvited



Van Allen Belts

visitors. Security and ID checks may be casual or thorough, depending on the station's purpose and the perceived threat. Most commercial stations only accept docking from invited visitors, though stations like hotels or factories usually have a regular stream of passenger or cargo vessels.

In an emergency, small stations and other vessels will be visited either by national military forces (for rescue) or, if the situation is beyond rescue, a Vacuum Cleaner salvage team. If an emergency occurs inside or in proximity to a large port like Von Braun, the station will deploy its own security, medical, and rescue teams.

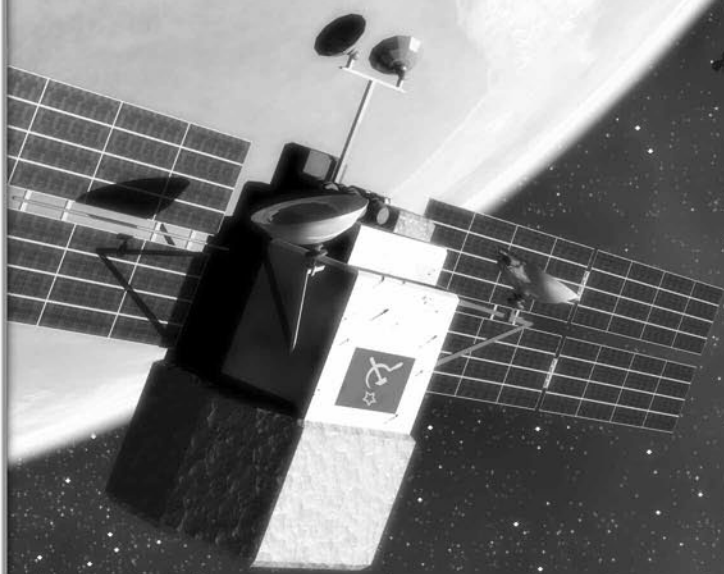
Security Forces and Weapons Laws

Stations in Earth orbit are a good deal more fragile than the large Lagrange colonies or deep space asteroid bases. Regardless of Control Rating, inhabited orbital stations usually have policies that ban guns, explosives, and other weaponry capable of damaging exposed machinery. Views on nonlethal and hand-to-hand weapons are in line with the station's CR; in rougher areas, many spacers like to carry a knife, shock glove, or electrolaser. Authorized possessors of weapons (such as police officers with appropriate jurisdiction) must present their credentials upon entering an orbital installation.

A typical non-military station has a civilian security force roughly equal to 5% of the population. Guards may be human, cybershell, or bioroid, sometimes (but not always) from a private agency, of which Executive Decisions International (p. TS94) and Orion Industries (p. FW79) are the largest. Guards will usually have skills such Electronic Operations (Sensors), Freefall, Guns, Judo, and Vacc Suit. The police armgun (p. TS156) is a favored civilian weapon, as it is completely recoilless; the electrolaser is used in atmosphere, and micromissiles (usually with tangler warheads) are used in vacuum or against armored targets. Recoilless rifles are used in high-threat situations.

2

THE VACUUM CLEANERS



The Vacuum Cleaners are a subculture with a job to do – keeping Earth orbit clear of “space junk,” dangerous inactive man-made objects. Because a completely “clean sky” is not realistic, they also work to track and record inactive (and active) satellites and debris. Many work for SDR Inc. (Satellite Debris Removal); others work for other corporations or government agencies, usually contracted to defend specific satellites or stations. A few are independent operators, taking small short-term “clean-up” contracts and searching for salvage (valuable either for its material contents or, sometimes, its historical or curiosity value).

“Vacuum Cleaners” is simply a nickname; other terms for this occupation include “Junkmen,” “Junk Cleaners,” “Orbital Sweepers,” and other variants in dozens of languages. Official statements usually talk about “salvage teams” or “safety teams.”

Some folks would say that the Vacuum Cleaners are not a “group” at all. It’s certainly true that they

have no single shared base, employer, or motivation for their activities. And yet, *they* mostly see themselves as a group. They share a fairly clear self-image, which leads to mutual solidarity and support; they are also recognized as a distinct group by other spacers.

In other words, there is a Vacuum Cleaner group meme. This has been noticed by many students of memetics, and the Cleaners themselves are used to receiving communications and even personal visits from academics keen to study the formation and evolution of this memetic cluster. It has become something of a standing joke among them, and some make a point of studying just enough memetic science that they can confuse these visitors, or lead them into seemingly simple conversations that suddenly turn on the vexed academic question of the validity of any “field” observations of a memetic carrier-group whose members are fully aware that they are being observed, and of the possible distorting effects on memetic evolution of this phenomenon.

HISTORY

The Vacuum Cleaners exist to solve a problem that was recognized not very long after the beginning of space flight. When an object is placed in orbit around the Earth, it stays there until something moves it. Objects in low orbits encounter friction with the tenuous fringes of the Earth's atmosphere, which causes their orbits to decay until they either burn up or crash. But this can take years, and objects in higher orbits are effectively there forever. Worse, fragments from destroyed vehicles (especially those destroyed by explosive motor failures), objects "dropped" by human space-walkers, and whole upper stages of old booster rockets proliferate even faster than actual satellites. While space may be infinite, the volume defined as "Earth Orbit" is finite, and could eventually fill up with enough junk to make major collisions inevitable. Such collisions are very likely to be catastrophic, and may make the problem progressively worse, through a "cascade catastrophe" (see below).

All collisions tend to throw off multiple fragments – all moving at orbital velocities. Thus, the more likely collisions become, the more fragments there will be in orbit, increasing the problem further.

THE DANGERS OF DEBRIS

"Earth Orbit" already contains enough material – almost all of it man-made – to create a significant danger of collision for vessels or satellites. Furthermore, the problem is persistent. Objects left in orbits below 400 miles will normally fall back to Earth within a few years, but at 500 miles, the time becomes decades, and debris left above 600 miles will continue circling the Earth for at least a century.

Collisions are in fact very frequent, but most involve very small debris particles (or micrometeorites), which lack the energy to penetrate even 20th-century space-craft hulls. Still, older stations and satellites are

invariably scarred and pitted by thousands of small impacts; the most obvious problem is usually that viewports and camera lenses become chipped and fogged. Delicate, large structures such as older-style solar panels and radiators suffer constant minor damage, degrading their efficiency over years or decades. Slightly larger collisions are much more rare, but much more dangerous.

The Cascade Catastrophe

But the dangers do not end with the possibility of a direct collision. *All* collisions tend to throw off multiple fragments – all moving at orbital velocities. Thus, the more collisions happen, the more fragments there will be in orbit, increasing the problem further. The problem will accelerate *even faster* than the rate at which civilization adds to the orbiting junk-pile.

In the late 20th century, it was realized that this could theoretically lead to a "Cascade Catastrophe," in which fragments from collisions suffered further collisions almost immediately, until the entire of LEO was filled with small, deadly, fast-moving fragments. Pessimists predicted that eventually, low orbit, and hence effectively all of space, could be rendered uninhabitable.

Mathematically, they were correct, and while they disagreed on exactly when this might have become inevitable, the fact that space travel is possible in 2100 is only thanks to active measures such as those of the Vacuum Cleaners.

CLEANUP

Agencies and companies with an interest in space began studying possible ways to clean up LEO in the late 20th century. In the early 21st century, a series of international agreements, cul-

minating in the Revised Outer Space Treaty (ROST, p. TS86), addressed this and related problems of "crowding in space."

Early plans for dealing with the problem remained mostly on the drawing board due to bureaucratic and corporate inertia. By the time that the ROST was negotiated, insurance companies were threatening to withdraw from the burgeoning space business due to accelerating payout rates. It was clear that some serious, continuing response was required. International organizations were created to coordinate "clean-up" activities, chief among them the Committee for Orbital Traffic Safety (COTS), established in 2026.

COTS AND SDR Inc.

*"Any micrometeorites or space debris that might endanger the hotel will be identified and eliminated by our Concierge-class guard modules long before they become a concern to you or to us. We **guarantee** that you will not only suffer no annoying puncture alarms, but that the station will not be obliged to perform any evasive maneuvers during your stay. Our promise – no motion sickness. And your view of Earth will be through crystal-clear, unfogged diamondoid windows."*

– Transcribed from the virtual reality brochure issued by the Tartessos Low-Earth Orbit Luxury Resort, 2099

COTS is the international organization technically responsible for orbital safety, but it was never more than a diplomatic shell which channeled funds and negotiated contracts on behalf of the signatories to the Revised Outer Space Treaty. Today, it exists only as an electronic address and a list of mid-ranking diplomats who rarely even speak to each other. Its first act was to issue an open invitation to bid on the task of controlling the debris problem. The winner of the contract was a consortium of space-related businesses which eventually became SDR Inc.

Incorporated in 2029, SDR was mostly a holding company, with large blocks of stock in the hands of parent companies in several different countries. At the time, its head office was in Luxembourg, while its craft operated out of various spaceports, including Cape Canaveral and (increasingly) Quito. Eventually, the combined company developed its own identity, assembling a small fleet of specially-built shuttle-type craft and unmanned, automated satellites. SDR had a fairly tight budget, but had to employ the best technology to meet its commitments; for example, it rapidly adopted laser launch technology in the early 2030s.

In 2049, SDR's headquarters moved to the newly-built Lammergeyer Station, in LEO. By that time, almost half of all

salvage and cleanup operations were already being handled by manned orbital craft with no re-entry capability. Many were employed directly by the SDR consortium; others were orbital construction workers hired for short-term contracts. Some of these found the work lucrative enough to make it their profession. In time, they all acquired the same nickname: the Vacuum Cleaners.

WAR AND PIECES

The biggest single event in the history of the Vacuum Cleaners was the Pacific War. The 2084-5 conflict between China and the TSA was the first to involve substantial combat in space, including numerous exchanges of fire in LEO. Life suddenly became much more interesting (not to mention potentially lethal) for the Vacuum Cleaners, and for a while, a Cascade Catastrophe looked very likely indeed.

COLLISION DAMAGE

In a circular orbit with an altitude of 500 miles (a good working LEO height), a satellite is moving at around 16,650 mph relative to the Earth; at 1,000 miles, that becomes 15,800 mph. A collision between two such satellites is sure to be at a significant fraction of these speeds, will *probably* be at a rather higher net speed, and if head-on, will be in the neighborhood of twice these numbers.

The damage caused by a collision depends on the size and density of the debris, the impact velocity, and numerous other factors. It can be determined for **GURPS** purposes by finding the average diameter of the object in inches, then multiplying by 125 to get dice of damage. (As with weapons, for large numbers, you can divide the number of dice by 6 and multiply the number rolled by the same amount.) So a 0.004" speck will do 1/2d damage, a 0.04" flake will do 5d (averaging 17.5 points of damage, with a maximum of 30), a 1/2" object (say, a large bolt) 6d¹⁰ (averaging 210 points), and something averaging 6" in diameter (perhaps a recognizable component of a large rocket, or even a complete micro-satellite) may cause as much as 6d¹²⁵ (average 2625). This is a rule of thumb only; objects in almost the same orbit can have low relative velocities, and hence cause less harm, while a head-on collision might cause twice as much damage.

A typical orbital spacecraft or ground-to-orbit shuttle has DR 20-30 (cDR 0.2-0.3). This means that it can withstand most impacts with objects up to 0.04," though something around that size might leave a shuttle stranded in orbit for several days, while the crew seals the puncture and triple-checks hull integrity. Shuttles must avoid anything larger.

Most stations and larger spacecraft have DR 100; their crews get nervous when objects approach the 0.2" size range, which can sometimes penetrate their hulls. They *have* to respond actively to anything larger. However, even large, solid craft may have external equipment – cameras, manipulator arms, radiators, sensors, etc. – which may be at risk from smaller debris. There is also significant danger to microsats, and to astronauts performing spacewalks in anything but cumbersome armored suits.

Large impacts could totally destroy even the most advanced vessel, but these are highly improbable. Modern satellites are usually recovered quickly when they break down or complete their missions, and are routinely tracked and catalogued.

It was prevented by a determined, sometimes heroic, operation in which every then-active Vacuum Cleaner worked alongside nearly every civilian and military group that had the equipment to help. SDR took a coordinating role, exerting pressure through the COTS framework to obtain both the assistance of neutral governments and financial remuneration – for independent contractors as well as for SDR itself.

Aside from the danger of the work, which was increased by the number of fragments which turned out to be unexploded munitions, the war years saw a great deal of political tension. Vacuum Cleaners and co-opted neutral military forces repeatedly found themselves dealing with “junk” that turned out to be still-active military equipment belonging to the warring powers, and sometimes blundered into attempts at stealthy operations by one side or the other. Frayed tempers, among both the combatants and the Cleaners, repeatedly threatened to draw neutral groups into the conflict.

When the war ended, nearly 200 neutral humans, bioroids, and sapient AIs had been killed by debris collisions in LEO, including 86 people aboard the German-owned Ingelheim Station, struck by fast-moving debris after the destruction of a TSA solar power satellite. The residue of debris and inactive munitions would make life more difficult (but profitable) for the Vacuum Cleaners for decades to come; it is certainly still the case in 2100.

Some fatalities many years after the fact have been blamed on war-originated debris, which occasionally leads to angry confrontations and some complex international legal actions. No non-essential satellites were launched to some altitudes until the 2090s, and the reduction in traffic through LEO compounded the war's effects and created a serious threat of economic recession.

The Pacific War and the barely averted catastrophe spurred many corporations to move space factories and research stations to more distant locations – chiefly Luna, L4, and the Main Belt – and created a climate favorable to the aims of the Olympus Project.

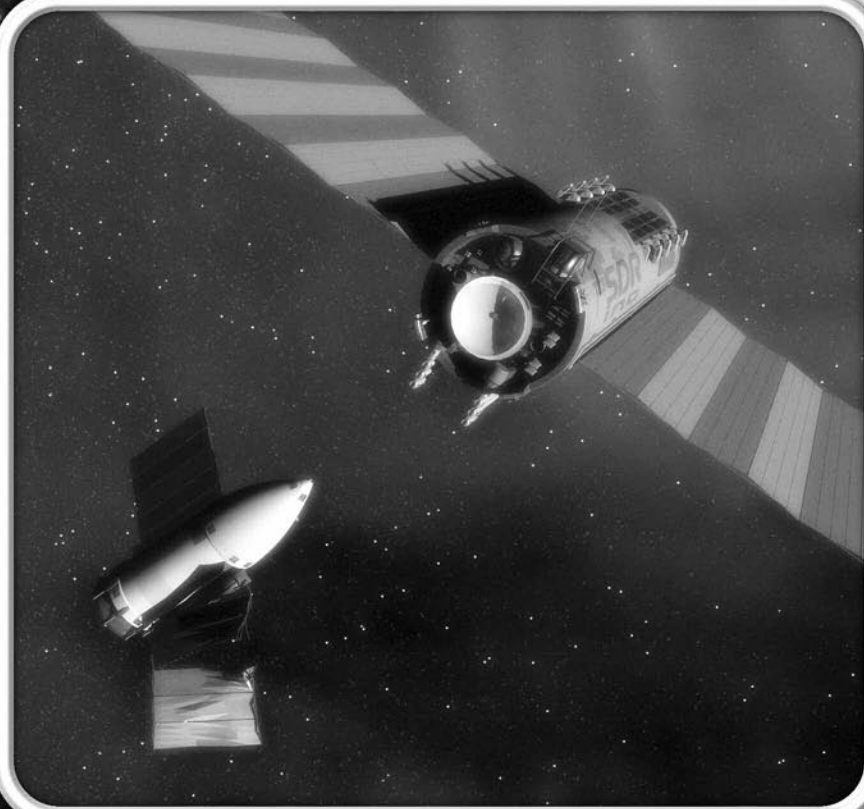
Through it all, LEO remains navigable. Furthermore, close cooperation has led to a considerable improvement in relations between Vacuum Cleaners and most military space forces. Attitudes that were previously guarded to the point of open disdain have become downright amicable at times, if only because both groups enjoy sharing complaints about politicians and ground-based corporations.

VACUUM CLEANERS TODAY

In 2100, the orbital salvage and clean-up industry has grown from a minor curiosity to a major, if unglamorous, profession. Independent vessels and small companies now have over half the business.

SDR Inc.

The oldest and largest Vacuum Cleaner company, SDR operates a fleet of 34 manned orbital vehicles, five shuttles, and over 100 automated monitoring and communications relay satellites, most of them with maneuvering capability. SDR has a relatively stodgy image; it is seen as relatively bureaucratic and dull, with more interest in shuffling databases than in salvaging forgotten 2030-vintage spy satellites or intercepting fast-moving debris fragments before they can perforate orbital hotels. However, the truth is that SDR pilots and operational experts are as capable and shrewd as most other Vacuum Cleaners; the idea that the others are somehow “flamboyant” disregards the essentially cautious nature of the business, which punctuates long periods of routine with tense moments of drama.



SDR remains the preeminent Vacuum Cleaner company, due to its iron grip on the COTS contract. The last time that the COTS seriously considered awarding its primary contract for LEO cleanup to anyone else was in 2084, just before the Pacific War. Some observers feel that another challenge may be due soon, if any conglomerate can put together a serious bid.

The reason that SDR continues to hold on to the COTS contract is the demand that the holder remove *all* threatening debris from certain orbits, however dull or valueless – or dangerous – the debris is. While the COTS contract pays quite well (from funds paid by signatories to the Revised Outer Space Treaty), a challenger would have to assemble a substantial infrastructure to even meet the minimum requirements to bid.

What might be slightly more likely would be for the contract to be split at some point in the future, with SDR and newcomers covering different altitude bands. A serious challenge along those lines might cause SDR to lose some of its easygoing attitude.

SDR's Data Feed

While the worst of the wartime junk is gone, LEO is crowded to the point of overload, and a significant part of the Vacuum Cleaners' work is now monitoring satellite launches and orbits and funneling the information to anyone else who needs it.

Use of SDR's encrypted data feed comes at a price. As a goodwill service, the company broadcasts on an open channel routine notifications of spacecraft launches, daily updates of new or changed orbits of large (6"+) objects in LEO, and alerts concerning very high risks. Beyond that, things start to cost you. Confirming that a planned launch is safely clear of 0.1" or larger objects, or checking a specific orbit up to 24 hours ahead, costs \$25. Detailed checks for very small particles in a specific orbit, or assessments of specific orbits weeks or months ahead, can cost \$50-\$500, depending on how much SDR has to use active sensors to find an answer.

Most manned craft in LEO pay \$50-\$500 a day for a continuous live feed of data concerning their current track, updated on request if they maneuver. Large stations and corporations have contracts worth several thousand dollars a day, giving them live, continuously updated

access to any data pertaining to the orbits of all their stations and craft, including information on dust-sized particles, and priority access to risk assessment programs. All these are factored into the routine cost of spacecraft operations in most cases.

Most users consider this service worth every penny. Because it is the only body that has ever gone to the trouble of setting up a full sensor system and data collation operation, SDR remains the most important operator in the field. However, the knowledge that several governments and corporations could match it with a little effort keeps SDR's prices down.

COLLISION AVOIDANCE

Spacecraft in LEO may link their navigation systems to databases of satellites and known large debris (see main text). They also routinely use their radars to track debris. Computers, often dedicated systems purpose-built for this environment, decide whether to maneuver away from possible impacts, and sometimes even control lasers that can either vaporize small fragments or "deflect" them by vaporizing part of their surfaces. The distance at which such a system can detect a problem is, of course, related to the power of the radar and the size of the object involved.

Detection ranges for sensors are determined with the rules on p. TS177: find the object's size modifier from the Size and Speed/Range Table on p. B201, add the system's scan rating + 10, and convert back to a distance on the Size and Speed/Range Table. For example, a stray bolt from an old station may be about 1/2" in size, giving a modifier of -12, while a medium radar has a scan rating of 33 (base range 5,000 miles in vacuum). $33+10-12 = 31$, giving a detection range of 200 miles.

Extrapolating the table downwards, a 0.04" object has a size modifier of -18; with the same medium radar, the calculation $33+10-18 = 25$ gives a detection range of 20 miles. A 0.004" speck has a modifier of -24, giving a detection range of 3,000 yards (about 2 miles). Smaller objects are rarely considered worth tracking.

A closing speed of 16,000 mph is equal to just under 4.5 miles per second, giving a vessel with the system described over 40 seconds to respond to the danger of a 1/2" object – less given higher speeds, but usually plenty of time to move out of its path with a 0.1 g thruster burn, or to aim a laser to vaporize or deflect it. Even 0.04" objects can usually be dealt with quite easily by automated systems, if the crew prefers to be cautious. However, in some debris-prone orbits (especially a few very crowded areas), crews of lightly protected ships may experience many "evasion burns," and motion sickness may become a real possibility.

Despite SDR's best efforts, there is a "danger range" of objects which could cause life-threatening (or at least mission-threatening) damage. Objects in extremely elliptical orbits can be a special problem, as they are harder to catalogue and may have high velocities when passing through the LEO region at perigee (up to 40% higher than objects in circular orbits, in fact); remember that high speed means both increased damage *and* less time to respond. Experienced spacers offered work in LEO invariably check the proposed craft's radars and rapid-reaction maneuvering capability.



SDR will also pay modest amounts (rarely more than \$100 – the company's AIs set the rate, usually quite fairly) for information on undocumented objects; their sensors would usually pick up the same information, but they pride themselves on their comprehensive, continuously updated database. Data feed contracts may include penalty clauses to prevent purchasers from illicitly re-selling information, although this is rarely a problem.

SDR's debris database is *large*. The company is required by contract to list any object with a mean diameter of 0.1" or more with an orbit that passes within 1,000 miles of the surface of the Earth, and also some smaller objects with exceptionally high kinetic energies, according to a complex formula.

This means that the full database describes over 200 *million* objects, with an index of how easily they can be detected by radar, orbital details, an estimate of diameter and mass, and in a minority of cases, notes as to probable or known origin. Smaller objects, although potentially dangerous to many craft, are simply too numerous, and too susceptible to orbital changes caused by solar radiation pressure, to catalogue comprehensively. SDR can provide short-term tracking data for some of them, but estimates place the number of potentially identifiable human-made objects in Earth orbit at well over a billion.

SMALLER SALVAGE COMPANIES

"Radar shows large-diameter debris coming our way, sir. Highly elliptical orbit, so it's not in the SDR database."

"Don't worry, we have a contract with A&H . . . there we go, their platform just killed it."

"Hey, that zap was from a Pakistani SDF!"

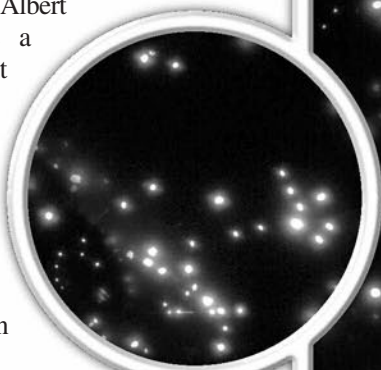
"Yeah, they earn some extra cash subcontracting out to A&H . . ."

– Conversation on an LEO research station, June 2100

Other companies like to remind SDR that it does not have any sort of legal monopoly on debris removal. They take the role of multiple Davids challenging the Goliath of orbital salvage and protection.

Lacking the COTS "clean sweep" contract, the smaller Vacuum Cleaner companies concentrate on specialist contracts, either salvaging specific non-functioning satellites or guaranteeing absolute safety for specific stations. This leaves them with a slightly more glamorous image than SDR, as they are less likely to be sweeping up bits of broken hull metal and more likely to be recovering functional (or at least recognizable) hardware.

None of these companies operate huge fleets. The largest independent, Albert & Haraldt GmbH, maintains a dozen orbital craft operating out of Station Légère Industrielle, one of the four manned LEO stations for which they have a safety-guarantee contract. Few others have more than three or four craft to their names; exact numbers and fleet sizes change from week to week, and even day to day.



Freelance Cleaners

With space now accessible to moderately-funded private operators, the salvage and junk elimination business has become an open market. Small-scale operators, with a single ship each, include former SDR employees who have convinced some corporation, government, or state to back them. Joining them are spin-off projects backed by other space-going enterprises, and a couple of Duncanite crews who have decided that their differences with anyone on Earth are less serious than their trouble with someone back home, and migrated here *from* the Belt.

The life of a freelancer in LEO is uncertain, but not necessarily profitless, given a little ingenuity and business savvy. The most reliable source of income is recovering defunct or malfunctioning satellites at the request of their owners, either for repair or refueling, or to avoid liability for any damage they might cause as debris.

It is also possible to find good paying work removing specific catalogued debris that might endanger some new project, or to obtain short-term contracts covering for a larger enterprise that is short-handed, for whatever reason.

Less reliable, but most colorful, is speculative object recovery – scanning the catalogues for large objects, often of uncertain origin, picking them up, and then determining whether they have scrap value or can be sold to collectors or historical researchers. This is a last choice for most sensible Vacuum Cleaners. It is rarely profitable, occasionally dangerous (old satellites often have volatile thruster fuel still in their tanks, and military devices are occasionally booby-trapped), and often costly in fuel. But there are enough moderate-sized bonanza finds every year to keep people interested.

actual geostationary orbit, and between times, they hunt down and recover whatever they can find in the Graveyard. Nonetheless, there are real dangers of collision with fragments even here. A few Cleaners, mostly freelances, occasionally operate in high orbit, the Lagrange points (not just L5, despite popular stereotypes), or virtually anywhere else in the Earth-Luna system if they receive a contract or identify a wreck of potential interest.

In all cases, Vacuum Cleaners require a base of operations; it would be uneconomic for them to operate in vessels large and equipped well enough for long-term occupancy. SDR crews have Lammergeyer Station, Albert & Haraldt has Station Légère Industrielle, and smaller operators may rent space in general-purpose industrial stations or even small “soda can” habitats – though few crews find that tolerable. A few independents specialize in working the Lagrange points, and are based in the large stations there.

DEBRIS ELIMINATION TECHNOLOGY

Vacuum Cleaners use a wide range of tools and techniques for eliminating debris. The most important tool is a spacecraft. Various types are used, from modified work pods and orbital transfer vehicles to purpose-built Debris Recovery Vehicle (DRV) salvage craft like the *Steptoe* class (p. 138). More important than the tools, however, is the technique. The three basic approaches are capture, destruction, and de-orbiting.

Capture technologies involve spacecraft with clamps or robot arms, or crew operating in space suits. Competent Vacuum Cleaners assess objects very carefully before they approach; they will rarely touch military devices without specific assurances from the builders, and will also be cautious around damaged rocket boosters. (Confronted with anything that even *looks* like an Autonomous Kill Vehicle, they will back off a long way and request a high-power solution from a helpful military platform, risks of fragmentation notwithstanding.)

But, caution aside, capture-and-recovery work can be very profitable; many owners will pay well to have their property returned, and even without this, the scrap or historical value of an old satellite can be significant. In game terms, it involves using Electronics Operation (Sensors) skill for the initial assessment, followed by Piloting (High-Performance Spacecraft) and a DX roll or two for use of robot arms, or Vacc Suit and Free Fall for “hand recovery” work, and sometimes some specialization of Mechanic. Failed skill rolls can lead to a wide range of problems; critical failures should result in seriously dangerous developments.

VACUUM CLEANING: OPERATIONS

Today, Cleaner operations are mainly concentrated in LEO, where the density of active and inactive objects is by far the highest. A secondary area of activity is geostationary orbit – and also just above, in a zone known to the Vacuum Cleaners as the “Graveyard” (see p. 25). Cleaners working in this higher region are more concerned with intact (if defunct) satellites than with fragments. They receive occasional contracts to locate and remove specific units in

SALVAGE, DEBRIS, AND SPACE LAW

The clauses of the Revised Outer Space Treaty relating to the *creation* of orbital debris are a compromise between the need to control the amount of junk and commercial reality.

Some factions would seriously like to make every organization operating in space liable for everything they cause to be in orbit, including objects launched before the treaty was negotiated, but this is generally regarded as not only unenforceable, but too extreme in principle. A less excessive approach would require every object placed in orbit to have a demonstrable capacity to de-orbit itself – i.e., to cause itself to re-enter the atmosphere and burn up – at the end of its useful life, or to be recovered by its owner. The former option is simply too expensive – it would demand that every cheap satellite would include a fairly substantial motor. The latter, which seemed ludicrous in the early part of the century, has become at least theoretically possible with the growth in low-cost space flight and routine human operation in space.

At the other end of the negotiating range, some groups (including, in 2100, some, though not all, nanosocialist states) argue that “space is free,” and that attempts to impose restrictions on its use represent an attempt by established Fifth Wave powers to close off an area they currently dominate due to their own earlier unrestricted activities. A less extreme faction, made up of an uneasy alliance of moderate nanosocialists and mid-sized corporations, argues for minimal restrictions based on “proven” safety issues.

The nanosocialists of the TSA clearly have an interest in avoiding taking much legal responsibility for past operations. Their orbital operations during the Pacific War were extensive, violent, and less well-documented than those executed by China, and as the losers in that war, they especially begrudge being forced to pay for any cleaning up. As a further complication, much identifiable debris left over from the war can be traced back to Thailand, which has undergone a regime change since the war. The new government reacts badly to attempts to hold it responsible for its predecessor’s actions.

The working compromise embedded in the Treaty has survived because neither extreme faction can muster enough support to change it, and most people feel that it works tolerably well. It is based on the concept of liability for any damage caused, and places a responsibility on courts and arbitrators to determine not

only the origins of an object which caused damage, but also the extent to which its builders attempted to minimize risk. For example, an LEO satellite which was designed to de-orbit itself but did not due to systems failure is considered less culpable than one that was simply left to drift. Originally seen as a “cop-out clause” that left corporations free to do what they liked with little chance of anyone proving their guilt, this rule has been enforced with increasing effectiveness as investigators gained better access to space flight, tracking systems, and databases. Several organizations that originally supported this “good intentions” rule do so no longer, now that they have suffered its effects.

The Vacuum Cleaners themselves – who are, after all, the ones paid to remove all the old satellites and other junk – love the rule, as it keeps them in steady employment. It can even be used to make sure a reluctant customer pays promptly and fairly. (If a “responsible party” seems ungrateful, the threat of bad publicity sometimes changes minds. Still, most Cleaners try to avoid being seen as blackmailers.) The rule can trigger interesting space-based detective/mystery scenarios, with the PCs working to track down the “owner” of some piece of debris which has just caused an accident, uncovering old secrets and illicit operations in the process.

Another section of the ROST deals with geostationary satellites. They are required at the end of their working lives to be either removed by salvage crews or nudged via “graveyard burns” (see p. 42) to designated higher-altitude areas. Recent concerns about the “Graveyard” becoming overcrowded may lead to changes in this policy, but nothing has happened yet.

More importantly, another clause extends various conventions governing maritime salvage into space; while there are sometimes disputes, it is now established law that, if an unmanned satellite is demonstrably no longer under control (not due to the actions of the salvager!), anyone who recovers it gains extensive salvage rights. In order to get the property back, the original owner must either pay the salvager’s price, or submit to the jurisdiction of a court to set a payment. Moreover, anything unused and uncontrolled for 30 years, or which was causing a significant hazard due to its uncontrolled status, belongs to whoever recovers it. Governments will often want to recover their property themselves, but stations are generally happy to have dangerous debris near them removed by anyone.



Destruction of dangerous debris sounds appealing, but obviously must be exceptionally thorough and reliable to avoid merely producing larger numbers of smaller objects.

This means that it is mostly limited to small (sub-1/2") debris; many Cleaner ships and some LEO stations carry low-power lasers for this purpose. Cautious Cleaners prefer to take some time to assess the object first, to make sure that it is unlikely to fragment explosively. In game terms, this assessment involves Electronics Operation (Sensors) skill, plus relevant Mechanic or Engineer skills to analyze larger objects; successful destruction is usually a simple Gunner (Beams) roll, with the gunner able to take plenty of time for a careful shot.

De-orbiting techniques are mostly used to deal with relatively large objects of low value. The principle is to change its orbit so that it encounters significant upper-atmosphere air resistance, which slows it and lowers its orbit yet more, until it falls into the atmosphere and burns up (or crashes in a planned fashion in an uninhabited area). Stopping an object dead in its orbit, so it falls directly to Earth, is technically possible but pointlessly inefficient.

There are several ways of deflecting an object. It may be targeted with a laser from a particular direction, causing parts of the surface to vaporize. This produces an action and reaction, in other words, thrust. The technique is popular and effective for deflecting debris from specific orbits even if it cannot be de-orbited. Again, cautious Cleaners will analyze the likely consequences before bringing their laser to bear; aside from the danger of fragmentation, it is very hard to predict the object's exact trajectory after deflection.

An older technique is the "foam sphere" system. A large ball of soft foamed material, many tens of yards across, may be placed into an orbit opposite to those of a large number of small particles. If this is set up correctly, the particles hit and embed themselves in the sphere, which is slowed in its orbit by the impacts, enters the atmosphere, and burns up. Few problems justify this approach in 2100, but SDR and some other companies with an LEO presence have the requisite equipment in storage.

One last common technique is to attach a rocket motor to an object to slow it down. The simplest version of this involves flying a manned ship up to the object, clamping onto it, then detaching and boosting away once the trajectory is set for re-entry. A safer approach involves unmanned, automated rockets, either cheap

one-shot units with solid-fuel rockets or more sophisticated reusable devices. This technique is still fairly common, but is not used on anything like the scale of the middle of the 21st century, when small fleets of robot de-orbiter rockets operated almost autonomously in very low orbit.

Plotting a de-orbiting operation requires some effort in itself; in game terms, Astrogration skill is required (often programmed into Vacuum Cleaner ships' computers). Then, Gunner (Beams) is appropriate if using a laser, or Vacc Suit, Free Fall, and Mechanic (Chemical Rockets) if going out to attach a booster by hand.

"It's a lot like tridee billiards, isn't it?" Samuels was enjoying the show on the Dustbuster's laser tactical display while Artie fed the next priority code into the AI he had come to know as "Deadeye."

"Yeah, kid, except the balls are moving at 16K and never bounce true." Artie didn't have a lot of patience for distractions while he and Deadeye were handling multiple targets, and while he thought Samuels would be a good pilot someday, he was a little too green for Artie's taste right now.

Still, he didn't want to grind the kid down too much. "Nine ball, upper corner pocket," he said with a sly grin as another bit of junk vaporized in a flash.

THE OLYMPUS CLEANUP

By far the largest single concern for Vacuum Cleaners, and almost everybody else operating in LEO or HEO, is the orbital cleanup program demanded by the Olympus Project (p. 23), the construction of an orbital elevator from geostationary orbit to the surface of the Earth.

Unfortunately, almost all the space junk currently in LEO or HEO will – sooner or later – intersect the planned position of the elevator cable. (Only specific orbital paths can be guaranteed to avoid this, so most satellites are not a danger.) The Beanstalk structure (including elevator cars and track) has been designed to withstand microparticle impact damage, but that still leaves thousands or even *millions* of possible threats to the space elevator.

At present, the project is still building large-scale infrastructure and manufacturing facilities in geostationary orbit and on Earth (specifically in Kenya; see *Broken Dreams*). But when the time comes, in a few years, to drop the first fixed cable from orbit to Earth, the space junk risk will have to have been dealt with.

Many older satellites in low orbits will have burned up by then; modern satellites and stations are being built or retrofitted (sometimes at the Olympus Project's expense) with the sensors, maneuver capability, and automation required to perform active collision avoidance maneuvers. The Beanstalk will also incorporate "point defense" laser installations at intervals along its length. However, there is still much to do.

Already, many corporate and independent Vacuum Cleaner crews are working on the problem full time, under contract to the Olympus Consortium; the certainty of more work is one factor that makes banks happy to provide financing for new freelance start-ups.

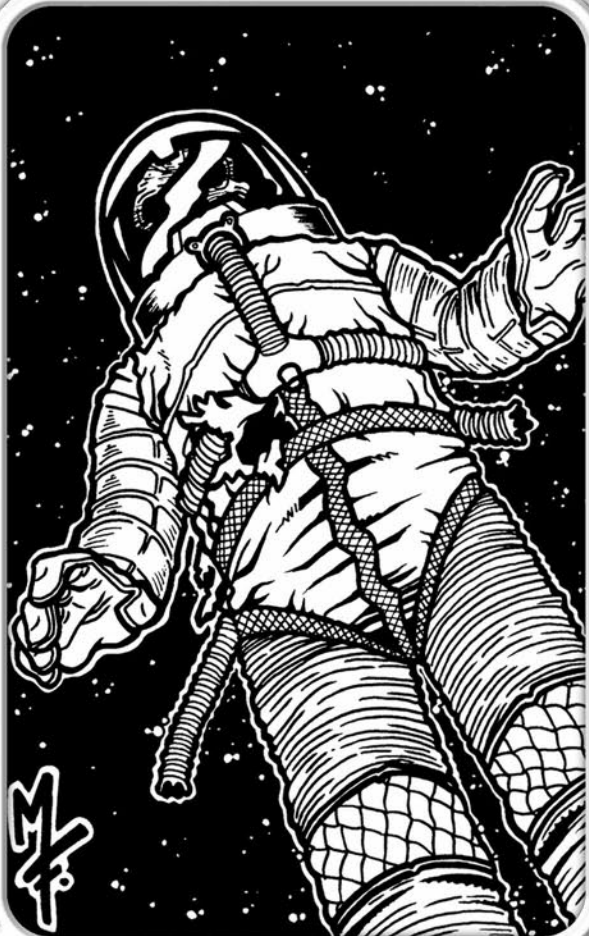
"Project" work includes accelerated efforts to destroy or capture "stray" objects in LEO or HEO, especially old, damaged, and high-mass satellites. It also includes a program of moving (mostly automated) orbital factories to safe orbits, or in a few cases, to L4 or L5. When these units lack substantial thrusters (as is usually the case), other craft must be attached as tugs; sometimes, specialized Debris Recovery Vehicles (DRVs) like the *Steptoe* (p. 138) perform this work, usually with the addition of external fuel tanks.

While most of this clean-up work is fairly routine, there can be numerous complications, both legal and practical. For example, the new collision-avoidance specifications adds substantial costs for many companies operating orbital workshops. The Olympus Consortium is performing underwriting these expenses, but many operators are unhappy nonetheless, and several dozen cases are going through various legal systems. The issue is complicated by the small but significant number of workshops doing illegal or "gray" work, or whose ownership is especially convoluted.

At the same time, the TSA and several other major powers have at best a grudging attitude to the whole project. Various U.S. space interests, seeing the economic damage that the Olympus beanstalk will do to their facilities at Quito, may be tacitly supporting almost anything that will cause problems.

Meanwhile, with *every* orbiting object now considered a potential future collision problem, Vacuum Cleaner crews are increasingly asked to deal with objects that they would have preferred to leave well alone in the past, including old military systems, spacecraft with unknown amounts of unstable fuel still in their thruster tanks, and some with possibly active (but dumb) automated meteor defense systems. There have been few serious incidents yet, but some industry experts consider fatalities to be merely a matter of time, and natural caution is slowing the clean-up program considerably – and possibly threatening the timetable of the whole Olympus project, and hence its financial schedules. This creates opportunities for start-up companies or freelance crews willing to accept clean-up operations that more experienced Vacuum Cleaner crews might balk at . . .

In addition, there are unconfirmed stories of subtler skulduggery. Some companies have been accused of buying up older orbital facilities in order to extract



THE SIX MOST INTERESTING SALVAGE FINDS OF 2009

6. The Bleep Box: This was a standard European communications satellite from the first decade of the 21st century, long since moved to the Graveyard and closed down. Some of its systems and solar panels survived intact, and were briefly reawakened by a freak micrometeorite impact. It began transmitting signals on a wavelength now used for emergency traffic control, causing concern on several GEO stations. It was recovered by an SDR crew and is currently the subject of competing bids from various museums and collectors.

5. Captain Palma: A casualty of a skirmish during the Pacific War, the Peruvian Captain Palma's body was coincidentally (and ironically) thrown into a Graveyard orbit, and only recently detected. It was recovered by an SDR team and returned to his family for burial.

4. The Emerald Earring: How this ordinary if valuable item of personal jewelry – a large natural emerald in a 22-carat gold earring mount, recovered by an Albert & Haraldt crew – came to be lost high in the LEO zone is unknown, as no one has come forward to claim it.

3. Xiao Chu 14: In 2007, Xiao Chu launched a group of 14 small “communications” satellites to LEO.

In early 2009, an independent Cleaner team determined that one of them had been rendered completely inactive by a power systems failure. Xiao Chu's failure to recover it, merely keeping the failure secret, was a classic false economy. The salvage team had guessed that Xiao Chu was using the satellites for commercial intelligence purposes. They secretly recovered the dead unit, and sold it to a System Technologies subsidiary, who in turn derived a useful amount of information from its physical design and memory contents. Xiao Chu subsequently discovered this through a counter-espionage operation, and is suing System Technologies and the Cleaner crew. (They are expected to win, but lawyers note that a totally inactive satellite in LEO is legitimate salvage.)

2. The Handbray Segment: HEO represents a larger volume than either LEO or the equatorial GEO belt, with much less traffic. Hence, large chunks of debris can survive there for long periods of time. This item was picked up by a routine sweep conducted by the SDR vessel *Anna Handbray*, under contract to a consortium of HEO stations, and was found to date back to before the Pacific War. It is actually an incomplete TSA battle station – or more accurately, the central core of such a station, which had never been fitted with power systems or pressurized (let alone armed). A little research determined that it was disabled in the early days of the war by Chinese forces. The TSA declined to pay the fees required to reclaim it, so SDR put it up for sale for scrap; two days later, unknown saboteurs planted small explosive charges on the segment, causing only minor damages and no casualties. This was generally assumed to be the TSA military just making sure that the segment had no intelligence value, but curiously, the TSA strenuously denies this, and has insisted that its own experts be involved in subsequent investigations.

1. The Cryptic Cybershell: This “inactive” object, recovered from a high elliptical orbit by an independent contract team, was subsequently determined to be an active, self-powered unit with extensive instrumentation and powerful beamed communication systems. The controlling computer is believed to be running a powerful advanced AI, but if so, it has ignored all attempts at communication. Its unorthodox software and hardware both incorporate extensive encryption, and are evidently designed to prevent reprogramming from outside. The cybershell is currently in the hands of an American government team on Columbia Station; observers from several other nations have access to it. Materials analysis and design details suggest that it was manufactured by Exogenesis, and it is widely assumed to be a spy or observer built by rogue former Exogenesis employees. As the AI is believed to be sapient, its “captors” are currently seeking legal clearance to conduct more intrusive and possibly damaging studies.

massive compensation from the Olympus Consortium, while other factions are accused of doing the same purely to create roadblocks. The latter factions are also suspected of starting rumors about the dangers and problems of junk elimination or diversion, possibly up to the level of a full-scale memetic assault on the Vacuum Cleaner community. Of course, some people conversely

claim that the Olympus Consortium is spreading rumors of memetic warfare in order to reduce the cost of what is actually a tricky and dangerous program.

And orbital bars are full of tales of Vacuum

Cleaners venturing aboard unclaimed mystery “soda can” workshop satellites, and what they find there.

Graveyard Burns

Because even inert geostationary satellites can be a problem and a danger to others, international agreements on the use of space have long required that they be removed from that orbit at the end of their working lives. Before space flight became affordable enough that the owners could simply send or hire someone to fly over and pick the satellite up, this was achieved by retaining a small amount of maneuvering thruster fuel to the end of the satellite's life, then using it to boost the spacecraft into a slightly higher orbit, where it would be out of the way. These so-called "graveyard burns" left a large number of early communications satellites in under-documented orbits beyond geostationary, where Vacuum Cleaners now scavenge. The margin on simple materials salvage here is generally too thin to be very profitable, but many of the satellites recovered are intact historical curiosities, for which museums and academic institutions are sometimes prepared to pay a decent price.

Beyond LEO

While most Cleaners operate in LEO, a few may be found in almost any part of Earth-Luna system space. The other region with a significant, if much more widely scattered, presence is a few hundred miles from geostationary orbit upwards (the "Graveyard"). There are also likely to be a few groups operating in the L5 region at any time. Cleaners met anywhere else will certainly be there for a specific reason – usually with a contract to recover some specific object, or possibly because they have identified a specific opportunity for valuable salvage.

Vacuum Cleaners encountered beyond LEO are most likely to be there because another party has offered them a contract to eliminate or recover some specific large object. Their equipment and skills (and availability) mean that they receive a fair number of such contracts, despite the fact that they often have to attach additional fuel tanks and even rockets to their craft in order to make the interceptions, and charge accordingly. Despite some popular fictions, they are highly unlikely to chase off into unusual areas because of a *rumor* of possible profit. Earth-orbital space has not yet become so wild and confused, or so heavily inhabited, that spacers can sit around in dark bars trading tales of lost satellites of gold and iridium. A well-documented historical record, backed up with precise orbital calculations that pass review by an unemotional AI, might be another matter.

GEOSTATIONARY CONCERNS

Geostationary orbit should, some people assume, be relatively clear of junk; after all, at an altitude of 22,236 miles, there is nearly 165,000 miles of circumference to play with. That, however, underestimates the sheer *usefulness* of this specific orbit. For more than 100 years, governments, communications companies, television broadcasters, and others have been jockeying for use of this region.

In 2100, international agreements assign five-year licenses for use of "slots" of 0.05 degrees, in which a licensee may place up to six

satellites at its own risk. In the event of a collision between any of these satellites, the licensee becomes liable for all consequent damage to other satellites and craft, and must make "reasonable efforts" to clear up any debris. While penalty clauses are rarely invoked, they theoretically permit the withdrawal of *all* GEO slot licenses from a licensee.

A slot thus consists of just 23 miles of that circumference; as even geostationary orbits are not perfectly stable, continuous active measures are required simply to remain in a slot, let alone to minimize the risk of collisions with other objects sharing the same slot (and the odd fragment of debris left over from past decades). Furthermore, many communications satellites receive data through tight-beam links; if they are too close together, or if beam-focusing systems fail, one may impinge on a beam intended for another, suffering interference or even reacting in unpredictable ways. Geostationary satellite operations require continual monitoring by dedicated AIs . . . and sometimes, active diplomacy between users.

To an extent, problems can be reduced by placing satellites in "inclined" orbits, rather than directly above the equator. They still pass through the plane of the equator twice per day, and a little careful traffic management can deal with any problems arising then. However, this is a solution of limited appeal; from the surface, the satellite appears to follow a figure-eight path through the sky rather than remaining truly stationary, which is supposedly the point of buying a GEO slot. However, the past use of inclined orbits by some operators adds to the complexities of traffic management and salvage in the region; a few major speculative finds have involved old objects in radically inclined near-geostationary orbits.

Although geostationary orbit sees significant Cleaner activity, not enough happens there to justify a permanent presence. However, reaching that orbit from LEO or L5 requires a significant boost, adding to the cost of the job. Therefore, Cleaners operating in the region are likely to have specific contracts, or to be pursuing profitable-looking ideas.

VACUUM CLEANERS IN THE JUNK JUNGLE

The Vacuum Cleaner community around the L5 point is a mixture of short-term visitors working on contracts from wealthier local stations, longer-established professionals who specialize in sifting through the excessive quantities of low-velocity debris that have accumulated in this ill-managed region, and “locals” who have entered the debris-recovery business out of misguided enthusiasm or desperation. The latter range from fairly competent teams to disasters waiting to happen; “real” Vacuum Cleaners regard the latter with concern or contempt.

VACUUM CLEANER CULTURE

Despite the variety of their backgrounds and employers, the Vacuum Cleaners have evolved a distinct culture of their own – a set of memes, assumptions, and prejudices. They also have slightly atypical demographics.

A disproportionate number of Cleaners are unmodified or only lightly modified humans. This is not glamorous work, and there are relatively few genetic adjustments available which are suited to making it easier.

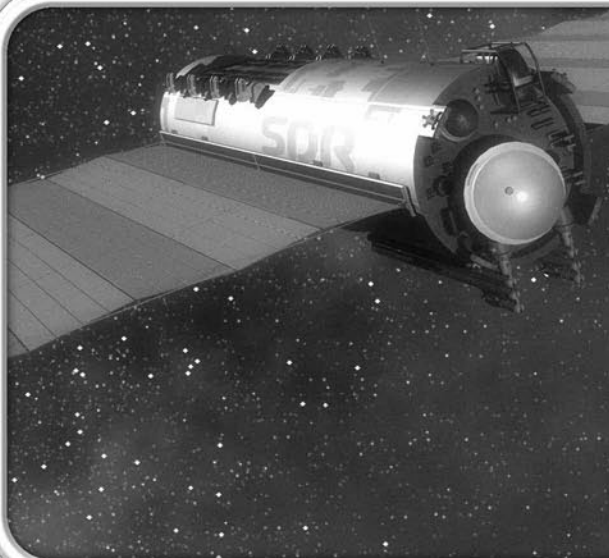
JOB TABLE ENTRY

Vacuum Cleaner work is treated as a Comfortable Freelance Job; even SDR employees have a significant amount of uncertainty in their lives, and can earn more or less in a month through overtime, bonuses, delivery penalties, etc.

The Prerequisite skills are any two of Electronics Operation (Sensors), Engineer (Spacecraft), Free Fall, Mechanic (Chemical or Fusion Rockets), Piloting (High-Performance Spacecraft), or Vacc Suit, at level 12+. Base Monthly Income is \$5,000, and the Success Roll is Best PR-2. The Critical Failure result is -2i/-2i, 3d.

PCs who set up as independent Cleaners, especially those who act as captains or business managers, may have complicated lives, having to deal with contracts, vehicle maintenance, crew problems, and business strategy. Their opportunities for profit and loss fluctuate accordingly. However, this sort of thing is better roleplayed, rather than trying to reflect it in a simple Job Table roll.

Those which make space travel safer and cheaper are an exception, but given the Cleaners’ fairly regular access to large stations and the Earth itself, even these are merely useful rather than mandatory. Thus, the ingenuity and investment of gene modifiers and bioroid builders tends to be focused elsewhere. Furthermore, operating in a fairly high-risk environment, Cleaners tend to favor proven technology over untested novelty, and having been in operation for most of the 21st century, their average age is a little higher than that of many space-going groups.



All of this tends to give them a reputation for crusty conservatism and mild technophobia. In truth, however, this is vastly exaggerated. No one survives and prospers for decades in space without developing a healthy liking for technology as well as a detailed grasp of its operation, and the Vacuum Cleaners know their tools very well.

All Cleaner operations use extensive non-sapient AI systems to track debris orbits and determine optimum

responses, and most will adopt the most powerful current *proven* technology they can afford. A few ships even have fully sapient AIs or ghosts as crew members, and the vast majority of Vacuum Cleaners regard these beings as equals. There are no known bioroids in the business, and only a few each of Avatar Tennin and Ziusudra-series parahumans, but this appears to be a matter of historical accident. If Vacuum Cleaners are prone to prejudice, it is directed more against people who underestimate

the dangers and complexities of the orbital debris issue – a category which includes some outer-system space operators and not a few Elfs and LEO station operators, as well as many “planet-bound” humans.

But the Cleaners’ image is based much more on positive attitudes than on prejudice. The stereotypical Vacuum Cleaner is even-tempered and treats poor traffic management or unreliable satellites as part of life; after all, they guarantee him employment. He has a dry sense of humor and a typical space pilot’s clipped, precise style of speech when “on duty.” Not all Cleaners live up to the stereotype in every detail (and outsiders may feel that their sense of humor often tips over into sarcasm), but it does reflect the nature of their lives. Although most enjoy their work, few would call it a career, and most aim to retire after a few years, or in the case of SDR employees, to move into “office” jobs. (Given that some of these involve telepresence operation of unmanned orbital devices, and almost all are on Lammergeyer Station, this does not necessarily mean that they want to get out of space.) A fair number transfer to other space-based work, if a good offer happens to come along; the Vacuum Cleaner meme is not particularly isolationist. This means that many spacecraft crews throughout the solar system include one or two members with contacts among the Cleaners.

SOME NOTED CLEANERS

Jutta Haraldt: Born in 2021, the co-founder of Albert & Haraldt was diagnosed as suffering incurable levels of cumulative radiation damage – the consequence of a lifetime of space operations – in the 2080s. She underwent uploading in 2092, and her ghost now runs on a very-high-security, high-speed computer system at an unknown location somewhere on Earth. She continues to supervise her company’s operations closely if sometimes erratically, sometimes even teleoperating small orbital vehicles. Her chosen image – a slightly idealized depiction of herself at 50 – is a familiar sight among Vacuum Cleaners.

Dmitri Volkovich: SDR’s chief of operations, based full-time on Lammergeyer Station, is the son of Russian immigrants in Canada; his accent is straightforward Canadian. Aside from being every SDR pilot’s supervisor, he often handles low-level negotiations with other groups. Slim, blond, and pale, he is widely seen as something of a cold fish by Cleaner standards, but he is highly reliable and honest with his employees. He also seems to know the orbital characteristics and current position at any time of every large object in LEO, and those who know him swear that he does not use any sort of AI for this.

Lucas “Glove” de Andrade: Originally an SDR employee, Lucas de Andrade has been freelance for the last 30 years, and is now probably the best-known and most widely admired Vacuum Cleaner. It is generally assumed that accumulated savings must have made him rich by now, and there is much speculation as to why he has not long since retired. Cynics suspect that he is addicted to fame and admiration; he certainly seems to enjoy his status. In 2079, he recovered an unidentified spacesuit glove from orbit, and legend insists that this was the glove famously lost by American astronaut Edward H. White in 1965, despite the fact that White’s orbit at the time was such that *his* glove must have burned up within days. De Andrade’s find has since been lost; details of how are unclear.

Samantha MacNamara: Senior partner and computer systems officer of a freelance Cleaner crew that has recently expanded into a two-ship company, MacNamara is a Metanoia upgrade (see p. TS116) who appears to be determined to demonstrate that she can achieve success through *personal* talent and hard work, rather than “coasting” on her genotype’s augmented IQ. Marginally workaholic and somewhat humorless, she nonetheless commands fierce loyalty from her junior partners, and is noted for turning up whenever anything interesting and potentially profitable shows up in LEO.

VACUUM CLEANER CHARACTERS

As individuals, Vacuum Cleaners tend to be relatively unremarkable. Although they are varied enough in their motives and histories, the majority are normal or lightly-modified humans. Still, gene-enhanced human or parahuman Vacuum Cleaner PCs would be perfectly

justifiable, though bioroids and sapient uplifts are unknown. There are some digital intelligences, usually running on spacecraft-mounted computers, or occasionally on fairly cheap mobile cybershells. In *GURPS* terms, most Vacuum Cleaners have reasonable IQ, and many have above-average DX.

Advantages: Cleaners always need some kind of protection from radiation damage and bone-calcium loss. This usually means that they have appropriate Nanosymbionts (or an appropriately non-human body). In theory, being based on an unusually large rotating station, using an unusually good spacecraft, and having a good excuse never to go spacewalking would serve instead, but very few Cleaners are so privileged.

Otherwise, no Advantages are mandatory for such characters, but a ship's crew may represent Allies (including Programmed Ally informorphs) or an Ally Group, an employer can become a Patron, and other Cleaners may represent Contacts or a Claim to Hospitality. Surviving the hazards of LEO can demand Acceleration Tolerance, Acute Vision, Common Sense, Composed, G-Experience, Night Vision, 3D Spatial Sense – or Luck. Success can lead to an increased Wealth level, and Deep Sleeper, Less Sleep, and Light Hangover fit the popular stereotype.

Disadvantages: Vacuum Cleaner crews are often close-knit, with members feeling a Sense of Duty to each other and regarding junior crew as Dependents. Anyone who works in small groups, away from large communities for much of the time, may be driven by Shyness or Demophobia – or motivated by poverty, Miserliness, or Greed. Cleaners may develop Intolerance of people who are sloppy about space traffic management and junk creation, and their dry sense of humor may become a full-blown Odious Personal Habit. The caution required for survival in space may make the character Attentive, Careful, or Staid. However, no specific disadvantages are mandatory, or even especially common.

Skills: Vacuum Cleaner operations demand Electronics Operation (Sensors), Free Fall, Mechanic

(Chemical or Fusion Rockets), Piloting (High-Performance Spacecraft), and Vacc Suit. All Cleaner characters

have at least one of these skills at good professional levels, and most have at least a point or two in each of them. Experienced Cleaners also develop Area Knowledge (LEO), and to make their working life easier, most study Computer Operation, Electronics Operation (Communications), Engineer (Spacecraft), and First Aid.

Other technical skills often found among Cleaners include Armoury (Spaceship Weaponry), Astrogation, Gunner (Beams), and Piloting (Aerospace or Low-Performance Spacecraft). Running an independent operation can demand Accounting, Area Knowledge (GEO or L5), Diplomacy, Law, Leadership, Merchant, or Traffic Analysis. "Off-duty" activities often imply Bardic Lore, Carousing, Games, History, Musical Instrument, Savoir-Faire (Military), Scrounging, or Streetwise.

PERSONAL INTERESTS

While Vacuum Cleaners have their full share of private hobbies and concerns (limited only by what is feasible in space), many have interests specifically related to their work. Among other things, the community includes some of the system's leading non-academic experts on the history of space travel – and they combine this with practical experience. (Those who engage in speculative searches may be particularly knowledgeable, or merely particularly optimistic.) Many develop

a taste for music, to which they can listen while working; when SDR determined that some styles had an undesirable effect on the moods of listeners, they surreptitiously introduced a memetic engineering program to minimize the ensuing risks, and most company employees are now long-standing devotees of a set of emotionally neutral "ambient" styles of composition and performance. Some smaller company employees and freelancers follow this; others defy fashion by deliberately cultivating tastes for eccentric styles of vocal music.



RELATIONS WITH OTHER GROUPS

Vacuum Cleaners are not, for the most part, at all as crusty and cantankerous as their popular image may suggest, but they are professionals with a certain amused attitude toward possibly ignorant outsiders. They are, in general, happy to do business with almost anyone, respect competence, and are usually polite to anyone with personal power or wealth (which they tend to interpret as a sign of competence, or at least the mark of a potential employer). That said, many of them have ethical standards and ideals; it is perfectly conceivable for a Cleaner to turn down good paying work because he despises the employer, even if he expects that someone else will promptly take the job. What does reliably annoy them is lack of respect for either their work or the dangers of poor orbital traffic management. It should also be noted that the widespread dry sense of humor sometimes makes it hard for others to tell what a Vacuum Cleaner really thinks.

Both SDR and smaller organizations have worked with virtually everyone who operates regularly in Earth orbit, especially anyone who operates a station in LEO. (People who merely fly through the region tend to think of SDR simply as the company that sells them traffic-hazard information.) While, like any relationships, these can turn sour, there is generally enough competition to keep everyone honest, and enough mutual respect to keep conversations amicable. There are a number of long-standing disputes and even feuds arising from contracts gone bad, but little that leads to more than verbal abuse or dragged-out court cases.

Many Cleaners have developed a cautious working relationship with the intelligence services – especially military intelligence bodies – of many terrestrial nations. This is both inevitable and inevitably tricky; a fair proportion of the defunct objects in LEO and the Graveyard were once state-of-the-art military projects, and a few of them represent secrets that their builders still wish to keep. Cleaners usually play safe in such matters; a simple “hands off” signal from a known government source will make most back away from any given object, although they may continue monitoring it quietly for a while out of nosiness. However, if the object represents a high risk to other active craft, they are likely to escalate the issue, quietly or publicly as seems most appropriate.

Any Cleaner who seems unwilling to treat military satellites with this sort of minimal tact is likely to be warned off, quite strongly, by others in the profession. On their side, many military organizations have

learned to be helpful to Cleaners. They are usually willing to warn of possible dangers in specific areas, and to react promptly if asked for advice (or even aid in knocking down large, dangerous debris), but this relationship is built on a degree of mutual trust that took some time to establish. Early Cleaners lost several ships to military booby-traps. Eventually, however, the threat of bad publicity made some military groups more helpful, while others realized that the Cleaners could cause trouble in other ways.

Many of them have ethical standards and ideals; it is perfectly conceivable for a Cleaner to turn down good paying work because he despises the employer, even if he expects that someone else will promptly take the job.

If a Vacuum Cleaner recovers something intact with military markings, there will usually be a period of delicate negotiation leading to the object being returned to its original owners in exchange for a fair “finder’s fee.” The legal and military power of intelligence agencies is balanced by the fact that most Cleaners have a lot of friends and some press contacts, and carefully log their activities. And again, both sides usually recognize the long-term advantages of tact. That said, Vacuum Cleaner finds have very occasionally triggered minor international scandals, and it is believed that some attempts at blackmail by greedy Cleaners have been ruthlessly quashed by irate agencies.

This sort of situation may be further complicated if military “salvage” originally belonged to regimes which no longer exist. Notably, objects launched by the pre-Pacific War Thai military on behalf of the TSA may be claimed by both the current Thai government and by the still-extant TSA. In such cases, wise Cleaners offload the problem onto international courts as soon as possible. Less wise Cleaners may try to start secret auctions, but the risks are usually too obvious.

3

LUNA



Luna was not where I'd expected to go when my promotion came through, but in retrospect it made sense. I had a certain reputation as a troubleshooter in Xiao Chu's mining division, and our helium-3 mining facility on Mare Nectaris was certainly in trouble. And if I can get NMC-1 operating at peak capacity, I'll be able to name any position I wish – even a senior Xiao Chu management post on Mars.

I slept on the flight in from Taiko Station to Luna, and did not awaken until the OTV was resting in NMC-1's cavernous docking hangar. As soon as they'd connected the boarding tubes, I strode out, moving with the

slow-motion "rabbit hop" I'd mastered during the training slinkies. In the low gravity, it was easy to carry my luggage, so I waved off the bioroid that met me, and asked to be taken to the plant manager's office.

NMC-1's residential complex was located underground, inside a natural lava tube. I took the elevator cage down, and found myself descending into a huge winding cavern, much like an oversized subway tunnel. The interior wasn't pressurized, but it was brightly lit with ceiling shafts, and housed a bustling town, the individual buildings connected by sealed walkways. I even spotted a greenhouse, and a domed park.

I followed V-tags toward the office, but was soon intercepted by a flustered Assistant Manager, whose name was Win Chow, who informed me that Plant Manager Zhang was unable to meet with me at present. After brushing off several transparent excuses, I found out why: Zhang was in fact en route back from the lunar north pole, where he and two female junior mining engineers had spent the last day at an “executive motivational workshop” . . . at the Moon-shadow resort. My, my, how productive.

The harried Win Chow nervously asked if I wanted to inspect the surface facilities, assuring me that Zhang would certainly return in time for lunch. As it was preferable to cooling my heels in Zhang’s office, I agreed. Of course, it will be Lunar morning for another five Earth days, so there’s plenty of time before noon, ha, ha. Win Chow looked at me oddly, then assigned me a bioroid to show me to my quarters to freshen up.

The room was small but adequate – it had a thick glass window that looked out into the lava tube, complete with a window box of brightly colored flowers. The bioroid, an attractive ZR-5 whose name was 3 Jingyu, suggested I commandeer one of the general-purpose cybershells and take a teletour while he gave me a massage, but I wanted to get a feel for the real Luna. Instead, I had him help me don my vacc suit, double-checked the safeties myself, and then reset its color to high-visibility orange. As I left my new quarters, I noticed the shift had changed – the corridors were now full of workers. I joined a group of cybershells and bioroids – some of whom seemed surprised to see a human going topside – and took the high-speed cargo elevator up to the surface garage, then crowded into the dustlock with the other workers.

The lock cycled and we all surged out into the lunar morning. The workers – most of them cybershells – pushed, hopped, and crawled past me to go about their

It’s still common for many people on Earth to call Luna “the Moon,” but doing so can occasionally spark arguments with lunar natives.

LUNA STATISTICS

Average Distance from Earth: 0.00256 AU (239,000 miles).

Diameter: 2,160 miles.

Mass: 0.0123 Earth masses.

Density: 3.34 g/cm³.

Gravity: 0.165 G.

Escape Velocity: 1.47 mps.

To Orbit: 1.05 mps.

Rotational and Orbital Period: 27.3 days.

Solar Day: 29.3 days.

Atmosphere: Vacuum.

Surface Water: None. Ice traces in shadowed polar craters.

Temperature: -387° F to 253° F (extremes). Mean -243° F (night) to 225° F (day).

Population: 290,000.

Control Rating: 2 to 4.

Spaceports: Large spaceports at Port Tranquility and Luna City, numerous small spaceports.

business, but for a long moment I just stood there by the elevator, gazing up into the sky, my gaze momentarily captured by the beauty of the Earth above.

I shook my head inside the helmet. There was no time to be homesick: if I ended up replacing Zhang as plant manager, I’d have time enough to howl at the Earth. Instead, I followed the workers out into the magnificent desolation that lay before me: the Moon.

*– Personal diary of Xiao Chu plant manager
Ni Quing, 2099*

Earth’s moon has been an object of wonder since the first human looked up into the night sky. The first visitors arrived in 1969, but until the early 21st century, only 12 men had ever stood on its barren surface. Now some 300,000 people live and work there.

Luna is an airless ball of rock, a little over a quarter the diameter of Earth. It is tidally locked to Earth, so that the same “near side” always faces Earth, and the “far side” always faces away from it. There is no “dark side of the moon” – both the near and far sides get sunlight half the time, with the exception of a few areas near the north and south poles.

The last 50 years or so has seen the classical Roman name for Earth’s moon, Luna, increasingly used in preference to “the Moon.” This usage has been spurred by lunar inhabitants, who see “Luna” as emphasizing their world’s unique identity, rather than its status as a satellite of Earth. Despite this, it’s still common for many people on Earth to call Luna “the Moon,” but doing so can occasionally spark arguments with lunar natives.

SELENOLOGY

4.5 billion years ago, the newly formed solar system was a violent and chaotic environment in which embryonic planets coalesced and collided. A giant planetoid – perhaps as large as Mars – crashed into the primal Earth. This collision sent an enormous jet of rock vapor and debris into space. This cloud condensed to form Luna, Earth's moon.

Luna is made up of lighter elements – particularly silicon, oxygen and aluminum – identical to those that make up the Earth's crust. It does not have a heavy iron-nickel core, as it was formed after those heavy elements had been utilized in other planetary bodies.

During Luna's early history, volcanic activity took place. Asteroid impacts pierced the moon's crust, and great lava flows created the dark maria that were once mistaken for seas, and formed the myriad tunnels and rilles that crisscross the lunar surface. However, for the last three billion years, Luna has been a dead, desolate body, the only changes to its surface the result of cratering and erosion caused by ceaseless impacts from space.

Without an atmosphere to burn up even the smallest objects, Luna's surface has been subjected to an unrelenting rain of celestial bombardment, from micro-meteoroids to comets. The most powerful impacts – from giant asteroids – produced enormous basins hundreds of miles across, and sent seismic waves rippling through the moon, creating areas of jumbled terrain on Luna's opposite side. Fortunately, humanity now has the capability to detect (and likely deflect) any large asteroid or comet heading toward Luna.

THE LUNAR ENVIRONMENT

Luna is a harsh environment, albeit slightly more friendly to machinery than people.

Vacuum

Luna's atmosphere is so tenuous that it's effectively vacuum – in fact, it's harder vacuum than Earth orbit, although this has become slightly less true due to industrial processes.

Gravity

Luna gravity is 0.165 G, so people and objects on Luna weigh about 1/6 what they do on Earth. This is similar to Titan's gravity, and roughly half that of Mars or Mercury.

People have adapted well to 1/6 G conditions. Those living on Luna who plan to return to a

higher-gravity environment need more exercise to retain muscle tone, but the more serious problems experienced in microgravity (see p. TS55) are not a great concern.

Day and Night

Morning lasts for one week on Luna. Over a period of seven Earth days, the sun slowly climbs in the lunar sky and the shadows in the craters shrink. The temperature gradually increases as the day warms the surface, reaching 225° F at noon. It takes a further week for the sun to descend, eventually sinking below the western horizon. Then comes the lunar night: two weeks in which the temperature drops to a frigid -243° F.

Temperature

Most of Luna's surface is subject to extreme temperature variations over its month-long day-night cycle. The mean temperature goes from 220° F in the day to -240° F at night, a difference of 460 degrees! This can be hard on equipment that is left exposed on the surface; machines must be built to take both extreme heat and cold.

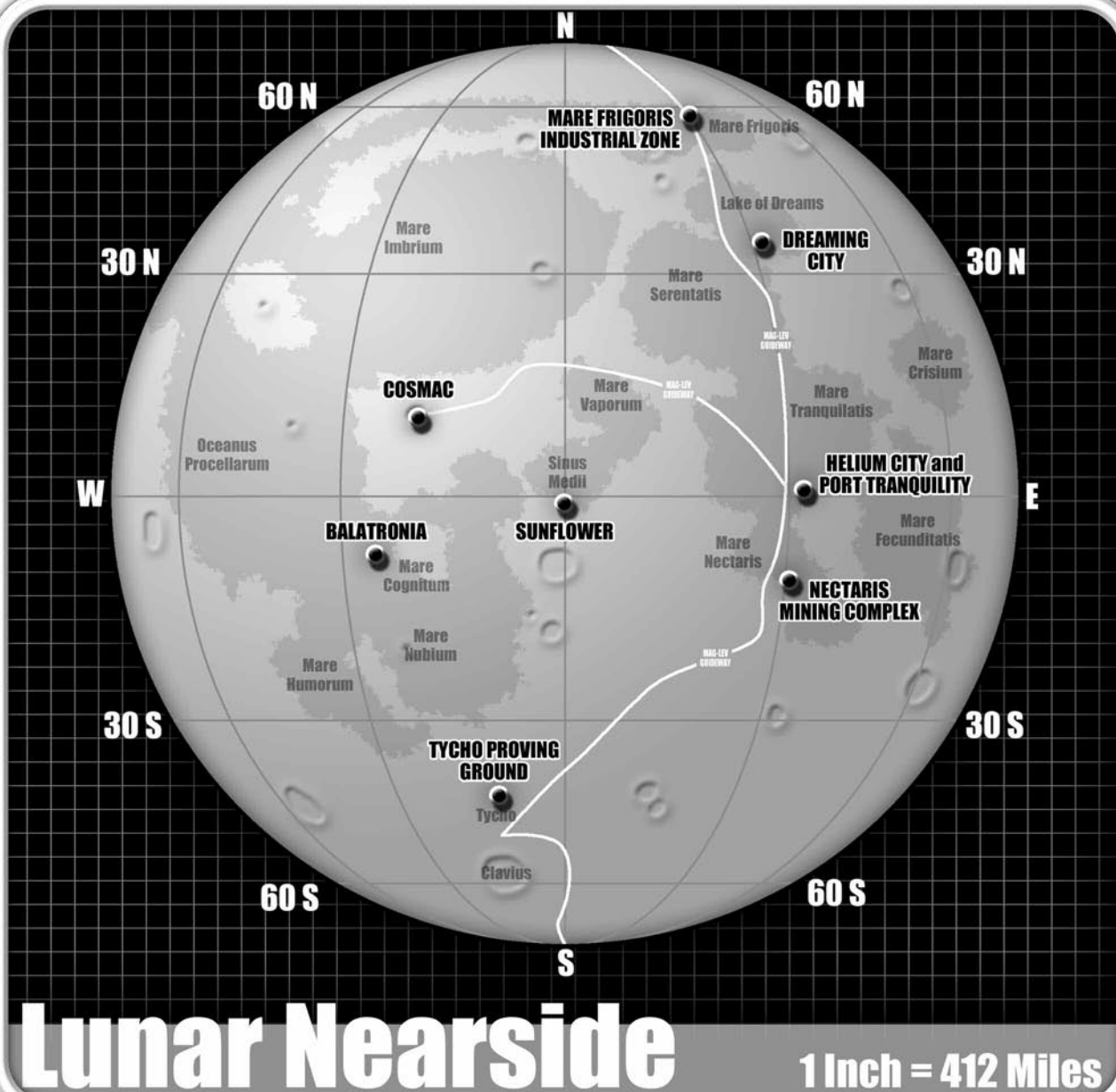
Polar regions where the sun is near the horizon at all times experience a smaller range of extremes (average temperature about -22° F). At polar crater rims and peaks exposed to near-permanent sunlight, however, the temperature may be up to 250° F, while the perpetually-shadowed crater floors may be as cold as -370 to -380 °F.

Light and Shadow at the Lunar Poles

Luna's two weeks of daylight followed by two weeks of night has major implications. The moon's axis of rotation, unlike that of the Earth's, is not markedly tilted compared to its orbit around the Sun, so Luna does not have distinct seasons. The sun does not rise very high (or fall very low) in the skies of the north or south pole over the course of a lunar day, remaining near the horizon over much of the polar region.

However, the rugged terrain of the Lunar south pole ensures that several mountaintops and crater rims are high enough up that the sun is always in sight. Similarly, there are many polar crater floors that lie in permanent shadow – places where the sun has not shone in over a billion years. The north pole is somewhat flatter, but there are still many hundreds of square miles of craters in permanent shade to be found there as well.

These permanently shadowed polar regions are among the coldest places in the solar system, and they also contain the only water on the moon, in the form of ice deposits. The combination of near-constant sunlight for power and agriculture and the deposits of water ice made the lunar poles attractive locations for human colonization.



Lunar Nearside

1 Inch = 412 Miles

Radiation

With neither an atmosphere nor a magnetic field, Luna is unprotected from both solar flares (p. TS30) and galactic cosmic radiation (p. TS59). Lunar bases must be buried underground (or heavily shielded) to protect their inhabitants.

Luna, like the Earth, is actually within the outermost effects of the sun's corona and during periods of peak solar activity, failure of electronic equipment and interference with radio signals are not uncommon. However, that same radiation provides Luna with the resources to support a colony. Billions of years of exposure to the solar wind (p. TS58) have impregnated Luna's regolith with the valuable element helium-3.

Water and Ice

Water is very scarce on Luna. What water there is came from ancient comet impacts. Numerous comets have struck Luna in the billions of years since its formation, and each produced clouds of water vapor on impact. These clouds fell back to Luna and froze. Most of this ice evaporated during the lunar day, but some ice in the perpetual shadow of craters near the north and south poles remained. (A similar phenomenon resulted in the survival of ice deposits on Mercury.)

About 6.5 billion tons of ice was found on Luna, split between various craters on the two poles. This may seem like a lot, but a city of a million people on Earth can use half a million tons of water each year . . . Even so, it's one of Luna's most important resources.

THE LUNAR LANDSCAPE

NMC-1 is located on the edge of the broad basalt plain of Mare Nectaris, the Sea of Nectar. From space, the dark lunar mare had seemed so smooth, but up close I can see plenty of small craters and boulders. I'd thought Luna's surface would be a barren ash gray, but in the light of the rising sun everything has a light tan color, and above the black line of the horizon, the distant basin rim mountains are a lovely tawny gold.

Closer to the base, the lunar regolith is anything but lovely: marred with tiling piles, and crisscrossed with tread marks and footprints. Spotting a dust cloud off to my right, I saw a Mobile Mining Crawler plowing along in a spiral pattern, chewing its way through a field of mature regolith as it sifted ilmenite grains for precious He-3. The crawler was about 2 km away, but thanks to the absence of air, details stood out with unnatural clarity: four sets of tracks, a segmented body, and a power-collection dish that was tracking one of our heliostat towers. The machine's size was impressive, but in truth, its design looked a bit awkward compared to some of the newer models that Tenzan Heavy Industries were marketing. Judging by the number of pits in its surface, the crawler was also pretty old.

As I watched, the gargantuan machine ground to a halt, retracting its magnetic rakes. Seconds later, a hatch opened, and a pair of tech spiders clambered out and began making adjustments to the power-collection antenna. My VI cut into their channel. Listening to the AIs and one of the bioroid crew chatter, I learned that breakdowns on this and other machines had happened twice this shift. Intolerable!

Suddenly, a shadow passed overhead. It was a moonhopper, descending toward NMC-1's landing pad. Ah! The tardy soon-to-be former plant manager, Zhang.

*— Personal diary of Xiao Chu plant manager
Ni Quing, 2099*

MARIA AND HIGHLANDS

There are two main types of terrain on Luna: the rugged, heavily-cratered *highlands* and the relatively flat basalt plains known as *maria*. Maria cover about one-sixth of Luna, but are concentrated on the near side. The rest of the near side and most of the far side and polar regions are lunar highlands.

The Lunar Highlands

The lunar highlands cover about 85% of the moon's surface. They are predominantly composed of countless interlocking craters of all sizes, and are made up of overlapping layers of material ejected from impact craters. Highland rocks tend to be 3.8 to 4.4 billion years old, and are rich in aluminum and calcium. Ground vehicles travel across the highlands at half their off-road speed, unless they move on legs.

The Maria

These vast, dark "lowland" plains dominate Luna's near side. The maria (singular *mare*; Latin for "sea") are giant impact basins that were formed some three to four billion years ago when asteroid strikes fractured the lunar crust. These impacts caused seas of lava to erupt from deep within Luna's interior. The lava flows partially filled the crater basins, smoothing them out and forming relatively flat basalt plains. These maria are roughly circular in shape, surrounded by a rim of mountains. Smaller mare patches can also be found on many large crater floors. The last lava solidified three billion years ago.

The surface of the maria are rich in iron and magnesium, with a high content of titanium.

Mare features named oceanus (ocean), sinus (bay), palus (marsh), and lacus (lake) are also maria. The largest maria are Oceanus Procellarum (Ocean of Storms), Mare Imbrium (Sea of Rains), Mare Serenitatis (Sea of Serenity), Mare Fecunditatis (Sea of Fertility), and Mare Tranquillitatis (Sea of Tranquility).

Vehicles travel across mare terrain at their usual off-road speed.

Mare-Highland "Coastal" Regions

These are regions bordering both mare and highland areas, and contain the greatest mineral (and scenic) diversity. The majority of Lunar industrial bases are located on mare/highland "coast" regions. This allows equal access to the resources of both regions.

REGOLITH

Billions of years of micro-meteoroid strikes have worn down every part of the exposed lunar surface, leaving behind a layer of sterile, sandy material called regolith. This lunar "soil" (although there is no organic component) ranges from 30' deep in the maria to over 300' deep in the lunar highlands. It's partly composed of dusty rock and mineral particles, and partly of agglutinates – minerals and rock that have been fused by the heat of meteoroid impacts into glass. Regolith is very dry – the only water is found in a few ice deposits on the poles. It's a fine-grained, fairly loose material, but solid enough to stand on without sinking more than an inch or two.

CRATERS

The lunar landscape is dominated by interlocking craters, which range from a few feet across to the giant South Pole-Aiken Basin, some 1,400 miles wide. The more recent impacts can be distinguished by the pale-colored “rays” emanating from them, the result of ejecta from the initial meteoroid impact that fell back to the surface. The enormous Tycho basin, whose rays extend halfway across Luna’s surface, is a young crater only 100 million years old. Older craters lack rays; they have been eroded by eons of micro-meteoroid impacts.

Craters are found most often in highland regions. In mare regions, the oldest and largest craters were covered by lava, although small craters are not uncommon. Some craters are still visible, but have mare floors.

Luna is still exposed to constant bombardment by small meteoroids. While rarely hazardous to individuals, large solar panels or antenna arrays on the surface require regular maintenance.

TRAVELING TO LUNA

Luna to L1: 35,000 miles (0.00039 AU).

Luna to L2: 40,000 miles (0.00043 AU).

Luna to L3: 450,000 miles (0.0051 AU).

Luna to Earth, L4 or L5: 240,000 miles (0.00026 AU).

MOUNTAINS

The lunar mountains can rise as high as 25,000 feet. Extended ranges lie at the borders of the mares and other major impact basins.

Large craters several miles or more across usually have a central peak and terraced rims. This mountain (or group of mountains) near the crater’s center is produced by the elastic rebound of the surface rocks immediately after the crater-forming impact.

SINUOUS RILLES

These are meandering canyons produced by lava flows that cut or burrowed through the rock. They were formed billions of years ago during periods of mare volcanism. They are found in the maria, and are associated with pits formed by volcanism, rather than meteor impacts.

Their width varies from several yards to two miles, depth up to 100 yards, and length from 1 to 200 miles. One of the largest sinuous rilles is Hadley Rille in Imbrium Basin.

Rilles offer ready-made locations for everything from waste dumps to bases. There have been plans to

roof over and even pressurize some of the shorter rilles, but so far actual lava tubes (see below) have been preferred as settlements.

Many rilles were once underground lava tubes (see below) whose roofs collapsed, leaving them open to the surface. In some cases, the roof remains intact over some sections; some rilles have an intact section of near-surface lava tube that runs underground for several hundred yards – or several miles – before emerging into the open again.

LAVA TUBES

Luna lacks the limestone caves that running and dripping water forms on Earth, but it makes up for this by having some of the largest stable lava tubes in the solar system.

In a volcanic eruption, lava flows through underground as well as surface channels. After an eruption, the lava drains away, leaving behind a meandering tubular tunnel running through the volcanic basalt. On Earth, these lava tubes are fairly small . . . but in Luna’s low gravity, they are significantly larger. A lunar lava tube can be hundreds of yards wide and deep, and several miles long.

Lunar lava tubes were formed in the maria about 3.5 billion years ago. Many have collapsed (often forming the sinuous rilles), but thanks to low gravity, vacuum, and a lack of major seismic activity, there are still plenty of large lava tubes that remain intact.

Lava tubes are preferred locations for settlements in mare and mare/highland coastal regions. They provide shelter from cosmic rays, meteoroid impacts, and solar flares. Located many feet below ground, they offer a dust-free environment unaffected by the extremes of hot and cold suffered by those on the lunar surface. Inside a tube, the temperature is, with only minor fluctuations, a constant -4° F.

LIFE ON LUNA

Although Luna has a population of 290,000 humans, parahumans, and bioroids, most of them are not permanent residents. The majority – 150,000 – are Earth, L4, or L5 residents who are working with a short-term (anywhere from a month to a year) employment contract, usually for a major transnational. The largest employers on Luna are System Technologies AG and Tenzan Heavy Industries.

Demographically, Luna is about 40% European (with a high proportion of Germans, Spaniards, British, and Norwegians), 30% Japanese, and 30% other nationalities, including Chinese, Koreans, and Australians, as well as a growing number who consider Luna to be their only home.

Most humans on Luna are genetic upgrades or parahumans, as companies tend to send their best and

brightest. There is also a high population of bioroids – perhaps 25% of the population. Many of these are emancipated, but about half are indentured workers.

The inhabitants of Luna – especially Luna City – have been nicknamed “rabbits,” because they usually live in underground warrens or lava tubes (for the radiation shielding). Humans living on Luna rarely venture onto the surface at all, but many of them are still very familiar with the lunar surface because of the time spent controlling teleoperated cybershells “topside.”

One feature of all lunar communities is an intensive program of water and hydrogen conservation. Although water recycling technology is very efficient, there are still small losses. While water is rationed only in the smallest communities, everyone growing up on Luna is taught to conserve water, and utility bills can be high. In contrast, oxygen is not considered a scarce resource, as it is easy to extract from lunar soil.

LUNAR SETTLEMENT TYPES

Luna’s low gravity permits lighter construction, so multistory structures, arches, and domes can be built on a massive scale relatively cheaply. Unfortunately, since there’s no atmosphere, radiation shielding against solar flares and cosmic rays becomes critical. It would be nice to put cities and gardens under soaring crystal domes, but for now, the vast majority of human habitats are buried under several feet of regolith.

Another limitation is material. Lunar settlements don’t use wood, vinyl, and some metals; even concrete is expensive outside of the polar regions. On the other hand, there’s plenty of titanium, aluminum, and iron, and glass composites are also easy to make, so they are the most common construction materials.

Warrens

These are common in highland regions, such as the north and south polar settlements. A warren is made up of individual habitats buried under about 10 feet of lunar regolith; most polar warrens are built into the rims of craters, where they can receive the greatest amount of sunlight; this also provides a nice view when anyone goes “topside.”

Warrens have a surface level – usually of simple cylinder, dome, or block construction – containing airlocks, storage areas and machinery, and an underground habitat level, or levels. Individual warrens rarely have more than one or two underground levels. Instead, big complexes have multiple adjoining house-sized warrens linked by roads, enclosed surface walkways, or tunnels. Many warrens are surrounded by unmanned surface installations, such as reactors, solar panels, and garages, warehouses and factories.

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Life in the warrens can be a bit claustrophobic. While virtuality and augmented reality can make small spaces seem much bigger – almost all make extensive use of 2D or 3D video walls (p. TS147) – there are no windows in the living quarters, and going outside requires donning a full pressure suit. However, this is mitigated by widespread use of teleoperated cybershells for external excursions – if someone wants to see outside, they usually just don a virtuality helmet (or use their implant) and take a cybershell for a ride.

Tube Habitats

These are the most common human settlements in mare and mare-highland coastal regions. They are settlements that have been built inside natural lava tubes (see p. 52).

A length of lava tube (usually no more than a half mile or so at first) is sealed off from the rest of the tube or rille. Elevator and light shafts are cut leading to the surface. Sunshine comes down simple shafts or is piped through optical cables.

A few tube habitats are pressurized – the preferred mix is about 0.5 atmospheres, with reduced nitrogen but Earth-normal oxygen: 42% oxygen, 58% nitrogen. However, this is rare, both due to the vast amount of imported nitrogen required and the risk of pressurization weakening the tube. The catastrophic collapse of one pressurized lava tube (at China’s NMC-1 complex) has dissuaded most architects from taking this step. Instead, the sealed-off lava tube is usually left in vacuum, and individual pressurized houses and other buildings are constructed on platforms on the tube floor.

Even with the need to pressurize buildings, construction inside a lava tube is much easier than building warrens, since there's no need to worry about radiation shielding. Moreover, life support is greatly simplified by the moderate temperatures inside the tube. Lava tube buildings range from very simple structures (such as inflatable domes) to elaborate multi-story buildings. Lava tube habitats with larger populations contain a maze of individual buildings. Many warehouses and factories are simply left in vacuum, as are areas inhabited by cybershells. In the dust-free, moderate-temperature environment inside the tube, these are ideal locations for long-term storage.

Individual structures are linked by pressurized walkways, malls, and even park-like greenways. Since there's no need for radiation shielding, it's possible to erect large, pressurized inflatable structures, making it easier to create walkways and gardens. Light shafts (with shutters) and optical fiber bundles are used to light the tube interior, and these can be opened or closed to create a normal 24-hour day/night cycle.

Despite one-sixth weight, full inertia is retained, so it's necessary to carefully think a few steps in advance to avoid tripping or landing badly and falling over.

The cool but steady -4°F temperature (which may rise several degrees due to human activities) found in a tube means that vacc suits and life support packs intended for "inside the tube" wear can be lighter, cheaper, and simpler. As a result, it's much more common for tube residents to go "outdoors" themselves, walking between individual housing complexes and other buildings. While the interior of the lava tube is barren rock, lunar residents rarely leave it that way. It's common for tube-dwellers to create elaborate Japanese-style rock gardens; such "vacuum gardens" have become one of Luna's recognized art forms. If finances allow, the entire roof of a tube may be covered with bioluminescent material or a video display to create the illusion of a starry night sky.

Surface access is provided by elevators, some built into tall buildings, others freestanding structures that also provide an excellent view of the lava tube town. Like warrens, lava tube settlements usually have extensive surface facilities outside the habitat, with structures housing heavy industry, landing pads, solar towers, and garages.

TRAVELING ON LUNA

Luna City and other communities are fairly compact, so most people get around on foot. Cybershell electric carts and similar vehicles are used for deliveries.

The most efficient means of travel between lunar communities is the mag-lev railway. For destinations not on the railway line, hiking is popular for trips of a few miles or less, while electric-powered wheeled or tracked vehicles are used for journeys up to a couple of hundred miles. Suborbital "moon hopper" rockets are used for more distant destinations.

Walking on Luna

Inside or out, the proper walking technique in the moon's reduced gravity is a modified "bunny hop" or "lunar lope" in which one puts one foot in front of the other, pushing off with one foot and landing on the other foot (but not separating the feet as in an ordinary walking stride). As one is "resting" while spaceborne, it's not too tiring, but it does require careful concentration, and this can be fatiguing. Despite one-sixth weight, full inertia is retained, so it's necessary to carefully think a few steps in advance to avoid tripping or landing badly and falling over. Another oddity about walking on Luna is that it's hard to tell whether you're actually standing perfectly upright or not. Without careful attention to posture, people tend to slouch forward a lot.

Outside, dust is another problem. The regolith is firm enough that it is easy to walk on, but walking does kick up a fine spray of powder. This isn't enough to obscure vision, but it does adhere to vacc suits or cybershells. To avoid a terrible mess, it's necessary to spend several minutes cleaning off before going into an inhabited area. Most airlocks have "dustlock" areas where this can be done. The low-tech solution is to stand in a large bag while removing a suit, and carefully shake oneself clean. Newer vacc suits and cybershells are equipped with buzzwear surfaces (p. TS146) to avoid dust adhesion in the first place. Cleaner microbot swarms and sonic showers in airlocks are also employed.

The Lunar Guideway

An elevated rail line links Luna City to other major settlements, including the Tranquility Industrial Zone and the Moonshadow resort. The lunar railway system is a magnetic-levitation (mag-lev) system, built by Maxim-Herzberg LIC (p. 94).

Instead of a conventional engine, mag-lev vehicles are levitated and propelled by superconducting electromagnets. The magnetic field pushes the vehicle along, while suspending it above a steel rail, called a guideway. The lack of friction produces a comfortable, smooth ride, lowers maintenance costs, and permits high speeds. In the lunar vacuum, mag-lev cars don't need any streamlining.

Usual speed is 500 mph.

Individual passenger mag-lev cars, or “pods,” are spacious, comfortable vehicles. A vehicle seats 90 people, and contains a snack and beverage bar. Seats can convert to small but comfortable beds; a typical journey is 3 to 8 hours between stops. All pods carry sufficient air, food and water for five days of life support. Each is 60’ long and 12’ wide, and is effectively a separate, self-propelled vehicle with its own airlock. Pods do not have much radiation protection, so the trains don’t run during intense solar flares. Other mag-lev pods carry cargo – ice shipments from the poles to Helium City and other near side communities are common.

The Lunar Guideway’s main line runs north from Luna City at the south pole to Port Tranquility on near side, with a second line running north to Moonshadow. Feeder lines run a few miles off the main line connecting to nearby communities – for instance, from Luna City to Malapert Mountain. Loop lines surround Luna City, Port Tranquility, and Helium City.

Travel between settlements costs \$1 per 100 miles, with a minimum cost of \$5. To help prevent accidents and terrorism, weapons and explosives are only permitted on these trains if stored in special locked compartments. Embedded sensors can detect and report most mechanical problems or sabotage attempts on the track itself.

Moon Hoppers

Emergency personnel, and anyone else in a hurry travels by rocket-powered “hopper.” Hoppers are the fastest way to visit any of the small independent communities that are not part of the Lunar Guideway line.

Moon hoppers are small, short-range spacecraft. Propelled by indigenously-fueled metal-oxygen rockets, they fly suborbital trajectories that can reach any point on Luna in under 90 minutes. Some can also reach Luna orbit (p. 72). The LRF (p. 56), a few wealthy private citizens, military units, and some lunar corporations own hoppers.

Commercial passenger flights depart every three hours between Luna City spaceport and Port Tranquility, and every six hours to and from Moonshadow. Hoppers can also be chartered (for about \$500/hour plus fuel) from Solar Express, the Luna City-based company Rabbit Transit, and from a few independent owner-operators.

Moon Bugs

Manned ground vehicles are a lot cheaper than hoppers, but considerably slower. The typical model is the same Astro-Bug used in the Deep Beyond (see p. DB146): an open-topped, fuel-cell-powered four-legged vehicle that can do 28 mph across most lunar terrain, with a range of 4 hours. It costs \$39,000.

A small moon buggy can usually be rented at Luna City, Helium City, Tycho, or Moonshadow for about \$50/hour. Unskilled drivers can rent appropriate Driving skill sets for their virtual interfaces, or hire a skilled infomorph as a driver and tour guide.

SAFETY AND THE LUNAR RESCUE FORCE

The risk of decompression due to meteoroid impact is low in a lunar base buried under several yards of hard lunar regolith. Instead, the primary dangers of life on Luna are mechanical failures or traffic and industrial accidents. Every year, about 150 people die in various vacuum-related accidents. Usually, these are industrial or recreational accidents that combine an injury with a ripped suit or sudden explosive decompression, leading to fatal complications.

Moreover, almost every year there is at least one moderately serious accident in some settlement that kills or traps up to several dozen people. The worst was in 2085, when a crack in a Luna City observation dome caused a large-scale decompression that killed hundreds of people. Since humans die in minutes when exposed to vacuum, and survivors are sometimes trapped in enclosed areas without external air supplies, lunar residents have developed protocols and procedures to maximize survival.

Settlements usually have airtight doors on all residences, emergency vacc suits or rescue balls in all large public places, and small emergency life support systems in all residences and shops. This allows the inhabitants to survive for up to 40 hours if cut off from all external life support. Rabbits are considerably more safety conscious than most people born on Earth – two generations have grown up with decompression drills and the constant awareness that sudden death waits just outside their walls.

Almost all lunar children learn to use a vacc suit by the time they are six years old. A rite of passage for all teenagers is their solo vacuum certification, which allows them to venture outside without adult supervision. In most communities, teens are first eligible to pass this exam when they are between 11 and 14. Many older teens express their independence by taking extended day trips on the surface.

All lunar residents are expected to have personal vacc suits and to maintain them in optimum condition. People who neglect their suits are considered slovenly and irresponsible. Most rabbits paint and decorate their suits, either digitally or physically, although corporate workers may be required to wear uniform colors while on duty. In addition to being a statement of personal aesthetics, this practice also helps people and machines recognize individuals from a distance, especially when out on the relatively featureless lunar surface. All of these designs are expected to be highly visible. Geometric patterns, reproductions of artwork, images from other worlds, family portraits, or even scenes from popular InVids are all popular personal suit motifs.

The Lunar Rescue Force

When all precautions fail and dangerous accidents occur, the Lunar Rescue Force (LRF) is called out to help. The LRF is a semi-private company supported by corporate and civic donations. It's a combination fire brigade, rescue service, and ambulance service, using a cadre of 200 full-time members and 700 part-time reservists. They use a fleet of 50 hoppers and 5 OTVs; the LRF can be anywhere on Luna in under half an hour.

In the event of a major disaster, such as a blowout, the LRF uses explorer microbots to locate survivors, set up portable airlocks and attempt to establish communications. Prompt action by the LRF is credited with saving over 2,000 lives during the Luna City disaster of 2085.

LRF members are all paramedics, and teams also contain physicians and cybershells designed for heavy lifting and construction work, as well as personnel trained in rescue work, hazardous materials disposal, spelunking, signal detection, and crowd management. The LRF is not a law enforcement agency, but does have some members trained to perform hazardous material and bomb disposal.

Prompt action by the LRF is credited with saving over 2,000 lives during the Luna City disaster of 2085.

THE LUNAR Economy

The lunar economy is primarily based on mining and heavy industry, and, to a lesser extent, tourism and scientific research.

SCIENCE

Big-science astronomy and physics projects funded by terrestrial governments helped open up Luna for colonization, and still pour billions of dollars into Luna each year. The earliest installation on the moon was the Farside

Observatory (see p. 74), while the COSMAC particle-physics laboratory (p. 66) is another major program. On a smaller scale, lunar planetology keeps thousands of people busy each year, though many of them are on Earth, using teleoperated cybershells). All in all, the various science programs employ 7% of the lunar workforce, and contribute considerably more than that to the overall economy.

Mining THE Moon

The principal industry on Luna is mining. The lunar regolith is an enormous source of raw materials. Moon rocks are rich in oxygen, calcium, aluminum, titanium, iron, silicon, and helium.

Many processes used for mining on Earth are not practical on Luna, as they require chemical agents and reactions that are not found on the moon or do not work in vacuum.

Instead, most lunar mineral extraction processes rely on electrochemical processes. Two examples:

Amorphite: An abundant mineral oxide in the lunar highlands. It is a compound of calcium (14%), aluminum (19%), silicon (20%), and oxygen (46%). It is heated to evaporate and extract the silicon oxide component, then an electric current is run into the molten metal (electrolysis) to collect the aluminum and calcium. The leftover silicon is also useful for many products, including solar cells.

Ilmenite: A glassy agglutinate of iron, titanium and oxygen, it is most common in mare regions. To process ilmenite, it is heated with hydrogen to 1,560° F. The oxygen combines with the hydrogen to form water. This leaves behind a mix of titanium and iron, which can be ground to powder and then magnetically sifted to separate out the iron.

Oxygen is bound up in all lunar rocks as metallic oxides. Over 40% of the lunar surface consists of oxygen compounded with other elements. Moonrock can be heated with methane to produce water and carbon dioxide, and electrolyzed to produce oxygen.

Oxygen is exported as rocket fuel and used domestically to make water and air. Luna also exports large quantities of oxygen to the Lagrange colonies and orbital stations.

Pure iron and iron compounds are found everywhere in the form of fine powder, the result of eons of meteorite bombardment. They are easily separated using magnetic rakes as regolith passes through a conveyor belt or other processor. Pure iron powder can be sintered into useful products. Such sintered iron lacks the same tensile strength as steel, but is useful for things like consumer goods.

Not all moon rocks are created equal, which means different mining operations are needed. The anorthite-rich highland regions (including the lunar poles) yield the most aluminum, magnesium, and calcium, while iron and titanium are found in greatest abundance in the mare regions. Resources from both regions are needed for many industrial products, such as the glass composites. These are fiberglass matrix composites that are manufactured entirely from indigenous materials found in lunar regolith. They replace plastics, synthetics, and wood in everything from appliance casings to furniture.

Helium-3 Mining

Billions of years of exposure to the solar wind has enriched the lunar regolith with the rare isotope helium-3, which is used as a fusion reactor fuel. Its extraction is the primary industry on Luna. He-3 mining is expensive and difficult, but the product is exceedingly valuable. Today, even with reduced prices thanks to the competition from Saturn, every pound of He-3 is worth over a million dollars. Unfortunately, it costs nearly as much to extract it from the lunar regolith.

The Lunar mineral ilmenite (p. 23) is found in mare regolith, and retains solar helium much better than other common lunar materials. Older, titanium-rich regolith is a better source of He-3 as it has been exposed to the solar wind longer and contains greater amounts of fine-grained aggregates that absorb solar volatiles.

Two regions proven to be good mining locations are Mare Tranquillitatis and Mare Procellarum. Other locations relatively rich in He-3 are the far side maria, as the Earth shields the Moon's near side from the solar wind for a portion of each solar orbit.

He-3 Extraction

The concentration of He-3 in mare regolith is less than 30 parts per billion, but it can be removed by heating it at 1,200° F. Unfortunately, due to the low concentration, about 100 million tons of regolith has to be processed to get one ton of He-3. Fortunately, the processing also yields numerous other useful elements – see *Byproducts of He-3 Mining*.

The amount of He-3 on Luna is estimated at over a million tons.

Lunar Mining Vehicles ("Mining Crawlers")

Truck-sized mining cybershells crawl slowly across the lunar surface, scooping furrows out of the regolith and leaving piles of melted slag behind them.

A typical LMV excavates lunar regolith to a depth of 10 feet, moving at speed of about 25 yards/hour. Each hour it excavates over 1,200 tons and processes about 600 tons of regolith. Most mining vehicles mass about 50 tons and end up producing some 70-80 lbs. of He-3 and 600-700 tons of other usable volatiles per year.

Initial sorting of the mined regolith takes place onboard the LMV, separating the fine grains and rejecting coarser material, and then heating that material via solar or electric furnace to extract volatiles. Some operations use separate transport vehicles to ship back processed volatiles; others connect the crawler via a long umbilical to a mobile mining base (see below). This allows extracted volatiles to be pumped continuously from the crawler to the base itself, where they are refined into individual elements, including He-3.

Byproducts of He-3 Mining

He-3, ordinary He-4, hydrogen, carbon, and nitrogen are all trapped within ilmenite.

A useful side effect of He-3 mining is that for every ton of He-3 produced, hundreds of tons of other useful elements and compounds are refined as a byproduct of the process. For each ton of He-3 production, the bounty of other materials includes:

Hydrogen	6,100 tons
Water	3,100 tons
Helium-4	3,100 tons
Carbon monoxide	1,900 tons
Carbon dioxide	1,700 tons
Methane	1,600 tons
Nitrogen	500 tons

Extracting these elements from lunar soil would not be economical on its own, but as byproducts of He-3 refining, they are affordable – and together they provide most of the resources to sustain life support, agriculture, and industrial needs of the humans on Luna.

Swarm Mining

Microbot swarms are increasingly being used in conjunction with mining crawlers to speed up He-3 extraction. Explorer and mining microbots range ahead of the mining crawlers, sifting through the regolith, and channeling fine volatile-rich material to the crawlers. Microbot swarms covering hundreds of square yards are a common sight.

Mobile Mining Bases

These are large movable outposts that act as a control center, power supply, garage, volatile refinery, and storage depot for mining operations. Each mobile base controls a number of mining crawlers (and/or microbot swarms). The crawlers are connected to the bases via umbilical cables. The base powers and services the crawlers, while the crawlers continuously pump extracted materials to the base.

Mobile bases come in several configurations; some are enormous self-powered tracked units, while others are towed into place by other vehicles. All contain power, volatile-processing, workshop, construction, and (in older designs) quarters and life support modules. A typical mobile base commands two to four mining crawlers, a couple of multi-purpose construction cybershells such as polypedes (p. TS123), and a half-dozen or so service cybershells like the tech-spider (p. TS125). Manned bases add a small human crew of managers and troubleshooters; newer ones may also have microbot cyberswarms. Some mobile bases are powered by fusion reactors, but most rely on hydrogen-oxygen fuel cells, which can be continuously fueled by the byproducts of He-3 mining.

Mobile mining bases usually set up shop atop a medium-sized crater or near a lava tube, which they convert into a temporary storage bay. If it's a crater, the crater walls, reinforced by local regolith, are also used to provide radiation shielding. Over the next few years, thousands of tons of useful He-3 mining byproducts (hydrogen, helium-4, etc.) will be produced, so as part of the set-up operation, insulated cavities may be dug into the regolith around the base to serve as cheap storage tanks. Eventually, temporary pipelines will be run out to transport the products from the mobile mining base to the nearest mining camp.

A typical mobile base will remain in the same place for several months to a couple of years. A base takes six months to four years (depending on its equipment) to mine a square mile of regolith down to a depth of 10 feet, producing just under a ton of He-3 in the process. After an area is mined out, the base will move on to another location, much like a mobile oil rig does.

The original mobile bases were manned, with a crew of a dozen or so human workers, teleoperators and supervisors. A few older bases are still in service, and these have one or two human or bioroid crew members. Most of today's bases, however, are managed by SAIs, LAIs, or mind emulations.

Mining Camps

Semi-permanent mining camps provide administrative and service support for several mobile bases in a region. They are also the main "switching station" of pipelines that pump materials between the temporary bases and the major lunar settlements.

A typical base camp consists of a cleared landing area and fuel depot for moon hoppers, an underground base with living quarters and/or cybershell garages, a workshop and minifac facilities to fabricate spare parts, and limited recreational and medical facilities. A typical base camp has a population of 10-40 humans and a larger number of informorphs and cybershells.

Mining camps are typically owned by one of the major He-3 mining corporations. The largest are System Technologies AG and Tenzan Heavy Industries.

Volatile Pipelines

The lunar landscape is crisscrossed with pipelines that connect the mining stations with the Tranquility Industrial Zone and Luna City. These are carefully insulated (and often buried) to protect them from temperature changes. Pipelines are primarily used for ordinary volatiles such as hydrogen, water, and nitrogen. The major pipelines connect the larger settlements, running parallel to the lunar guideway (p. 54). In areas where pipelines are not laid, the mag-lev guideway or large cybertrucks transport volatile tanks instead.

Old Mining Zones

Old mining zones are circular areas that have been strip-mined by He-3 or other regolith-mining operations. These cover hundreds of square miles of Luna, particularly in and around mare regions in the Tranquility Industrial Zone.

Old mining zones are devoid of small craters, as they have been erased by the mining crawlers and swarms. The regolith itself is crunchier underfoot, because it is now mostly coarse-grained material and baked waste produced by the mining process.

There is usually an abandoned mobile base site at the center of old mining zones. This is usually a small crater a few dozen yards across, or sometimes a lava tube entrance or rille. Under and around it will be underground volatile storage areas, usually empty. The actual mining base machinery will have been removed and all debris salvaged, but in a few cases there may be a few broken-down cybershells or other machine parts that were junked rather than salvaged.

Since the site has already been prepared, old mining zones can be useful shelters in the event of a sudden solar flare, as well as good hidden bases for lunar hermits (or criminals), or would-be colonists operating on a budget. While the chambers left behind are unpressurized, they could be converted into habitats without too much work.

LUNAR HEAVY INDUSTRY

In the 2050s, as the demand for He-3 increased, it proved to be too expensive to import additional mining machinery and processing plants from Earth. Instead, automated robofacs were established on Luna itself. The sprawling Tranquility Industrial Zone (p. 64) became the first true "robofac" complex in the solar system, a largely self-contained manufacturing center whose self-replicating capabilities enabled mushroom-like growth.

As Luna's population increased, the robofacs have diversified their output from mining equipment to consumer goods, spacecraft engines, and other products to support lunar needs, and to export products beyond the moon. With only one-sixth Earth's gravity, shipping goods from the moon into space is competitive, thanks to the ready resources that are already on Luna.

The Tranquility Industrial Zone emerged as a major supplier of machine parts and cybershells to the growing conglomeration of research stations, factories, and habitats in Earth orbit, L4, and L5. With no air to pollute or ecosystem to spoil, Luna has become a place where the solar system's unwanted but necessary industrial activity is concentrated.

LUNAR TOURISM

Luna is Earth's closest natural neighbor, and unlike the other planets, Luna is only a few seconds timelag distant from Earth. This allows visitors based on Earth, in Earth orbit, or at L4 and L5 to explore the moon via cybershell.

Teletourism was one of Luna's first industries. For decades, small teleoperated cybershells have been guided through the more spectacular lunar landmarks, or visited various attractions. Chief among these historical sites is Tranquility Base, where the remnants of the first manned spacecraft to land on the moon, the *Eagle*, have been carefully preserved against vandalism.

Today, the vast majority of Luna's teletourists are children from Earth and the L4 and L5 colonies, visiting to learn first hand about extraterrestrial environments, gravity, vacuum, and planetary geology. Lunar natives have gotten used to the brightly colored ceramic alloy cybershells controlled by inquisitive or bored school children that scramble over the landscape, their movements tentative or jerky thanks to the 1.3-second timelag.

Not all teletourists are children. Each year thousands of adults rent cybershells to climb the mountains of the moon, or experience a variety of low-gravity sports, or just explore an alien world first hand. The companies in the Tranquility Industrial Zone have to monitor their operations carefully to insure wandering tourist 'shells don't interfere with their mining operations. Similarly, Luna City

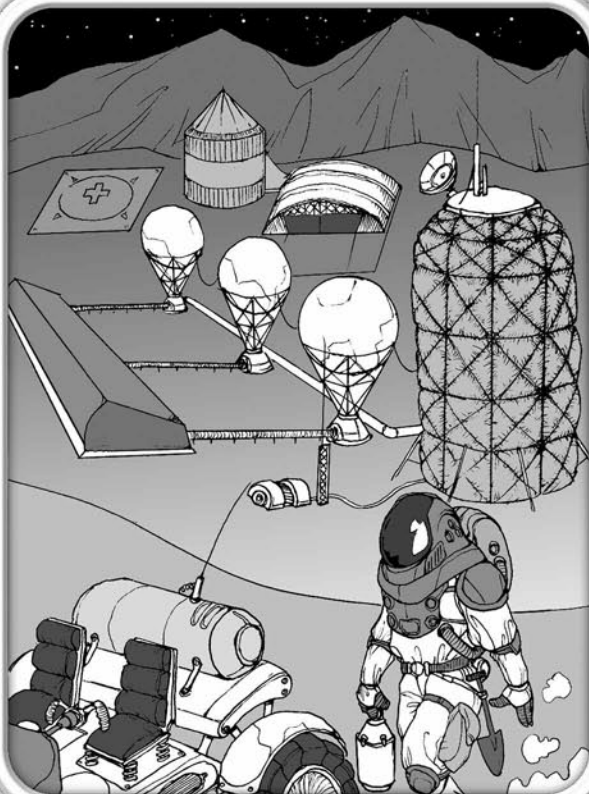
residents play host to visiting architects, tourists, and economists interested in their unusual city.

However, while research and educational teletourism is here to stay, there are fears that the number of recreational visitors may be dwindling. As mining and industry has taken its toll on the lunar landscape, some areas of Luna are starting to look more and more like a leftover strip mine and less like the inspirational pictures taken by the old Apollo crews in the 20th century. Dust clouds thrown up by He-3 mining operations often block scenic vistas. Tourists are sometimes disappointed by the litter and raw tailings. Some teletourist companies have attempted to make the best of this, highlighting the "dramatic" mining operations and the huge machinery used. For now, however, the vast majority of Luna still remains largely unspoiled.

Cybershell Rentals

Several companies on Luna manufacture, rent and maintain cybershells built for tourism. They are designed to allow tourists to explore the lunar landscape, take guided tours of the bustling Tranquility Industrial Zone, climb the lunar mountains, prospect unexplored lava tubes, visit the historic locations of old space probes and Apollo landings, or just wander through Luna City or other habitats, gawking at the buildings and inhabitants.

Tourist cybershells are rented by the hour, by both rabbits who want to take a look at their own home and by groundhogs. The Lunar Cooperative Credit Union, along with Luna City and Moonshadow, manage the satellite network and bandwidth rentals.



Endymion Cybershell 290 points

Attribute Modifiers: ST +1 [10]; HT +2 [20].

Advantages: Absolute Direction (Uses GPS, -20%) [4]; Attractive (Off-the-shelf looks, -50%) [3]; Chameleon 1 [7]; DR 3 [9]; Extra Hit Points +3 [15]; Machine Body [37]; Micromanipulators 1 [15]; Microscopic Vision 10 [40]; PD 1 [25]; Radio Speech (Radio and Laser, +40%) [35]; Sensitive Touch [10]; Spectrum Vision [40]; Vacuum Support [40].

Disadvantages: Mistaken Identity [-5]; Skinny [-5]; Social Stigma (Valuable Property) [-10].

Features: Complexity 6-8 microframe computer.

Date: 2092. **Cost:** \$90,000 + computer.

Developed by Kanzaki Robotics' Luna office, these humanoid but obviously inhuman cybershells are popular with teletourists and ghosts, who enjoy the feel of walking "naked" in vacuum, and experiencing Luna through enhanced senses. Tall and skinny, these inhumanly graceful machines have chameleon surfaces that seem to flow like liquid metal, and long fingers branching into micromanipulators. These – and their enhanced senses – also make them very practical workbots. 105 lbs., 7' tall.

Live Tourism and Moonshadow

Even as adult teletourism has declined, visiting the moon “for real” has become more popular. Luna remains the only large natural body reachable without weeks or months traveling through space. “For a real adventure, come to Luna,” is the slogan.

A limited amount of realbody tourism has been going on since the 2040s. One of the earliest tourist businesses was “moon looping” cruise flights that combined microgravity experiences with dramatic views of the lunar surface as a cruise spacecraft orbited between Earth and Luna. These were followed by “extreme adventure” tours (similar to traveling to Antarctica, only more expensive). Potential visitors had to train for space flight, room and board were unsophisticated, and often there weren’t any proper tour guides – just scientists and engineers eager to get a visitor out of their hair.

Moonshadow (p. 68) changed all that. At Moonshadow, the lunar environment is only one part of the package – an exotic spice for those who have been jaded with Earth or even Mars. Located at the relatively undeveloped north pole, this resort settlement caters to the wealthiest of the wealthy with luxury amenities, a carefully planned and maintained community, and the best pleasures money can buy.

Pro-Gov Rabbits

There are factions of pro-government lunar inhabitants – most of them permanent residents – who want to replace the current freewheeling corporate anarchy with a real federalist government. They’d like Luna to have its own constitution and become an independent nation.

Lunar Democratic Congress: This organization wants to establish a Lunar Republic via the mechanism of a general referendum and “constitutional congress.” They are attempting to gain signatures from the resident lunar population in support of this. The organization is strongest at Luna City, where perhaps 20% of the permanent residents are in sympathy with the idea. The congress leadership spends time developing economic scenarios, drafting prototype laws, and seeking to win the support of Earth governments.

Lunar Preservationist Party: The so-called “Red Rabbits” believe Luna is being gutted by soulless corporate forces. They’d like to nationalize (or heavily tax) the major corporations and enact laws that would protect the lunar environment and preserve the dwindling polar ice deposits (and even He-3 reserves) to support Luna’s own future interests. Membership has grown as profits from He-3 mining on Luna have decreased. Some of the group’s leaders are quietly supported by the influential lunar science lobby at Tsiolkovsky and COSMA, who believe that continued Lunar economic development threatens the isolation they require. The Red Rabbits have spawned a splinter activist group known as The Regulators, who have occasionally held angry demonstrations, attempted to sabotage corporate operations, and roughed up rivals (mostly the LDC).

ISOLATE COMMUNITIES

While the vast majority of lunar settlements are connected to the power and transport grid, some are not. These habitats are typically owned by eccentrics or isolates of various sorts, or by corporations or governments performing secret research. They rarely welcome uninvited visitors. Most are hidden inside lava tubes or old mining stations.

LUNAR INSTITUTIONS

There is no pan-Lunar government. Most settlements are the property of various corporations, such as SpaTek or System Technologies, or of scientific foundations. Some settlers would like to see a “free” Luna, but a combination of Earthside business interests and the “big science” lobby have presently trumped any desire for independence.

THE LUNAR COOPERATIVE CREDIT UNION

The LCCU began in 2062 as a financial institution open to any permanent settlement on the moon and that remains its major function. The LCCU provides loans, currency exchange services, bank accounts, insurance, and investment services to its members. Over the years, it

has also evolved into the lunar bargaining and lobbying organization serving the interests of the rabbits over the interests of the groundhogs.

The greatest success of the LCCU was the Lunar Guideway mag-lev rail system. System Technologies and Tenzan Heavy Industries had both planned their own cargo railway systems, but LCCU provided the administrative and financial backing to transform these concepts into a workable and profitable commuter transit system. The LCCU is also responsible for coordinating the funding of the Lunar Rescue Force (p. 56), and has been instrumental in representing the interests of Luna residents during the disaster relief effort and rebuilding of Luna City.

LUNA, INCORPORATED

The majority of people on the moon are directly employed by large corporations. Only about 15% of the populace are self-employed, work for small businesses, or run their own enterprises. Some of the most important corporations on Luna include:

System Technologies AG: This giant transnational is the leading He-3 mining company. It presently owns about 30% of all property on Luna. System Technologies was, with Tenzan, largely responsible for creating the Tranquility Industrial Zone.

Tenzan Heavy Industries: This Japanese corporation (see p. TS96) was one of the pioneers of Lunar He-3 and ice mining, and still owns 30% of all He-3 mining on Luna. It has also diversified into heavy manufacturing and industrial robotics. Tenzan's important lunar headquarters is at Luna City, with a branch headquarters at Helium City.

Biotech Euphrates: This genetic engineering transnational (p. TS94) rebuilt Luna City, and is a major player in Lunar agriculture, designing many of the plants, bacteria, and animals used on the moon. It has several offices and research labs on Luna.

Kanzaki Robotics: This Japanese cybershell company has large factories and labs in the Industrial Zone. In addition to industrial cybershells, it also manufactures various high-end technical and consumer models.

SpaTek: This health care and sports company is headquartered at Luna City, and operates Moonshadow, making it one of the most influential corporations on Luna.

Lunar Optronics: This British company is known for its high-quality PESAs and lasers, used in many commercial and military spacecraft and for beamed-power systems.

Malapert-Solaris: The major solar power company on Luna.

Alliance Volatiles: A consortium of Australian and Korean mining interests has a fairly new He-3 mining complex in the Mare Frigoris region. By using state of the art Nanodynamics mining swarms, it hopes to remain competitive with gas giant He-3. There's considerable rivalry between Alliance and its older competitors.

Artemis Studios: This rising Malapert Mountain-based media company is described on p. 62.

Earthlight Enterprises: This company imports digital content from Earth and repackages it for a Lunar audience. It is also the moon's major web service provider.

Nanodynamics: A huge transnational (see p. TS95), its presence on Luna is relatively small. It does not have mining interests, but has established a cybershell factory in the Tranquility Industrial Zone. Most companies use older Kanzaki, System Technologies, Tenzan, or Vosper-Babbage machines, but Nanodynamics is aggressively marketing a new line of autonomous mining swarms and nanotech-based He-3 processing plants.

LUNAR SETTLEMENTS: SOUTH POLE

The major feature of the Lunar south pole is the South Pole-Aiken Basin, the single largest impact crater in the solar system. The polar topography was shaped in part by the enormous impact that created the basin, resulting in very rugged highland terrain of widely varying elevation. The basin itself is about 1,600 miles in diameter and 7.5 miles deep, surrounded by rings of mountains – a basin wall that extends across the south polar region.

The undulating polar terrain also has many mid-sized and smaller craters and mountains. One of these craters, Shackleton, is located right next to the south pole itself. Some of the craters are in permanent shadow, and contain frost or ice deposits.

Jeanette Remillard leaned over the shoulder of the digital editor and peered at a corner of the screen. "What is that," she said, pointing. "Dust cloud?" Her editor, a hyper-active twenty-something with tousled hair and anachronistic black glasses, drummed his fingers on the work panel without missing a beat as he worked. "Could be a weird light refraction, kinda hard to tell," he said. "Want me to get rid of it?"

"Please," Remillard said. "Moonshadow wants this slinky to be perfect, and that's what they're going to get. "Now, what can we do about R's expression here? I want more 'come hither' and less 'bad hot dog for lunch.'"

– "The Making of 'Moonshadow Private Tour,'" Artemis Studios

SHACKLETON CRATER

Shackleton is a 12-mile diameter crater located next to the south pole (89.9° south, 90° east). The crater rim rises 1,000 yards above the surrounding terrain, and the crater is about 2 miles deep. The floor of Shackleton is in permanent shadow, with substantial ice deposits on the surface.

“The Peak of Eternal Light”

This is a series of high points on the rugged, raised rim of Shackleton Crater where the sun is above the lunar horizon more than 80% of the time. From these peaks, the sun always remains very low in the sky, only bobbing up or down by 1.5 degrees over the course of a year. As a result, the “peak of eternal light” locations enjoy almost continuous sunlight. In the first years of Lunar settlement, these locations were covered with many thousands of square feet of solar collectors. Solar power from the Peak of Eternal Light was crucial to Shackleton Base’s operation, meeting the early community’s energy requirements. As the community grew, this was supplemented by beamed power from Malapert Mountain and He-3-fueled fusion reactors. However, the Peak’s solar collectors still provide a large portion of the city’s power, and the high ground on the crater rim is still covered with a forest of solar panels.

Luna City

Luna City runs – or perhaps grows – part way along the rim of Shackleton Crater, and is one of the oldest communities on the moon. Once known as Shackleton Base, it was damaged in an accident and rebuilt as Luna City. It is described in detail on pp. 73-80.

Luna City Spaceport

This large spaceport is located in a cleared area of the crater floor a few miles from Luna City. It’s not as busy as Port Tranquility (and the polar location is not optimum for space launch), but is a nexus for regular moon hopper flights, as well as cargo OTVs shipping water up to Port Diana and other goods or passengers down to Luna City.

ARTEMIS STUDIOS

Jeanette Remillard was a multimillionaire whose parents made their fortune creating genetically engineered crops. In an effort to foster practicality and self-reliance, when she was 25 her parents gave Jeanette 25% of the business. She immediately turned this over to managers and SAIs and set out to fulfill her dream of running a successful interactive entertainment studio. Against all odds, she was successful, and the Malapert Mountain-based Artemis Studios has recently blossomed into a billion-dollar enterprise.

Artemis Studios began by staging some of Luna City’s most popular reality games, such as the popular “Helium Raiders,” a romantic spy epic set in the Pacific War. These productions were unknown outside of devoted followers in Luna City, but attracted a cadre of young people dreaming of a career in entertainment. Recently Artemis has branched into slinky production, using home-grown lunar actors – many of them bioroids, although the company claims all its bioroids are free citizens, not indentured workers.

Remillard and her directors prefer slinky productions to InVids, as these can shoot on location with live actors. Partly funded by corporate donations, Artemis Studios has also shown a preference for productions that showcase Luna. Its initial output was mainly recruiting, educational, and training productions aimed at new corporate employees considering work on Luna. With titles like *Moving Safely in 0.165 G*, they weren’t exactly the most creative endeavors. However, Artemis hit its stride with a contract with SpaTek to produce a series of infomercials showcasing the Moonshadow resort. These sensuous infotainments starring a lovely and enigmatic bioroid known only as “R” proved immensely popular, and won Artemis several industry awards. They were banned in the Islamic Caliphate, and pirated and cobbled together into a soft-core porn slinky by a company in Bangladesh.

Artemis changed its tune again in 2098, with the semi-historical slinky drama *Men of Malapert Mountain*, an epic saga of two pioneering lunar families. Compellingly directed by Remillard herself (and featuring many of her trademark live stunts), the epic saga was picked up by Mawari Digital and has been experienced by nearly 100 million people, making its previously unknown star, Andrew Galliard, a household name. Investment money has recently poured in, and Artemis has reportedly begun casting calls for its next epic, whose exact nature remains a closely guarded secret.

The Ice Mines

Shackleton’s crater floor is the site of an ongoing ice mining operation. A network of roads and mag-lev tracks run from the crater floor up to Luna City on the rim, carrying frozen volatiles to Luna City and other locations, or shipping it to the nearby spaceport.



As we crested the last ridge on the western face of Malapert, Jimmy, my sherpa, reminded me – for the seventh time – to darken my faceplate before leaving the shadow. “And do not stand on the terminator,” he said. “Half your suit will try to cool off and half will try to warm up. It’s hell on the circuitry.”

The solar panels glinted a dull violet in the low sunlight as we came around a boulder and saw the hectares of power equipment on the summit. I unslung my maintenance duffel. “Jimmy, wait here. I shouldn’t be more than an hour.”

“Sure thing, Nyota,” he replied, and leaned back against a promontory, his toe scuffing patterns in the regolith.

I walked half a kilometer or so, out of Jimmy’s sight behind a microwave relay, and opened my duffel. Todd, my husband, probably wondered why I hadn’t taken my toolbox on this repair job, but it simply wouldn’t have fit inside the bag – not with the corpse of Todd’s lover inside, anyway. I left him propped up just inside the support of one of the largest relays, where his body would probably mummify before anyone found it. I pulled my tools out of his pockets and placed them inside the duffel; it wasn’t as bulky as before, but I doubted anyone but Jimmy would notice . . . and Jimmy was loyal to me.

Just before getting back to where Jimmy was meditating, I took my small laser welder and burned some new tracings into my footgear. A determined forensicist wouldn’t be fooled by my new footprints, but I didn’t want to take chances even with the amateurs Todd could afford.

“Let’s go home, Jimmy. My work here is done.”

MALAPERT MOUNTAIN

This mountain is located only 76 miles from the south pole, and at 16,400 feet, is tall enough to provide an excellent view of the entire south pole region. In particular, the Peak of Eternal Light (p. 62) on Shackleton’s rim is in direct view from Malapert. Just as importantly, Earth’s disk is in constant view from Malapert.

Due to its commanding location, the (relatively flat) summit of Malapert has been covered with transmission and relay antenna, solar cells, and microwave and laser beam arrays. Malapert is the communication hub for signals between Earth and Luna City, and also acts as a relay between the other bases and mobile receivers (personnel, cybershells, etc.) across the south polar region.

The upper slopes of Malapert are almost continuously exposed to sunlight (89% of the time). Acres of solar panels not only power the Malapert community, but also allow export of energy to Luna City and other outlying bases and vehicles. Energy is beamed to customers via laser and microwaves. This beamed power is not as vital as it was in the early days of colonization, thanks to fusion reactors, but is still important for Luna City and surrounding environs.

The summit is also occupied by Malapert Mountain Space Defense Headquarters, which is operated by LSDI (p. 71). A battery of six heavy laser towers, along with an array of large radars, ladars, and PESAs, provides a commanding view of the surrounding terrain. They have the capability to intercept small- and medium-sized

meteoroids – or spacecraft – that threaten Luna City or any other south polar stations subscribing to their services.

Malapert’s northwestern slope is fairly shallow, and it is here that a roadway has been built up the mountainside. Burrowed into the slopes and beneath the mountain is a thriving warren-town with a population of 3,200.

Life in Malapert tends to be faster-paced than in Luna City, with a closer connection to Earth. Many of the people working here are representatives of terrestrial information and media companies doing business on Luna. Some native Lunar companies in the optics, laser, media, and beamed power technology fields are also headquartered here, including Lunar Optronics, Malapert-Solaris, and TEN-Malapert. Malapert is sometimes called the “bollywood of Luna,” as the site of the majority of Lunar entertainment companies, including the rising star Artemis Studios (p. 62).

LUNAR SETTLEMENTS: NEARSIDE

The majority of Lunar economic development has occurred on the nearside, facing Earth, thanks to the prevalence of titanium- and solar volatile-rich mare basins there.

In addition to the large settlements described below, there are dozens of small and moderate-sized lunar bases scattered across the near side.



TRANQUILITY INDUSTRIAL ZONE

The Tranquility Industrial Zone is located in the Mare Tranquillitatis region of Luna's near side. The Sea of Tranquility is a vast, smooth, equatorial lava plain – the first manned spacecraft to visit Luna, Apollo 11, landed near its southern edge.

The Industrial Zone is centered around Port Tranquility and the "Helium City" manufacturing complex adjacent to the port. There are about 100 square miles of active bases and mines, but the actual area of the Industrial Zone is considerably larger.

It's been called the ugliest place in the solar system. Mobile mining complexes have scraped up the surface throughout the Zone, and in some areas swarms of microbots have combed through the regolith, extracting oxygen, titanium, iron and the rare He-3. With no environmental regulations, the landscape is littered with broken machinery, antiquated tools, and even personal trash such as non-functional space suits and garbage. Most of the trash in the Zone is mechanical in nature, and a few startup companies have begun to make a living scavenging these discards with specialized microbots. Preservationists and pro-gov activists point to the Tranquility Industrial Zone as an example of everything that is wrong with human habitation on Luna.

As the profitability of lunar He-3 declines due to competition from Saturn, the importance of lunar heavy industry has increased. Many cybershells, spacecraft

components, and power plants are manufactured here and exported across the solar system. Structural supports, modular living quarters, mag-lev pods, and telescope arrays are built in the Zone. The Industrial Zone even exports some goods to Earth and Mars, although most of its output supports space stations and habitats of Earth-Lunar space. This includes the massive construction effort for the Olympus Project space elevator.

Tenzan Heavy Industries, Kanzaki Robotics, Nippon Uchuukaihatsu Kaisha, Vosper-Babbage, and System Technologies AG own most of the Tranquility Industrial Zone's factories. While Tenzan and Vosper-Babbage continue to focus on He-3 mining equipment and cybershell manufacture, System Technologies, Kanzaki and NUK handle most of the aluminum, oxygen, iron, and titanium manufacture. They and several smaller companies also build most of the other products that the Industrial Zone manufactures, ranging from fusion reactors and solar cells to vacc suits and consumer goods.

The Zone is administered by the Tranquility Industrial Development Board. Board members are either corporate representatives or executives of the World Trade Organization. It works to ensure that inter-company friction does not affect overall profitability. Aside from that, there is no law, no government, and no overriding organization. Hired security forces protect their company's property. There are occasional disputes, but in general, everyone behaves themselves.

Overall, the Industrial Zone is CR 1.

HELIUM CITY

The heart of Tranquility Industrial Zone is the sprawling "Helium City" manufacturing complex centered in and around Tranquility Spaceport. Unlike Luna City (p. 73), most of Helium City is above ground. It's a maze of open pit mines, factories, cranes, reactors, tank farms, smelters,

The Blue Flame

The oldest restaurant in Helium City's Metropolis district is the Blue Flame. Theodore and Mario D'Mellio began with an abandoned warehouse and a salvaged food vat. Over the years, the couple's tinkering with their food programs has created an eclectic menu of virtual flavors. The Blue Flame still shows its rough origin in the echoing spaces of the main dining room and the industrial furnishing scavenged from abandoned machinery, but most spacehaulers and shuttle pilots make the Blue Flame their first stop in Helium City.

*– Copernicus Jones,
Lonely System Guide to Luna*

landing pads, junkyards, and waste dumps. The Zone is largely empty of human life, but crawls with industrial cybershells, and microbot swarms. The junkyards and waste pits are full of salvage swarms that often prey upon one another in their quest to salvage and recycle usable material.

Helium City has a population of 23,000 sapient beings and 250,000 cybershells.

Most of the human, bioroid, and parahuman residents are engineers, security specialists, and administrators who look on their assignment as a kind of purgatory.

Most of the biosapients live in the Metropolis district, a sprawling collection of underground housing, offices, warehouses, and a few amenities like bars, clubs, whorehouses, and hospitals. In the early days, the population consisted mainly of company workers and the occasional transient ship crew waiting for their hauler to be loaded with aluminum or oxygen. Over time, these residents have attracted a population of bar and restaurant owners, pawnbrokers, cyberdoll prostitutes, and other service personnel. As Tranquility Spaceport has grown larger, more and more people come through the city – and some end up staying, for one reason or another. Helium City is CR 1.

Port Tranquility

Port Tranquility is one of the largest and busiest spaceports in the solar system, rivaling Cape Canaveral or Sriharikota on Earth, or Taiko Station in orbit. The industrial port can handle almost a hundred heavy haulers and has dozens of small spacecraft cradles. Hoppers and OTVs shuttle between Port Diana and Port Tranquility around the clock, and vehicle traffic into and out of the port is constant. Small companies too poor to build their own docks rent or lease cradle space from larger companies – or build their docks farther from the manufacturing center, which increases the costs of shipping.

Tranquility is operated by the Luna Port Authority, a multinational corporation whose major partners are System Technologies, Vosper-Babbage, and Tenzan Heavy Industries.

Adjacent to Port Tranquility is a small military base garrisoned by the Japanese Combined Lunar Force.

It is a large spaceport, and CR 2.

TYCHO SPACEPORT AND PROVING GROUND

Located in rugged terrain in and around Tycho Crater, this European Union military base is used primarily for cybershell tests and large-scale live-fire combat exercises.

The base has a civilian population of about 700 humans and parahumans, mostly working for military contractors such as Vosper-Babbage. It is also home to the E.U.'s STANEXFORCISLUN (see p. 72). It is CR 5, with a small spaceport inside the crater.

MARE FRIGORIS INDUSTRIAL ZONE

This He-3 mining facility is located on a mare/highland coastal region about 600 miles from the North Pole. The facility is relatively new and is operated by Alliance Volatiles (p. 61). The mining facility is officially considered Australian territory.

“The Combs” is a nearby lava tube complex with a population of 700 people, plus numerous AIs. The complex is expected to expand into a significant manufacturing center over the next few years. The complex has a small spaceport and is CR 2.

NECTARIS Mining Complex-1

NMC-1 is a collection of habitat lava tubes, landing pads, and surface He-3 mines sprawling over a few hundred square miles of the Mare Nectaris region, along the mare/highland coastal strip, some 1,200 miles from the North Pole.

The Nectaris Mining Complex is China's major Lunar He-3 mining station, with a population of 700 people (80% of them bioroids). Work began on it in 2069, but the facility has been plagued with a string of management problems, technical errors, and industrial accidents, among them poorly built breakdown-prone mining cybershells, a bribery scandal involving the chief executive, and the tragic collapse of a lava tube habitat that killed some 60 engineers. In the 2080s, with NMC-1 utterly failing to make production quotas, China was left with a serious He-3 shortfall and was forced to buy from European and American sources . . . leaving it vulnerable to embargo.

Some problems were fixed following the Pacific War, and NMC-1 is operational again, but China and Xiao Chu now see power production on Mercury and He-3 mining of Uranus as more profitable, and NMC-1 is not getting the funding it needs. Morale is low at the station, work hours are long as personnel are not being replaced, and the accident rate remains high. Worse, some of the current administration is in bed with the Martian Triads. They have taken to selling some of the bioroid workers to “snakehead” recruiters that promise them better lives elsewhere in the solar system in return for extra indenture time, and using the money to fund expensive “vacations” at Moonshadow. However, Xiao Chu is not unaware of these problems, and is sending in a new administrator to clean house . . . if the Triads don't get her first.

NMC-1 is a CR 3 facility with its own small spaceport facility.

THE DREAMING CITY

There's nothing like basking in the rain of natural universal energies! The bright flashes of cosmic rays impacting on my retina remind me of the immensity of god's realm, and the insignificance we represent compared to the life and death of stars.

— Syndi Brooks, *The Posthuman Always Knocks Twice* (Dreaming City, 2099)

The newest habitat on Luna represents a reaction to the womb-like protectiveness of Luna City or the underground burrows of Malapert Mountain and the tube habitats.

Located in the Lacus Somniorum (“Lake of Dreams”) mare region on the northeast edge of the Mare Serenitatis, this is an architectural marvel: a lovely ethereal city standing naked beneath the stars. Most of it is built of gleaming aluminum and glass composites, light and airy, with thin towers reaching into the lunar sky, soaring arches, and an enormous central dome.

The Dreaming City makes almost no concessions toward radiation protection (except for a half-dozen emergency storm shelters buried under the station, for use by tourists in case of a major solar flare); moreover, much of it is unpressurized and open to vacuum. Its architects defend this decision: anti-radiation nano has been available for two decades, and moreover, a majority of Luna’s population are cybershells. Why should the cities on the moon suffer the aesthetic restrictions imposed by mere human flesh?

This call has resonated among some Fifth Wave youth, who have rushed to purchase condominiums and property here. With no industrial capacity beyond a few minifac shops, the Dreaming City is primarily an artist’s and tourist’s community: a city of poets, writers, sculptors, philosophers, and sycophants. There are few permanent residents, but it’s become a status symbol for Islandian, Seventh Heaven (p. 134), and Luna City residents to have a second home here. Two-thirds of the 1,700 occupants that are here at any given time are cybershells of various sorts; most of the rest of the population are humans and parahumans availing themselves of cell-regeneration nano.

The Dreaming City is CR 2, and operates under Luna City jurisdiction. There is no spaceport, but a spur of the mag-lev line connects it to other lunar settlements.

COSMAC

Thanks to Luna’s excellent hard vacuum, it’s easier to build particle accelerators on the moon than on Earth or in Earth orbit. There are several particle accelerator research facilities on Luna; one of the largest is the Copernicus Superconducting Macro-Particle Accelerator (COSMAC), built in and under Copernicus crater on near side. Funded primarily by the European Union but with broad multinational participation, COSMAC first

became operational in 2060, and has been continually added to ever since.

Today the 150-billion-euro complex is one of the solar system’s major particle physics laboratories, probing the mysteries of creation and the Big Bang by smashing beams of relativistic particles together and measuring the results. At one point COSMAC was used for antimatter manufacture, but this has since been taken over by dedicated factories on Mercury; at present, its role is ostensibly pure science. During the early 2060s, COSMAC was one of the facilities involved in testing the grand unified field theory of Dr. Arifa Ali.

COSMAC’s most powerful instrument is a 57-mile diameter circular proton-antiproton super-collider that runs the entire circumference of Copernicus’ crater rim, but the installation also includes a wide variety of other circular and linear accelerators, all powered by a 1.5-gigawatt fusion reactor. The installation is almost entirely automated – there is no human presence at the base, although several hundred AIs and numerous cybershells (often teleoperated) are present, including some security RATS. It’s CR 4.

Vacuum Pollution?

The quality of the lunar vacuum has degraded somewhat over the last few decades due to industrial processes. As a result, while building accelerators like COSMAC on Luna is still easier than doing so on Earth (there’s more land area and you need smaller vacuum pumps), it’s not the pristine environment it was. This has required some upgrades to COSMAC’s vacuum pumps, and led particle physicists to dream of newer, and bigger, accelerators elsewhere in the solar system. Exogenesis Station on Vesta and the ongoing Arges project in Jupiter orbit are examples of such remote high-energy facilities.

BALATRONIA

This lunar base is owned by Balatron, a wealthy British SAI who made its fortune in He-3 and antimatter commodities trading, and who also sits on the board of Vosper-Babbage. The habitat is a large castle-like mansion located inside a lava tube on the edge of the near side Mare Cognitum.

Balatron is a leading digital supremacist philosopher, although many people don’t take it very seriously. The SAI resides in a mainframe, but also owns a bush robot vessel. It has several bioshell and tech-spider servants controlled by LAIs.

The interior of Balatronia is furnished in 19th-century Victorian style, but with a confusing low-gee architecture reminiscent of an Escher print. Balatron is an aficionado of 16th- to 19th-century clockwork toys, and has many agents scouring Earth and the Web in search of additions to its sizable collection.

A party is always happening at the station, which has a floating population of transhumanist sycophants, ghosts, journalists, and others who discuss Balatron's views and plans for the coming machine singularity. There is a firm "no biological sapients" rule, save for bioshells or those with sapient virtual interfaces.

In recent weeks, Balatron has been more serious and more distracted than usual, and has often been observed in private conference with a couple of newly-arrived digital intelligences whose identities remain mysterious. There is speculation that they might be former Exogenesis SAIs and ghosts, possibly with connections to the enigmatic "terrorist" group AXON battling Nanodynamics in the outer solar system.

Balatronia has a population of about 100 cybershells and bioshells housing sapient AIs. Balatron is a British citizen and the station is U.K. territory.

SUNFLOWER

Sunflower is another of Biotech Euphrates' experimental "living complexes." It is located in the southern region of Sinus Medii, near Oppolzer crater at the center of nearside. The facility houses some 700 people in an underground facility. The complex is actually a joint venture between SpaTek and Biotech Euphrates, and is a high-rent "gated community" for upper-level employees of lunar corporations.

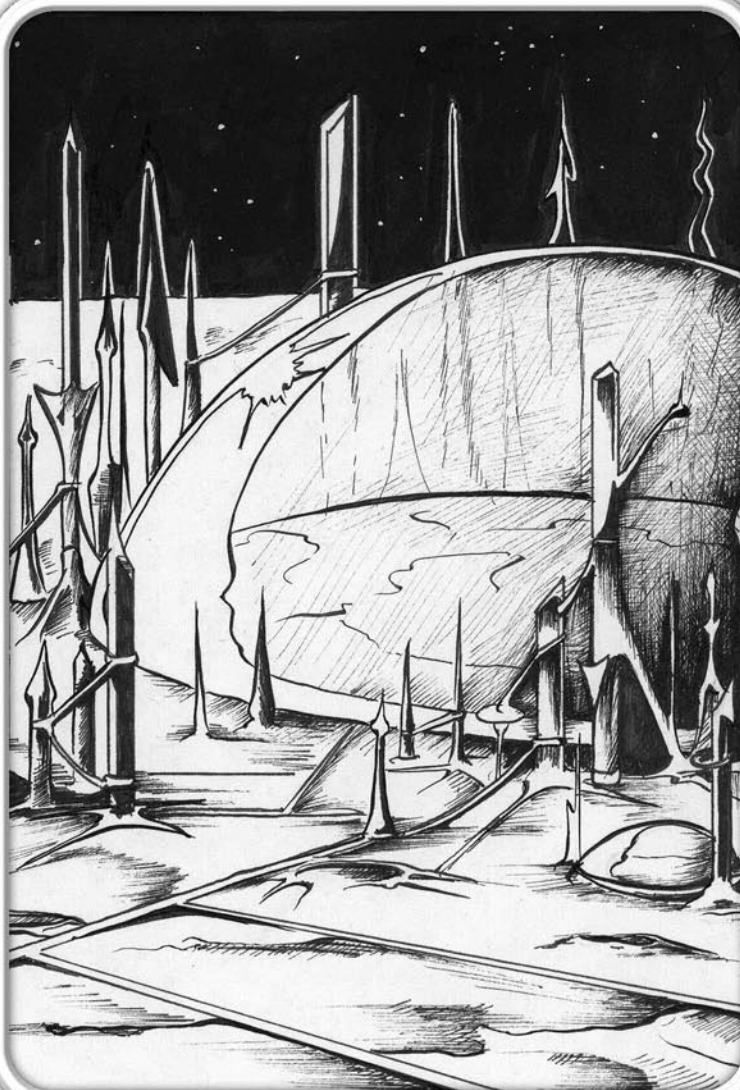
The first thing a visitor will notice is the array of organic solar collectors. Stretching out across the lunar surface from Sunflower is a vast network of leaf-like structures that covers an area of approximately four square miles.

The individual leaves are thin, flat, circular, and between 0.1-2 yards in diameter. They are black on the top and pale silvery white underneath. During the bright lunar day, they lie flat on the lunar surface creating the chemical energy that powers this great metropolis. However, as soon as the two-week lunar night falls, every leaf rolls up into a narrow silvery-white cylinder to minimize heat loss. During the day, the complex appears to be surrounded by a lake of darkness, while at night it seems to be at the center of a huge silver spider web. Sunflower is CR 4.

LUNAR SETTLEMENTS: NORTH POLE

The topography of the north pole is relatively flat, but there are still many small craters. One of the largest is Plaskett (113 miles from the pole). Another significant feature is an old, shallow, and heavily-eroded impact basin, Sylvester-Nansen (250 miles across).

The near-perpendicular orientation of Luna's rotation axis to its orbital plane means that the light conditions at the poles are heavily dependent on their topography. While the more rugged south pole has more shadowed and sunlit regions due to its high mountains and deep craters, the flatter north is in more of a state of continual twilight.



Moonshadow

Moonshadow is a dedicated resort town on the north pole, home to about 5,500 permanent residents – most of whom are employees of SpaTek Corporation. The settlement is buried under 10 feet of lunar regolith, but careful engineering makes it seem as if Moonshadow is a gigantic oasis miraculously blooming on the barren lunar soil. The chameleon walls of the settlement are programmed with seamless imagery of the lunar surface (minus the unappealing ice processors and trash that litter the actual surface above Moonshadow), mimicking the lunar day/night cycle and the beautiful, if artificial, rising and setting of the Earth.

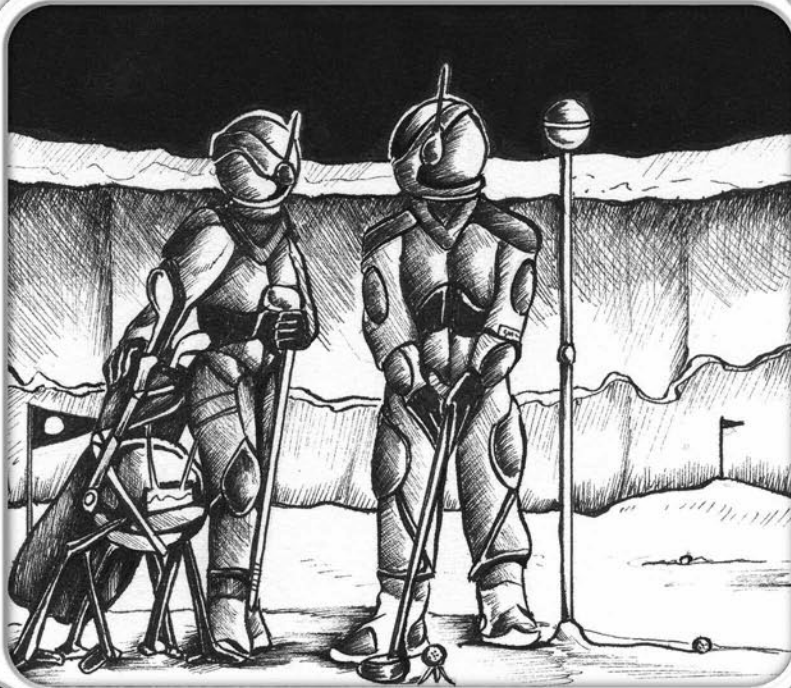
Inside, the hallways and caverns of Moonshadow are landscaped with genetically-modified plants and animals to resemble a fertile, but exotic, parkland. The animals are albinos, and most of the plants and flowers are white, or luminous, or both. There are flowers and even fruit trees inside personal residences – Lunar trees are particularly spectacular since the low gravity gives them a tall, slender, almost ethereal appearance.

Large fireflies blink among the slender dogwoods and white rhododendrons bred especially for the resort. Streams chatter near paths of white sand, alive with glowing fish and iridescent freshwater crayfish. All of the larger animals, such as the white deer and the albino birds-of-paradise, have been altered to possess calm temperaments, and are tame and friendly.

The center of the resort is Diana's Crescent, a simulated "city center" of cafes, small shops, a live theatre, art galleries, and a music hall. There are performances at all hours, with both family and adult themes. SpaTek has a small army of talent scouts and theatrical agents who search out the most unusual (but tasteful) emerging artists and performers.

One of the amenities that Moonshadow provides is personal, living service. The actors in the theaters are real, as are the musicians, the escorts, and the friendly staff serving meals and cleaning cabins. Much of the staff has been modified to have a pale, non-offensive prettiness, but no one employed in the resort can have inhuman looking modifications.

Not far from Diana's Crescent is the SpaTek health resort. This complex, carefully engineered to create a soothing and relaxed environment, is the heart of the Moonshadow experience. Here guests are pampered, comforted, rejuvenated and, if necessary, healed. All forms of treatment can be found here, from the latest nanotechnology to traditional Chinese remedies. Moonshadow is



justly famous for the luxurious playground it has created but it is also, arguably, the best hospital and medical facility in the inner system. Rejuvenation therapies are available for the elderly wealthy who vacation here, and some spectacular biomods have emerged from the SpaTek laboratories. SpaTek pays high wages to attract the best researchers and scientists to keep the resort at the cutting edge of legal medical technology.

Behind the scenes in Moonshadow, a good-sized army of employees keeps the resort running, ensuring that each and every guest has the best experience money can buy. The habitat is CR 5.

The Guests

Guests of Moonshadow usually book for at least a week, and often a couple of months, as visits are usually combined with therapy of some sort. Excluding such treatment, a stay at Moonshadow averages about \$2,400 per day.

Moonshadow's popularity and reputation means it plays host to famous Slinky actors, corporate executives, brilliant scientists, and leading politicians . . . as well as less savory individuals. Security is tight, and except for the company's own security, no weapons of any kind are permitted in Moonshadow.

Of the permanent residents in Moonshadow, most are employees who work in the Square or the resort, but there are some permanent guests. The resort's high cost means that few lunar natives can afford to visit. However, Moonshadow makes an effort to hire at least 40% of its human staff from Luna City and other communities on the moon.

Shepard Golf Course

One of the attractions of Moonshadow is the 1/6 G golf course. It was designed by the brilliant Junichiro Tanaka shortly before his assassination, and assisted by an eidolon of the late Harry Colt. The vacuum course (which requires wearing a vacc suit: no cybershells are permitted, except as the ever-present caddies) was once considered a gimmick. However, it is now recognized as an architectural triumph, and one of the most subtle and starkly beautiful in the solar system, while Hole 17, “over the horizon,” should not be missed. In 2009, Shepard was rated #5 on Golf Web Europa’s “System’s Greatest” list just behind Pine Valley and St. Andrews (Restored). The lunar course also offers one of the longest holes in the solar system, and it requires a supreme degree of skill.

LUNAR SETTLEMENTS: FAR SIDE

The lunar farside is more rugged than nearside, and is dominated by heavily cratered highlands. There are only a few minor maria: Mare Moscovense, Mare Ingeni, Mare Orientale and Mare Australe. However, prospecting has shown these mare are relatively rich in solar volatiles, and there is growing pressure to begin He-3 mining there.

Tsiolkovsky Farside Observatory

In 2022, the European Union and Japan decided to embark on what may have been the most significant science project of the century. Taking advantage of the growing space launch infrastructure, they decided to return to the moon, with the goal of creating the ultimate astronomical observatory.

Throughout the 2020s and 2030s, they erected an array of optical, radio, and infrared telescopes on the lunar farside that eventually formed a distributed network some 1,100 miles in diameter.

The control and service center is located at Tsiolkovsky Base, but the actual telescopes are spread over a far larger area.

The simply-named Lunar Optical Array (“LOA”) gets most of the press thanks to the amazing images it produces, but of even greater scientific importance is the vast “Bruno” radio telescope array now being used to make observations of the large-scale structure and arrangement of all detectable galaxies, as well as taking part in the renewed SETI effort.

Farside’s total isolation from all earth-based electromagnetic interference is a significant element in its

success. To maintain it, the European Union and Japan have negotiated international agreements that place the far side of Luna off limits to settlement, and which restrict radio transmissions by anyone or anything on or in orbit over farside. This restriction has been disputed in recent years as Luna has become more industrialized and settled, but for the moment at least, it remains in place. The major European and Japanese space industry companies that might otherwise lobby for farside expansion have regularly (and conveniently) received contracts to install new astronomical systems . . .

Today, the Farside Observatory is one of the three most important observatories in the solar system. Its optical capabilities are staggering. It can produce detailed maps of planets orbiting stars out to a distance of more than 100 light years. It has penetrated back into the farthest reaches of time, unlocking the origins of the universe itself. Cosmological observations from the Farside Observatory were instrumental in the development of Arifa Ali’s Grand Unified Theory (in 2059), which remains the basis of modern physics.

THE QUIET SIDE OF THE MOON

The electromagnetic isolation on farside has made the region attractive to individuals and groups who desire privacy and secrecy. Several small settlements have been founded by would-be lunar hermits. As long as they follow regulations and avoid either seismic or radio disturbances, the farside isolates are largely ignored by the rest of Luna society.

There are also rumors that a few corporate, military, or government bases have been established on farside – possibly European Union or Japanese research stations or intelligence facilities. These rumors have not been confirmed.

Tsiolkovsky is home to the only LRF team based on the Lunar farside. Three times in the past decade, serious accidents at isolated communities have resulted in calls for help to the LRF team stationed there. There is also a persistent rumor that the team has been called out to provide assistance to secret government or military installations. If true, it’s possible that LRF team members may be approached by foreign agents to learn what they discovered – or perhaps to install a sleeper agent (or implant) that would help them gather intelligence in the event of another such incident.

Why Do Astronomy on the Moon?

The lunar farside is an ideal location for astronomy. Luna has no atmosphere to interfere with optical observations, and its lack of geological activity makes it an incredibly stable platform for mounting telescopes, especially linked together into large arrays. The two-week-long lunar night is another advantage – it gives a telescope 28 times as much time to gather light from a distant object than a telescope would have on Earth, and much more time than one would have in Earth orbit. The lunar farside also offers an excellent location for a radio telescope array, as it is shielded from the radio noise of Earth's civilization.

Current Projects

Tsiolkovsky Farside Observatory has been instrumental in discovering 23 habitable planets (the closest of them are dozens of light years away, however). It has also produced detailed maps of Virginia, the nearest life-bearing extrasolar planet so far discovered.

The observatory devotes some resources to an ongoing Search For Extraterrestrial Intelligence (SETI) program, scanning numerous frequencies in the hope of discovering alien signals. In addition to hunting for radio signals, the SETI program also looks for optical, infrared, and radiation signatures that might be associated with propulsion systems, e.g., fusion or antimatter drives. So far, there have been no unambiguous signs of extraterrestrial intelligence, although a few anomalies have defied explanation and raised hopes.

The observatory is continually being upgraded. Its Long Term Gravitation Study (LTGS) is one of the major new programs to come under its auspices. In 2097, work was completed on the Lunar portion of the long baseline gravity wave detector; the second detector element, buried deep inside the asteroid Vesta, was completed in 2098.

Until recent events at Exogenesis disrupted the project, LTGS was creating the first detailed gravitational map of the galaxy. Not only have astronomers engaged in the LTGS succeeded in making highly accurate measurements of the mass of the giant black hole at the center of the Milky Way galaxy, they have also mapped the motions and positions of many of the stars closest to the black hole, and have observed one star actually being sucked into it. On a more local scale, LGTS has discovered thousands of previously unknown brown dwarf objects, as well as several large transient gravitational anomalies that have defied explanation.

Tsiolkovsky Base

Located in the 70-mile-wide mare-filled Tsiolkovsky Crater on farside, this underground warren is the remote control and service center for the Farside Observatory, and Luna's oldest permanent settlement. It is located at

some distance from the actual telescope arrays, to minimize the possibility of electromagnetic interference with the radio telescopes.

The base has a population of 900 humans and parahumans (and 1,100 SAIs), most of them scientists and technicians. Researchers from all over the solar system fight for access to Tsiolkovsky's instruments. A third of the population is long-term residents; the rest are graduate and postdoctoral students or visiting faculty who stay for a few months.

Except for technicians and other support personnel, almost everyone in the colony is a member of the observatory staff. However, tourists are allowed. Visitors can take virtual tours of the station, led by students and some of the station's older SAIs. However, every year a few hundred people physically visit the observatory. It offers week-long classes for interested lay people, as well as lengthy and detailed tours of its facilities, and a chance for wealthier visitors to give a distant star a name of their choosing.

Daedalus Farside Radio Telescope

More commonly known as "Bruno" (both for its size and the nickname of its first administrator), this network of phased-array radio telescopes is the "ears" of the Farside Observatory. It is located inside the 60-mile-diameter Daedalus Crater on farside, at the antipode (direct opposite point) from Earth, where electromagnetic "pollution" is minimized from Earth, Earth orbit, and the many stations and colonies in L4 and L5.

Time Capsules

As Luna lacks both an atmosphere and water, its surface does not suffer chemical weathering. Underground, in rilles shielded from the rain of micro-meteors, rocks over four billion years old still remain intact. Their study yields planetological information about the early history of the solar system. Lava tubes have also been used as time capsules, since they are cool, climate-free, and geologically stable. Items stored in them might remain undisturbed for a hundred million years or more, unless an asteroid happens to hit near the tube. In fact, some organizations actually think that visiting extraterrestrials might have left messages on the moon, buried deep in some lunar cave, and a few amateur "alien contact" devotees actually spend time looking for them . . .

MILITARY FORCES on Luna

By tacit international agreement, the surface of Luna has remained largely free of national military forces. However, both the E.U. and Pacific Rim Alliance – with large populations and extensive infrastructure on the moon – maintain small forces on Luna.

LSDI

This organization – originally the Lunar Space Defense Initiative – was founded to provide anti-meteoroid defense for Luna. Its surface and space-based sensors track meteors and space junk that may impact the moon, and provide warning, and where necessary, the interception of any objects with a trajectory that threatens subscribing Lunar settlements.

During the orbital tensions of the early 2080s, the LSDI quietly became more professional – and paramilitary – in training and organization, hiring several ex-ESCA and Japanese Space Self-Defense Force officers as cadre, running regular space-defense drills, and acquiring a battery of laser cannon. This preparedness paid off in 2084, when orbital fighting between China and the TSA spilled into trans-Lunar space. LSDI tracked several errant railgun projectiles that might have otherwise posed a threat to Luna City, and its tracking ladars illuminated Chinese and TSA combatants that were approaching a declared “no fly” neutral zone around Luna settlements.

LSDI is funded by subscriptions from corporations and insurance companies on Luna. It has a small full-time staff of about 100 humans and sapient digital intelligences who maintain its systems; the rest of its personnel are part-time, but can be called up in the event of an emergency.

JSDF Lunar Composite Force

During the run up to the Pacific War, the Japanese government grew afraid that Chinese or TSA forces might land on Luna and attempt to seize stockpiles of He-3 and pulsedrive fuel pellets. With the permission of Tenzan Heavy Industries and the cooperation of LSDI, the Japanese Self Defense Force (JSDF) deployed a squadron of spacecraft to Luna orbit (backing up a couple of German vessels that were already there), and landed a battalion-sized task force of combat cybershells and engineers to defend Port Tranquility and the Industrial Zone – the first large-scale troop deployment on Luna.

In fact, no Chinese or TSA invasion took place. The only fighting involving JSDF troops was a brawl at a Helium City dive between a group of Ground Self

Defense Force ghost troopers and a rowdy group of System Technologies engineers. The operation might have been regarded as an expensive waste of resources, except that in 2085, just before the troops could be sent home, a disaster struck Shackleton Station. JSDF combat engineers deployed to the disaster site, and proved invaluable in rescuing trapped and injured civilians. After this performance, the Japanese government decided it was in their best interests to maintain a small force on Luna, both to assist corporate and volunteer organizations in event of emergencies and to protect Japanese and allied interests.

Since Shackleton, the JSDF force has seen action only once: in 2094, when an emergent intelligence manifested at a Tenzan Heavy Industries mining camp. JSDF troops stormed the facility, defeated a number of teleoperated mining machines the EI was controlling, and rescued six trapped human and bioroid engineers that were being held hostage, one of whom the EI had apparently fallen in love with and wished to marry. The EI's appearance was traced to a virus spread by an agent of a European infosocialist terrorist cell, who unfortunately escaped before she could be arrested.

In 2085, just before the troops could be sent home, a disaster struck Shackleton Station. JSDF combat engineers deployed to the disaster site, and proved invaluable in rescuing trapped and injured civilians.

Japan's lunar force consists of a squadron of Space Self Defense Force craft (usually one SDV and several smaller vessels) in Lunar space plus a company of Ground Self-Defense Force troops (mainly cybershells) that are based at Tranquility Proving Ground. The present force is optimized for counter-terrorist, combat engineering, and emergency-rescue operations. In addition, a small number of other Pacific Rim Alliance and New Zealand troops also rotate through, often getting plenty of hostile-environment training. A platoon-sized unit of Australian SAS commandos is presently stationed there, where it provides useful backup to the JSDF in its counter-terrorist role.

Standing Extraterrestrial Force Cis-Lunar (STANEXFORCISLUN)

This unified European Union military command consists of a mix of space and ground forces that operate in cis-Lunar space, i.e., Luna, Earth Orbit, and the surrounding Lagrange points.

On Luna itself, STANEXFORCISLUN usually has an SDV or two in orbit, as well as a ground contingent consisting of a company each of French Foreign Legionaries and German Army commandos. They spend most of their time engaged in counter-terrorist and hostile environment training, while keeping a wary eye on the JSDF troops at Tranquility, who, while ostensible partners, are still part of a rival power bloc.

PORT DIANA IN UPROAR OVER SPIN GRAVITY PROPOSAL

Port Diana, Luna Orbit – After 34 years as a microgravity environment, the lunar space station Port Diana is reeling by a proposal from a Tenzan Heavy Industries vice-president that the station would be better off spinning at a simulated 0.6 G.

“The station was originally designed to withstand spin forces,” Tenzan’s Hoshi Makami said. “We’d save on zero-G nano, and the port would offer a better transition for Earth-Luna passengers.”

But Port Diana residents and frequent visitors are not so happy. “Sure it was designed for spin,” Station Engineer Alfred Manson said. “But that was a long time ago. They better test this baby thoroughly before they fire ‘er up.”

System Technologies cargo agent Khalid Andrews is a local who doesn’t think it’s a very good idea. “I spend as much time here on Diana as I can, because it’s so much fun. If you introduce gravity, you lose everything that makes it special. She’ll be just another truck stop in space.”

A Tenzan spokesman said that no decision had been made yet, nor was one expected this year.

—Teralogos News, June 19, 2101

LUNAR ORBIT

Lunar orbit is less crowded than Earth orbit, but there are still several hundred satellites and small stations circling the moon. Satellites include a Lunar Positioning Satellite navigation network, numerous radio and microwave communication satellites and relays, and quite a few corporate and military remote sensing and imaging satellites used for surveying and surveillance.

The restriction on farside radio pollution means that satellites passing over the farside are required to shut down electronic emissions (or communicate only by laser). While all satellites passing over the farside are capable of sending and receiving radio signals, communicating with them in this fashion results in a \$2,500/minute fine levied by the consortium of nations responsible for funding the Farside Observatory. The only exception to this rule is during an actual emergency. In such cases, the LRF notifies the observatory and all satellites over the farside begin normal radio broadcasts.

PORT DIANA

Port Diana is the largest inhabited station in lunar orbit. It is used by low-acceleration vessels that cannot land safely on Luna, as well as large vessels that want to drop all their Luna-bound passengers and cargo in one place. Port Diana practices electronic emission control when its orbit carries it over the Lunar farside.

Port Diana has a 240’ diameter spherical hull and has docking space for up to 5 large vessels, as well as hangers for up to 5 *Kagoshima* OTVs and 5 lunar hoppers. It carries enough metal-oxygen fuel to refuel up to 10 lunar hoppers for their journey back to the surface.

Port Diana has a permanent staff of 50 people, but can handle the arrival of up to five of the largest deep space vessels and house up to 1,200 temporary residents.

For both the comfort of microgravity-adapted visitors, and to improve docking safety, Port Diana is a non-rotating station. Some lunar residents come to Port Diana for zero-gravity vacations.

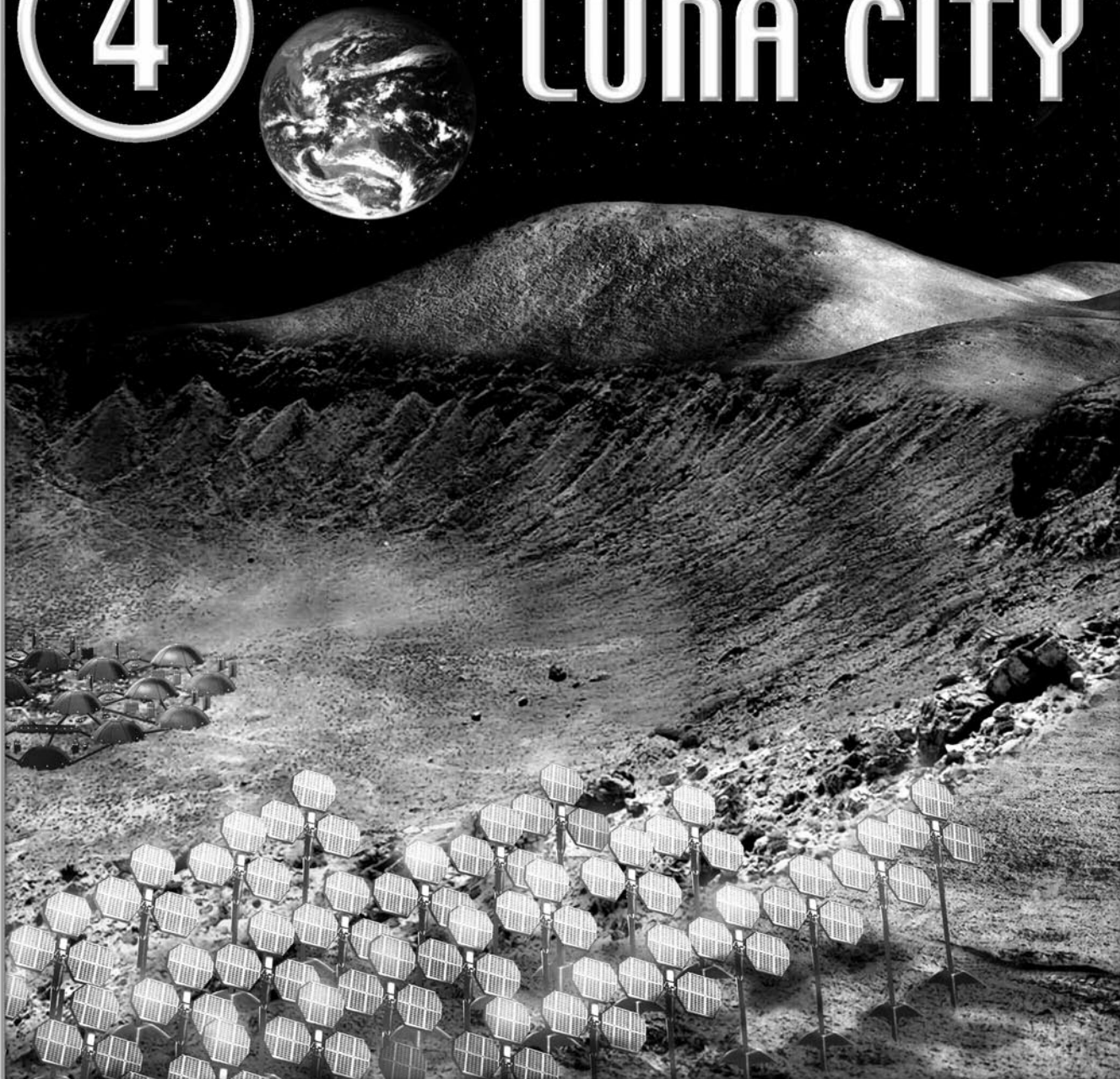
Port Diana’s small fleet of OTVs and lunar hoppers can rapidly ferry cargo and passengers to and from the surface.

The station was built in 2067 as a joint venture of Tenzan Heavy Industries and Vosper-Babbage. Most large vessels from the rest of the solar system and the Lagrange colonies dock here.

The station is a small spaceport, and is CR 3.

4

LUNA CITY



They say you can't come home again. The Luna City my parents lived and died in no longer exists. It's been eaten alive, transformed into the system's first vacuum-dwelling bio-arcology, some 12 square kilometers of living machinery. I was afraid returning to Luna City would be like visiting a graveyard. Wrong. It's like returning to the womb.

I'm sure it's deliberate – the product of Biotech Euphrates memetics engineers, intended to soothe the trauma of the worst extraterrestrial disaster humanity has endured. But sometimes all the warm pink walls are a bit overwhelming. True, the floor grass is better than

most carpets, but branches growing out of your wall is pretty odd, even if the fruit is wonderful.

Some of the rabbits who live here are . . . a little strange. I'm not sure if it's a reaction to the quake or something else, but they talk constantly about their "reality games," which can get tedious real fast if you're not plugged in. Hey, give it a try – you might like being a secret member of the Galilean Illuminati cabal for a change. And remember to ask a friend to take you out to the old city – it's a great place to tell ghost stories. Or meet ghosts.

*– Copernicus Jones,
Lonely System Guide to Luna*

Luna City is the moon's largest settlement. It is a free city located on and under the rim of Shackleton Crater (p. 62) on the lunar South Pole, in a location blessed with major ice deposits and abundant solar energy.

Luna City Data

Location: Shackleton Crater.

Population: 290,000.

Spaceport: Large.

Average Wealth: Wealthy.

Control Rating: 3.

HISTORY OF LUNA CITY

In 2011, probes confirmed the existence of substantial ice deposits in several deep craters located at Luna's poles. One of the largest was in Shackleton Crater, near the lunar south pole. In 2031, the Lunar Consortium, a group of far-sighted European and Japanese space development corporations and their government sponsors, began building an ice-mining station there. Its mission was to supply volatiles to other lunar and orbital stations such as the Farside Observatory, and to support industrial projects in the lunar highlands.

In the late 2040s, the development of He-3 mining on Luna saw Shackleton Station become the major agricultural producer for the lunar consortium, growing food for both humans on the ground, and, increasingly, exporting it to the construction shacks in L4 and L5.

Fed by He-3, Shackleton experienced steady growth, not only as a mining center, but also increasingly as a community for people who lived and worked on the moon. The first baby was born in 2037. Throughout the 2040s and 2050s, Luna City and its neighborhood grew steadily.

A dispute between Japan and the European Union over ice mining tariffs was resolved by declaring Shackleton Station a duty-free port and "free city" in 2068, as part of a reciprocal agreement that also encompassed the newly-constructed Islandia colony. Under the agreement, Shackleton became a self-governing community, although in practice it remained a pawn of the lunar consortium.

Nevertheless, the arrangement attracted additional investment, notably by genetic engineering giant Biotech Euphrates, who in 2071 established a major branch office in Luna City. The population further increased through the 2070s, partly thanks to large-scale manufacture of bioroids, which at the time were regarded as little more than sapient robots. This brought additional construction to the city. Unfortunately, things moved too quickly.

On March 29, 2085, stresses from one of many construction projects caused a serious crack in the Papillion dome. The sensors that should have detected the

problem, for unknown reasons, did not. The crack weakened the dome to the point where internal air pressure caused the entire dome to explode – right in the middle of a shift change. The explosive depressurization caused severe damage to four nearby tunnel complexes. In the ensuing panic, several safety doors were pried open, further spreading the destruction and pressure loss. The explosion and the depressurization destroyed more than 10% of Luna City. Hundreds of people were killed or injured, and the city had to be evacuated.

Damage was extensive, but the lunar combines were determined to repair the city. Several contractors were invited to submit proposals. The winner was Biotech Euphrates, which proposed to use its revolutionary bio-city technology, which had already been successfully deployed in India. While this had never been used in vacuum before, Biotech Euphrates believed that the location – next to abundant ice deposits and year-round solar power – would be a showcase for the new technology. In the first quarter of 2086, the deal was signed and Biotech Euphrates went to work. A new Luna City began to sprout from the ruins of Shackleton.

Over the course of the next several years, the "bio-arcology" grew in size and complexity. As the city expanded to encompass over half of the old Shackleton City, residents began to return. By 2092, the living city covered 70% of the old city. Since then the initial growth spurt has slowed, but the city continues to slowly expand to keep pace with commercial development and population increases.

VISITING LUNA CITY

Visitors usually reach Luna City from the mag-lev rail station, although there are 11 other main access points for vehicle, cybershell, and foot traffic from the surface.

Luna City's close ties to the European Union and Japan mean that visitors from these states and their close allies can enter freely after a brief identity check, followed by a non-invasive scan to see if they are carrying any prohibited technologies or weapons. Other visitors are subject to more rigorous entry controls, but unless evidence of illegal activity is uncovered, customs rarely takes longer than 30 minutes.

Illegal visitors who enter the undocumented sectors face none of these checks, but typically must pay many thousands of dollars or more – and anyone without guards, allies, or other protections may also face robbery or worse at the hands of unscrupulous entry brokers.

PHYSICAL STRUCTURE

Luna City is one of the more unusual urban environments in the solar system. With sufficient access to sunlight and small quantities of water and nutrients, it could theoretically support its inhabitants for thousands of years without maintenance or supplies from outside.

The rim of Shackleton Crater is covered with solar collectors. These large panels are mounted on stalks that swivel to follow the sun over a lunar day.

The city itself is almost invisible from the surface. Except for six transparent observation domes and airlock shafts, it is buried under several yards of lunar soil. The observation domes are self-polarizing, between 5 and 30 yards in diameter. The airlocks are low, rounded structures, with circular doors that open and close in a manner reminiscent of an eyelid. The airlocks resemble well-worn, polished driftwood painted in bright primary colors.

Inside the city, the walls are normally as smooth as finely finished hardwood and vary widely in color. In public areas, the usual color is a pale rust, brown or green, but the walls can turn almost any color or color pattern imaginable. The floor is slightly soft, like a grassy carpet over a wood floor. However, the textures of both the walls and floor can vary from smooth hardness to luxuriously soft fur over a flexible surface like a waterbed.

While most residents use wall-fruit only for snacks, poorer inhabitants can live entirely off the bounty of the city.

Residents can purchase hormone sprays that trigger changes altering the colors and textures of their dwelling. The actual layout of a dwelling can also be changed. Although most public spaces are larger, private rooms can be made no bigger than 2,000 square feet. Individuals can spend several thousand dollars to purchase single-use sprays that allow them to trigger alterations that will add rooms to their home. Both new and existing rooms can be shaped to the resident's taste. In Luna City, purchasing an apartment means either buying one from a resident who is leaving, or purchasing the sprays from the housing office and having the city grow you the desired number of rooms in an available location. Growing a new room takes two to three days, depending upon its size.

The entire city is lit by flat bioluminescent panels that mimic sunlight. At every corner, and at regular

Hidden Wealth

Some of the stories of hidden wealth are true. Many Luna City residents have heard that the head of one of the Martian Triads had been hiding out on Luna City, and that she was killed by rivals shortly before everyone moved to the new city. There are rumors that her wealth has never been recovered and that perhaps the codes to her numbered orbital banks accounts lie somewhere in the rubble of the old city. The key to this fortune has not yet been recovered.

Here's what actually happened: Pei Chen, a deposed Triad boss, fled to Luna City in 2090 and was killed there in 2092. She left the codes to her orbital bank accounts (valued at over 7 million dollars) on a chip imbedded in a small ivory netsuke now hidden in a ventilation duct. Anyone finding these codes will have to face both law enforcement officials eager to confiscate her illegal-gained funds, and the current Triad leaders, who will claim this money for their own.

intervals along the walls, there are small, flat vine-like excrescences bearing small fruit that vary in size from plums and grapefruit. Coded by color, this "wall fruit" has a wide variety of tastes and textures: apples, oranges, fresh-baked bread, and even cooked chicken. All are free for the taking, but residents and visitors must pay a special biomass tax to remove them from Luna City. While most residents use wall-fruit only for snacks, poorer inhabitants can live entirely off the bounty of the city. Recently, the term "remora" has been used for these people, carrying connotations of laziness and uselessness.

The city also provides protrusions and hollows that can serve as benches, tables, chairs, and sleeping pads. Many residents purchase conventional furniture for their dwellings, but most public areas are furnished in integral city-created furniture. The city also provides all plumbing facilities, and individuals can use special hormones to create special fixtures that dispense substances similar to fruit juice, milk, or beer. Growing a new piece of built-in furniture like a fruit juice dispenser, bed, or table can be accomplished in 8-12 hours.

Other than the city's unique structure, life within Luna City is much like life in other prosperous arcologies. The residents live in rooms and commute through spacious corridors. These converge in squares, where people congregate to shop, drink tea in sidewalk cafes, or eat in one of the city's many restaurants. There are public parks, complete with trees and birds bio-engineered with sanitized metabolisms.

THE OLD CITY TODAY

Today, the remains of the Old City surround the living Luna City. The Old City was stripped of valuables and vented to vacuum, and is normally completely empty, except for a small memorial near the original entrance which is devoted to the history and construction of the original Luna City and to the victims of the disaster.

Visiting the Old City carries with it a suggestion of danger. It's a popular destination for young teens who've

passed their vacuum certification and are now able to go out on the surface without an adult. Morbid teens often visit the Papillion Dome (the site of the tragedy) to tell ghost stories, or search through the old ruins for collectible artifacts. There are urban legends of forgotten caches of money, old cybershells, and other valuables, although exploration and pilfering has stripped the old city of everything easy to find.

GOVERNMENT

Luna City has the same stance toward pan-sapient rights as the European Union. Luna City is governed by a mayor; its legislative body is a 20-person city council. Both serve two-year terms of office. The city council is selected randomly (much like jury duty) in a European-style cyberdemocracy process; once in office, they're advised by the city's permanent AI staff (known as the "city managers"). Many issues are decided by petitions and referendums involving all Luna City citizens. The mayor is elected by popular vote, but only members of the last city council are eligible to run. In essence, citizens choose the council member they liked best to serve two more years as mayor.

One of the most important civic obligations is deciding on the structure of the city. Since the entire interior of Luna City can be easily altered, new ideas for "improvements" come up all the time. To keep things from getting too chaotic, the citizens usually vote on such changes. While private dwellings and shops are exempt from changes by anyone other than their residents or owners, all public regions can be altered by popular vote. If someone can get 5% of the city's current population to sign a petition to change a portion of the city, an electronic vote is held. However, the city manager AIs first describe the advantages or problems such changes would cause, and can overrule changes that would threaten the safety or prosperity of the city. Short-term changes in public spaces are far easier to effect. All that is necessary is for more than half of the members of a neighborhood to agree to such a change. Such changes can normally be kept no longer than one week.

Luna City is still expanding, and is gaining enough space to house an additional 2,000 people every year. However, this expansion is not likely to continue indefinitely – too large a population would deplete the city's water ice resources.

The SAIs lay out the initial plans for all new neighborhoods, but citizens can choose between the four or five different options presented to them. Making temporary changes in currently uninhabited sectors only requires an inexpensive permit from the city government. Various recreationists and reality gamers (see below) often use these areas for their more extensive entertainments. Such changes can remain in place until people start to move into the new district.



Economy

Luna City provides many benefits merely as a byproduct of its existence, and so it costs nothing to merely subsist off its natural bounty. However, in addition to selling dwelling-alteration sprays, the government imposes a flat tax (currently 5%) on all goods and services. This tax services the city's debt (primarily to Biotech Euphrates), and pays for various other essential services, such as law enforcement and maintenance of non-biological systems such as safety sensors or auxiliary power systems.

Ice mining remains one of Luna City's major sources of income. Using cybernetic pumps, the city gathers ice from the mining operation on the crater floor, and pumps carefully regulated quantities up for sale and for its own use. Luna City gave 20% of the revenue derived from the sale of this ice to Biotech Euphrates as one of the conditions for building the living city.

Luna City has been a primary transit nexus for Luna since 2067; since its reconstruction as a living city, it has also become an extremely popular destination for wealthy tourists. Today, tourism is one of its more important industries, and visitors can take advantage of well-trained and knowledgeable living, LAI, and SAI guides. The rise in tourism has sparked a rise in gambling, low-gravity sports, and consumption of new intoxicants. As a free city, Luna City permits the sale and use of any intoxicant that does not have immediately lethal or medically irreparable effects.

CULTURE AND SOCIETY

Luna City is an extremely cosmopolitan society. Members of many different cultures, subcultures, and races live side-by-side in relative harmony. The old Shackleton City was a joint Euro-Japanese venture and inhabitants from nations as diverse as Japan, Spain, and Norway all shared its crowded warrens. While Luna City is now far less crowded, the legacy of these early days remains. Japanese VR gaming parlors, French brothels, and Spanish cafes all sit next to each other on the streets of the living city.

Diversity and interaction are encouraged in all neighborhoods. Ever since Luna City was founded, there have been weekly and monthly social gatherings ranging from small "block parties" to festivals celebrating various sporting events, and popular ethnic holidays like Christmas, Bastille Day, or the Japanese Children's Festival. The German pre-Lenten carnival holiday of *Fasching* is particularly popular, and features large parades with humorous and exotic floats. Wearing masks in public is part of the *Fasching* celebration, and during this week-long festival, masked street parties are held throughout Luna City.

Residents of Luna City normally spend a great deal of time with their neighbors. They typically eat more than half of their meals at local restaurants, where neighbors exchange news and gossip. They may be

exceptionally devoted members of various religions, or elective hermaphrodites with no obvious gender, or one of many other non-traditional lifestyle choices, but they are still expected to take part in the local festivals and socialize.

Of course, this sense of community is not without consequences. Failing to participate in the social life of your neighborhood is seen as a personal failing, and people who isolate themselves are regarded with suspicion and distrust. Also, gossip is a constant feature of life in Luna City. The little privacy present here is carefully guarded, since secrets can be very difficult to keep.

Discreet gatherings, whether for illegal commerce, sensitive business deals, or romantic interludes, are as important here as elsewhere, but they are handled somewhat differently. For those who do not wish to meet in virtual reality, many restaurants, bars, and private clubs provide specially designated privacy rooms. Such establishments have a separate section in the back with a dozen or more small, pleasantly furnished rooms. Businesses with privacy rooms make a point of maintaining no sensors other than legally mandated atmosphere and pressure monitors. Also, these rooms are shielded against all transmissions to the outside, and no attendants or other staff members ever enter without permission, except in obvious emergencies. While it may be obvious that someone is going into a privacy room, the lack of sensors and the multiple entrances ensures that no one will know who they are going to see.

The use of privacy rooms works largely because everyone agrees to ignore those who use them. However, anyone who spends too much time alone is regarded as both suspicious and somewhat uncivilized. Watching InVids and other activities that are normally part of someone's "private life" are public activities in Luna City. There are local clubs where the members watch and discuss the news, and bars and cafes where the regulars meet to watch various sports teams or InVid series.

Much of the in-person socializing that makes up the heart of Luna City culture has a practical basis. Luna City is the only large settlement on the moon, and both the Lagrange colonies and Earth are a quarter of a million miles away. Real-time online interaction with anyone off of Luna is distracting due to the 2.5-second lightlag delay. As a result, the citizens of Luna City are somewhat separated from both Earth's billions and the nearly one million Lagrange colony residents. While Luna City has its own Web, it is limited compared to what Earth's can offer. Residents rely on in-person interactions and location-based communities in a way that many inhabitants of Fifth Wave nations regard as both eccentric and archaic.

THE FLYING DOME

Luna City's flying dome is 1,000 feet in diameter. The central 200 feet protrudes above the surface and is transparent, revealing the full glory of space. Here, Luna City's oddest residents, the bat-winged Chiroptians, can fly with ease. While this dome is reserved for their use for six hours every day, the rest of the time it is open to everyone. Every day hundreds of rabbits and visitors strap on lightweight plastic wings and attempt to fly. A number of Chiroptians earn money putting on flying shows and giving flying lessons to non-winged humans. The flying dome is one of Luna City's most popular tourist attractions.

BIOTECH EUPHRATES CHIROPTIAN 93 POINTS

Attribute Modifiers: ST -1 [-10]; DX +1 [10].

Advantages: 3D Spatial Sense [10]; Acute Hearing +2 [4]; Acute Taste and Smell +1 [2]; Claws [15]; Early Maturation [5]; Extended Lifespan [5]; Flight (Winged, -25%; Requires Low Gravity: 0.35 G, -30%; Nuisance Effect: No Fine Manipulators, -30%) [10]; Fur [4]; Immunity to Disease [10]; Longevity [5]; No Degeneration in Zero-G [3]; Oxygen Storage (10 minute duration, -60%) [6]; Prehensile Toes [7]; Radiation Tolerance 3 [7]; Sharp Teeth [5]; Sonar Vision [25]; Ultrahearing [5].

Disadvantages: Fragile [-20]; Skinny [-5]; Unnatural Biochemistry [-5]; Unnatural Feature (bat-like face) [-5].

Features: Due to their hollow bones and slight build, weight is 50% of the norm for their height. Taboo Trait (Genetic Defects).

Date: 2077. **Cost:** \$167,000.

Chiroptian-series parahumans have a number of bat genes spliced into their genotype. They have large, pointed ears, short silky fur, and sharp teeth. Like bats, they have natural sonar, and they can fly by unfolding the large wing membranes on their arms. However, they cannot use their arms for any other purpose while flying.

When Luna City was being constructed, Biotech Euphrates asked for the inclusion of a large dome where its young Chiroptian parahumans could live and fly. Around 1,600 Chiroptians now live in Luna City. Biotech Euphrates is evaluating this genotype for any unforeseen problems, and runs periodic medical checks on all Chiroptian residents. While the Chiroptians were born and raised in a higher gravity to strengthen

their bones, they were all moved here when they were between five and eight years old.

The Chiroptians are a modification of the experimental Camazotz parahumans (p. BIO47). They were originally created amidst predictions that the renewed Mars Terraforming project would give Mars a dense, earthlike atmosphere as early as 2110. In a bold public relations move, Biotech Euphrates decided to create flying parahumans that could inhabit this new world.

Unfortunately, these early predictions proved incorrect. The Chiroptians cannot fly or even live on Mars without additional biomods, and even the most optimistic predictions indicate that it will be more than 50 years before air pressure on Mars will have risen sufficiently high to allow them to soar through the Martian skies. Several geneticists on the Chiroptian design team feared that the terraforming predictions were too optimistic and made certain that the first generation of Chiroptians would be long-lived enough to enjoy life on Mars, even if there were serious delays. Some of these Chiroptians have emigrated to Titan or have found jobs in the larger low-g and zero-g space colonies. However, many remain in Luna City and hope to eventually fulfill their destiny in the skies of Mars.

REALITY GAMES

Lightlag means that the cutting-edge virtuality games available on Earth's Web are less enjoyable for people living in Luna City. So rabbits have developed their own entertainment. Luna City's strong communal atmosphere, combined with the fact that both dwellings and public spaces can be temporarily reshaped, have spawned a form of urban entertainment known as the "reality game." In their most extreme form, these reality games involve reshaping an uninhabited sector of Luna City into a representation of the game's setting. Everyone dresses up in costumes, and a game normally takes place over the course of one to seven days. These games range from elaborate court dramas set in 17th-century France to space adventures set in fictional alien or fantasy worlds.

While reality games set in imaginary places or other times receive the most publicity, games set in the present day, where individuals play themselves, are more popular. In these games, individuals lead their normal lives but

These games range from elaborate court dramas set in 17th-century France to space adventures set in fictional alien or fantasy worlds.

participate in an ongoing story where they are also spies, master criminals, supernatural beings, or the like. Events of the reality games are interwoven with the rest of the individual's life.

Game moderators track the movements and activities of players, participants receive electronic messages at any time, and all events take place in real time. Members meet in each other's homes, or in clubs, or restaurants set up to specifically fit into the ongoing story line. The participants' virtual interfaces provide additional setting details, including various special effects using augmented reality technology. Participants frequently plan missions electronically, meet to discuss and execute their plans in person, and then share their success or failure with other ersatz magicians or secret agents in appropriate settings.

Action sequences usually take place in uninhabited areas specially formatted by the games' moderators, or in participants' homes. Other players normally play a group's primary opponents (e.g., a team playing thieves will be opposed by another team playing law enforcement agents). The games' moderators play minor roles and use infomorphs, cybershells or bioshells to take the part of victims, informants, and other "extras."

Reality games serve as entertaining distractions for people leading otherwise unexceptional lives, as well as providing opportunities for people to meet each other and do things they would otherwise only be able to experience second-hand. If appropriate release forms are signed, the players can even use a limited selection of non-lethal weapons. Only tangles and electrolasers (modified to stun the target for a quarter the normal time) are allowed. However, even this gives the games a high degree of realism. Since bystanders can also be hit with such weapons, participants are expected to post



ILLEGAL HORMONE SPRAYS

Some criminal gangs purchase or manufacture special hormone sprays that can manipulate the city in prohibited ways. These typically cost about \$200 per dose. The most common such spray causes all of a room's exits to seal, trapping the resident inside. Used along with a sensor jamming device, this can let criminals commit crimes with little possibility of intervention. Another illegal spray causes a room or corridor to begin reacting in random and potentially dangerous ways, opening and closing doors, flashing the lights on and off, and randomly changing the texture of the floor and walls. Both of these sprays only operate for 3d minutes before the city overcomes their effect.

There are urban legends of sprays that will cause the city to literally eat someone . . .

both physical and virtual signs around the vicinity of a potential combat area to warn outsiders of the (small) risk. Some non-players enjoy watching the games and are invited by the moderators to take the part of bystanders and civilians.

A quarter of the population of Luna City play reality games occasionally, and 11% are regular players. Participation in reality games can be used to explain all manner of eccentricities. Reality games offer a socially approved escape from convention, and a risk-free chance to experience a secret, exciting, and dangerous existence.

The idea that thieves and terrorists might masquerade as reality game players, or that someone would be recruited into a real conspiracy under the guise of a game, has been used in several InVid and slinky productions. There have been a few actual cases of criminals using reality game membership to gain access to victim's homes and workplaces or perpetrate various cons; most rabbits are aware of the risk, and will exercise appropriate skepticism in any situation that holds the potential for danger.

THE HIDDEN SECTORS

There is not much privacy in Luna City. In the interests of public safety, the city council uses electronic sensors track the movements and activities of people in all public places. Residences are equipped with sensors to detect air pressure and composition, as well as temperature and the presence of biological activity. However, these sensors are not an integral part of the living fabric of the city, so there are a few areas that are beyond their reach.

Using the proper hormone sprays, people can easily create small pockets within the city that are cut off from all normal contact with the rest of the populace. Most such pockets are no larger than a room, but several can be linked together if necessary to form fairly large hideaways. The hormones necessary to create such spaces are supposed to be licensed and controlled, but like everything else, they can be acquired for the right price.

There are almost 1,500 undocumented residents living within hidden sectors of Luna City. Passing into or out of the “legal” regions of the city requires spoofing the city’s security sensors, which can detect both the opening of a portal into the main city and the presence and movements of previously unknown residents. Successfully becoming an undocumented remora involves paying someone for both the correct sprays and the location of one of a few unmonitored tunnels in the old city that leads to the exterior of the living city. Communication with the outside world can be accomplished through these same tunnels, or using another spray to open a new undocumented passage into a contact’s apartment or an unoccupied space.

Most undocumented residents are smugglers and other criminals. Some are fugitives, while others use undocumented regions as a place to safely transfer stolen goods or operate illegal businesses. Some are human or parahuman, but there are also rogue SAIs residing in cybershells or bioshells. The most dangerous is a cell of the Eugenics Liberation Front, who is planning to use their Luna City hideout as a base of operations against Biotech Euphrates and SpaTek corporate targets.

The largest and most prosperous groups of these squatters are the members of the Lynx Crew, a Euro-orbital criminal organization. The Lynx Crew is primarily involved in smuggling luxury goods and illegal profits between Earth and Luna, but they have also been involved in fencing xoxnapped celebrities, illegal brainbugs and the 3D printing of pirated goods. Lynx Crew members living

in the documented areas use small, disposable cybershells equipped with illegal hormones and short range jamming equipment to carry goods directly into the houses of the buyers.

Luna City law enforcement officials are currently attempting to track down the Lynx Crew, but have had little success in locating them. Since the Lynx Crew largely avoids violence, they are popular heroes among some of Luna City’s less prosperous residents. This hampers investigations and makes it easier for law enforcement officers to accept payoffs from them.

LUNA CITY EXTERNAL RELATIONS

As the largest community on the moon, Luna City is connected with most other lunar communities. Luna City residents telecommute (or physically commute) to work in outlying factories and bases, while a weekly visit to Luna City is a welcome diversion for those living in many smaller communities.

Luna City has a close relationship with the European Union and Japan; many Luna City residents originally came from these nations (sometimes by way of orbital stations), and it is common for many residents to hold dual E.U. or Japanese citizenship.

Luna City has considerable commerce with the various Lagrange colonies, and several colonies have been founded or are partially owned by Luna City residents. As the two largest extraterrestrial settlements in Earth-Lunar space, Islandia and Luna City share a special bond. The leadership of both colonies often find themselves working together in commercial and political negotiations. Islandia is a favorite destination for rabbits who want to visit an “Earthlike” environment without the culture shock that visiting Earth itself entails. However, there is also a friendly rivalry

between the two colonies. Both microstates see themselves as the twin capitals of the high frontier, and passions can occasionally run high.

Clarke-1 is another Lagrange colony that Luna City has a close association with. When Clarke-1 first became independent, many Luna City residents donated money and skills to help the Vacs transform their station into a thriving colony. Joseph Rosen has come to speak at Luna City several times to promote his station and raise investment money, and Vacs often visit Luna City for business or pleasure.

Luna City Adventure Seed

Luna City authorities believe that the Lynx Crew has recently acquired a shipment of secret experimental brainbugs (p. TS163). These tailored nanodrugs seem to be a new and powerful euphoric that produces a feeling of intense spiritual bliss, which is what most consumers are buying them for. However, this brainbug also induces a deep hypnotic state where users become extremely suggestible to outside commands.

The authorities are worried that the Lynx Crew will sell this brainbug and use its side effects to “program” citizens to aid their criminal endeavors. Since the Lynx Crew knows the identities and methods of all Luna City law enforcement personnel, the authorities have been forced to recruit outside help: the PCs. They can set them up with false identities as criminals attempting to join the Lynx Crew, or give the PCs the names of a bar (the Gilded Crater) with a series of privacy rooms that are believed to be used for meetings with Lynx Crew contacts, and allow the PCs to pose as buyers of the euphoric.



5

L4: CITIES IN SPACE

"We now have the technological ability to set up large human communities in space – communities in which manufacturing, farming, and all other human activities could be carried out. Substantial benefits, both immediate and long term, can accrue to us from a program of expansion into that new frontier."

*– Gerard K. O'Neill,
The High Frontier, 1976*

Lagrange points are five locations in space where a small body – like a space station – can maintain a stable orbit despite the gravitational influence of two much more massive bodies – like Earth and Luna – that are orbiting a common center of mass. The five Lagrange points in the Earth-Moon system are referred to as L1, L2, L3, L4, and L5. At these points the gravitational pull and orbital forces of the Earth and Luna balance out.

The Lagrange Points: Where Are They?

L1 is located between Luna and the Earth.

L2 is located on the opposite side of Luna from Earth.

L3 is located on the far side of Earth in the direction opposite Luna.

L4 is located 60 degrees ahead of Luna's orbit around the Earth.

L5 is located 60 degrees behind Luna's orbit around the Earth.

Objects orbiting in the L1, L2, or L3 points are “metastable” (like a ball perched atop a hill top). The slightest push, bump, or external influence – including the influence of the sun's gravity – can change their orbit. A station or spacecraft at one of these points will need to regularly burn reaction mass to avoid drifting away.

In contrast, the L4 and L5 points behind and ahead of Luna's orbit are “stable” locations. An object placed in either of these locations will circle the Lagrange point (taking 89 days to make a complete orbit) but not leave it.

This makes L4 and L5 ideal places to put large space colonies, since no station-keeping mechanism is required.

ASTEROID MINES

The first permanent stations placed in L4 were built in 2032, as part of an aggressive program by space development pioneers Tenzan Heavy Industries and Vosper-Babbage to mine metal and volatile-rich near-earth asteroids (bodies whose orbits crossed the path of Earth) in order to gain access to their resources.

The most ambitious element of this plan involved the installation of mass drivers – electromagnetic catapults – on four small NEAs. Using portions of the asteroid's own mass as reaction mass, each of the asteroids (two metallic, one stony-iron and one carbonaceous body) were maneuvered into stable orbits in the L4 and L5 points. These mining stations provided the raw materials that were used to build a wide variety of spacecraft, satellites, and stations in Earth-Lunar space.

The earliest permanent Lagrange habitats were small stations built in, on, and around the asteroid mines, most of them lacking artificial gravity. They were inexpensive and easy to construct, but all

personnel had to be rotated back to Earth every few months to avoid serious health problems. This all changed in the 2050s, as development in L4 continued.

SPACE HABITATS

The asteroid mines proved extremely successful, spawning on-site ore processing plants, manufacturing stations, and spaceyards. As infrastructure grew, other businesses began to move from the increasingly crowded neighborhood of Earth orbit to L4, drawn by the innate advantages of the Lagrange location. As the Lagrange population increased, it became no longer cost-effective to rotate personnel back to Earth. Instead, stations were designed as habitats: company towns with their own agricultural capacity and residential quarters.

The first habitats in L4 were manufacturing stations, but some were intended from the start as communities. The 2060s were a time of social upheaval on Earth: the period of the Majority Cultures Movement and the Transhuman Awakening (p. FW11-13). Many humans felt they no longer fit on an Earth that was changing before their eyes – or not changing swiftly enough. Some left for Mars, a few for other parts of the solar system, but for many visionaries L4 and L5 seemed to beckon as a promised land that was much closer to home – a chance to build a micro-world of their own. These space colonists were not poor huddled masses yearning to be free. Those would come later, and go elsewhere. *These* pioneers came from the wealthiest nations and organizations. Their numbers included religions like the Church of Latter Day Saints, billionaires such as Hiroshi MacLarren, and well-funded commercial ventures like Islandia Corporation.

CITIES IN SPACE

The decision to build the enormous Islandia colony (p. 83) – the ultimate space industrial park and community – in L4 made that region the primary nexus for commercial development in Earth-Lunar space . . . and condemned L5 to ghetto status. From 2057 to 2070, the construction of Islandia employed thousands of zero-gravity construction engineers and tens of thousands of specialized cybershells. While the station itself was fully operational by the mid-2070s, construction continues inside and around it, as dozens of smaller satellite stations and factories are built to support continued growth.

The Pacific War (2084-2085) seemed to prove the wisdom of Islandia's investors. The space fighting mostly took place in Earth orbit, and the damage produced by orbital debris (and the risk of a second conflict at a later date) convinced many businesses to relocate to L4 . . . and Islandia.

The progress of the Olympus Project (p. 23) space elevator has accelerated this trend. Its backers are encouraging emigration to L4 in general and Islandia in particular, both to make room for the elevator and because they expect a flowering of the L4 region to be the natural result of cheaper access to high orbit. The Euro-Japanese-African space conglomerates behind the Olympus Project see Islandia and the space elevator as synergistic: industry moved to Islandia makes room for the space elevator, while the space elevator, when it comes on line, will greatly reduce the cost of transporting products from L4 to Earth (and vice versa), increasing the L4 colony's profitability, and eventually leading to the construction of more Islandia-sized habitats.

DISTANCES FROM L4 AND L5

L4/L5 to Earth or Luna: 240,000 miles (0.0026 AU).
 L4 to L5: 360,000 miles (0.0039 AU).
 L4/L5 to L3: 420,000 miles (0.0045 AU).
 L4/L5 to L2: 270,000 miles (0.0029 AU).
 L4/L5 to L1: 180,000 miles (0.0019 AU).

THE L4 POPULATION

One million people live in Lagrange 4: half in Islandia, the other half in three dozen mid-sized colonies and 100 smaller stations. Most L4 stations were built within 50-500 miles of each other, the entire cluster making a complete dumbbell-shaped orbit around the L4 point every 3 months.

ISLANDIA

"Open skies, clouds, real rain, normal gravity, and all the recreational substances you can afford – what more could you ask for? You have your choice of mild temperate seasons or the perpetual early summer of the tropics, complete with daily rains.

"The folks who built this place were aiming for paradise in space, and they came pretty close. Of course, paradise isn't always cheap. Living space, electricity and similar necessities are all paid for in your taxes, but you buy everything else, and prices can be pretty steep. Whatever can't be built here is imported from Luna or Earth, and "everything the market will bear" is the motto of most retailers here."

– Jessica Chen, from *Visit Space!*
An Unofficial Guide to the Solar System

Islandia is the largest space colony in the solar system – a gigantic twin-cylinder rotating habitat inspired by space visionary Gerard O'Neill's "Island-3" concept. It represents the ultimate expression of the E.U.'s space program. While China and the United States settled and terraformed Mars, the European Union (with substantial assistance from Japanese and Korean partners) *built* a world in space: Islandia, an enormous island in the heavens, the crown jewel of Lagrange 4.

HISTORY

In 2051, the first wave of L4 settlement was well underway. At this time, a coalition of economic interests headed by the E.U.-based System Technologies AG decided to create a large station to serve as a major spaceport and a trade city. Buoyed by the profits from lunar He-3 mining, the consortium received a commitment from 17 major corporations (mostly from the European Union, Japan, and Korea) to place their space manufacturing facilities there. Islandia was to be a combination of industrial park, agricultural provider, and residential community that would house corporate employees and space entrepreneurs.

To accommodate these diverse goals, the engineering team decided to construct a pair of linked rotating cylinders. A single nickel-iron asteroid was captured, transported to L4, and cut into two equal portions using great solar mirrors. Then both pieces were melted and used to create the two colony cylinders. Construction was completed in 2069, and the first colony cylinder was habitable in 2071 (the second would not be fully landscaped until 2082). Offering earth-normal gravity, open sky, and living space for up to 1,000,000 people, Islandia attracted residents who would never before have considered living off of Earth.

The two habitat cylinders were differentiated by climate. The first to be inhabited was named Matsuzawa, after Koji Matsuzawa (the chief architect of Islandia, tragically killed in a shuttle crash), and has a range of sunlight and temperatures similar to Hawaii. The second cylinder was named Remillard, after Elizabeth Remillard, a French politician and former European Space Agency head hailed as the chief architect of the E.U.'s mid-21st-century space policy. It has a temperate climate similar to Southern France.

Since its completion, Islandia's population has risen steadily. Today almost 40% of the population of L4 lives in these two cylinders. Furthermore, Islandia's open-entry policy, its declaration of pan-sapient rights, and its more liberal (than the European Union) policies toward genetic engineering have made it a Mecca for parahuman and transhumanist subcultures. Almost a quarter of the population is parahumans, free bioroids, clone families, and various other elective forms of posthumanity.

THE ISLANDIA HABITAT

Islandia is the largest space habitat ever constructed. It is a pair of coupled O'Neill cylinders, each about 5 miles long and a mile in diameter, which counter-rotate to provide gravity. Inside each cylinder is a fully landscaped interior with its own towns, farms, and factories. Each cylinder has one end-cap made almost entirely of steel-hard zero-gravity-manufactured glass. Large mobile mirrors opposite these windows focus sunlight into the colonies, enabling both to experience a normal 24-hour day-night cycle.

The two cylinders are held three miles apart by massive composite girders. The space between them is used for zero-gravity industries. These factories (and those inside the two cylinders) allow Islandia to produce a wide range of goods for both domestic use and export. The inter-cylinder space also houses a large spaceport capable of repairing and refitting any ship in service.

With 1 G gravity, an Earth-normal atmosphere, and large expanses of open parkland and working farms, Islandia is by far the most Earthlike of any extraterrestrial habitat. It even possesses naturally generated clouds and normal rainfall.

Islandia has a population of 497,000, making it easily the most populous station in the solar system. The residents have an average wealth level of Wealthy. The colony has a large spaceport, and is CR 2 (CR 4 for weapons). Each cylinder is 25,000' long and 5,000' in diameter. The statistics for each cylinder are:

Design: Cylinder hull (1 billion spaces, steel alloy, light frame), cDR/cPF 7/500 (slag armor). Solar cells (25,000 ksf). Solar panels (250,000 ksf). Hull radiators (1,000 ksf).

Modules: [Each cylinder]: 2 old control center; 2 medium radar; 2 large PESA; 2 medium ladar; 10 radio-com; 50 lasercom; 2,000 new fusion reactor; new fusion reactor core; 20,000 tanks (10,000 MOX, 5,000 nuclear pellets, 5,000 water); 3,000 farm; 1,000 factory; 2,500 housing; 100 robofac; 88,259 open; 3,000 park; 1,000 plaza; 10 large entry modules; 10 large robot arms; 300 surgery; 10 spacedock hangers (each 400' long, 400' wide, 400' high, 128,000 spaces); 50 vehicle bays (for *Predator* AKVs); 3 external cradles (5,000 tons each); 11,000 lab; 100 physics labs; 100 minifac workshop; 10,000,000 cargo (50,000,000 tons).

Statistics: EMass 1,021,987,204 (each cylinder); CMass and LMess 1,072,357,707 (each cylinder). Cost M\$790,647.82 (each cylinder), cHP: 3,300,00 (each cylinder). Size Modifier +22/+18 (each cylinder). HT 12. Maintenance Interval: 0.02 hours (4,268 man-hours/day). RRA 1,000.

Performance: None.

GOVERNMENT

"Islandia is a safety valve for the European Union. It's a bit wilder, a bit freer, and a lot less preservationist – after all, there's no "nature" that needs to be protected in Lagrange 4.

"I like to think of Islandia as a controlled sociological experiment for the progressive elements in the E.U. Things happen faster there, like digital sapience rights – but it's an enclosed environment, so if something goes wrong, it's easier for us to fix it."

– Alexandria LeClerque,

The Islandia Experiment (Teralogos, 2094)

Islandia is a free city associated with, recognized by, and protected by the European Union, but is not actually an E.U. member. Its Islandia Charter guarantees a wide range of pan-sapient rights and freedoms, and sets out the basic form of the government.

Legislative affairs are voted on by the citizenry as a whole, who may also propose referendums. Citizens also vote to select various Islandia Business Committees (IBCs), choosing a slate of members for each, with one third of the IBCs changing membership every two years.

The 186 IBCs manage different issues – economic development, legal affairs, education, housing, resource management, spaceport authority, etc. Each committee has 3-12 members; they elect one of their members as chair. The chair of the "central policy committee" is Islandia's chief executive. Currently this is Alexandria LeClerque.

The judicial branch is the Court of Islandia, whose judges are selected by the IBC's legal affairs subcommittee, but serve until they retire or are recalled by the citizens. Recalls (and constitutional changes) require a 67% supermajority vote.

Islandia has no income tax for residents who spend two-thirds of their time living on station. Residents and businesses pay monthly utility bills for air, water, power, and so on, including a resource-usage tax based on the volume of the station that is occupied; this is essentially a flat property tax. Other commercial transactions are untaxed.

Islandia law is fairly typical of most Fifth Wave nations, and in most respects is similar to the European Union, but is notably more liberal in regard to human genetic engineering and other issues regarding morphological freedom. Some zoning restrictions within the colony restrict property use and development.

Islandia has no custom duties, but does regulate import or manufacture of any materials deemed hazardous to public safety. There are also strict controls on weapon possession (as per CR 4). Port inspectors make sure illegal substances and devices are not brought into or manufactured in Islandia. Everything else (literally) can be freely bought and sold.

Economics and Finance

Islandia's construction was financed by a combination of pre-sales and long-term leases of space to both corporations and individuals.

A portion of Islandia's territory was provided to the European Union on a 99-year-lease; this territory is used for an embassy, ESCA base, and spaceport. In exchange, the European Union recognized the sovereignty of Islandia and provides military protection to the station.

Utility fees and property taxes support most of the colony's operating costs. Islandia also operates the spaceport and charges docking fees on the many vessels that carry cargo and passengers to and from the station.

While these incidents have never escalated above a few dozen people brawling, there have been several identity-motivated murders.

Living in Islandia

"Minolla, you must come with me next time I visit L4. The two weeks I spent in Islandia were like living in an InVid! You forget you're in a cylinder, and then it hits you, and you look up, and up, and see the parks and farms peeking through the clouds overhead.

"By the way, tell Grandmother she doesn't need to worry – at least I haven't gone and joined a Hive! Sure, it's true that some Islandians are utterly postal, but there's plenty of neo-trad identities as well. Take the Mayan ritual I attended – giving blood to the old gods by piercing my tongue – it was so tropic!"

*– Anna Maria Perez to her friend
Minolla Herrera*

The population of each of Islandia's cylinders almost equals the population of Luna City, and Islandia has not reached its full capacity. With abundant living space, several miles of open sky, natural clouds and rainfall, Islandia is less crowded than many Earth cities.

The overall standard of living is high. Even the least affluent residents can afford apartments comparable in size or larger than those in most terrestrial cities, while the wealthiest citizens live in large villas surrounded by several acres of parkland.

The amount of parkland and farmland in Islandia surprises visitors, especially those who have lived on Luna, the asteroid belt, or other L4 or L5 colonies. Residents and visitors can buy locally-produced coffee, tea, fresh fruit, and fresh herbs. Islandia is widely known as having the best coffee off-Earth. Its wine and brandy, mostly produced in Remillard, is quite adequate and is regularly consumed by the residents of Luna and other Lagrange colonies.

There are 12,000 acres of farm, orchard, and parkland that is open to all residents. Some of this land will be developed as the population expands, but many developments are being built underneath hills and hummocks to help preserve green space.

Society

Islandia is a highly cosmopolitan, extremely diverse environment. Since many people come into space to leave the prejudices of Earth behind, the number of parahumans and individuals belonging to unusual subcultures is quite high compared to most Earthly cities. While bigotry certainly exists on Islandia, almost 30% of the citizens are parahuman, and more than 15% have obvious genetic and biosculpted modifications.

Identity-based neighborhoods are one of the key features that separate Islandia from Luna City and most smaller space colonies. The residents of Islandia tend to live and associate primarily with others of their own subculture, religion, subspecies, nationality, or whatever other distinction they feel is of primary importance.

Such divisions are formalized to a degree uncommon on Earth. Many apartment complexes are inhabited solely by members of a single identity group – Virts, Buddhists, actors, members of a single African tribe, fans of a popular InVid series or sports team, or even elective hermaphrodites. While inter-identity prejudice is common, unlike the ethnic neighborhoods of the 20th-century United States, actual oppression is largely impossible because none of these groups makes up more than 12% of the total population. However, inter-identity violence is somewhat common in some of the poorer neighborhoods. Rival ethnic groups, religions, and sports fans are responsible for the majority of such violence. While these incidents have never escalated above a few dozen people brawling, there have been several identity-motivated murders. The IBC remains concerned that one of these brawls could escalate into a full-scale riot.

The various identity groups help maintain order in the colony, and most police the actions of their members. As a result, while there is friction between the various groups, most identity communities are fairly orderly. Anyone who does not belong to an identity community will find themselves socially isolated, especially since much of the colony's networking involves making contacts through your own identity group. Less than 10% of the population does not belong to any identity community.

Local Memes

The large number of extremely diverse identity communities provides Islandia with varied and conflicting memes, but some points of commonality are shared by all Islandians and reinforced by the IBC's memetic programming. The most universal is tolerance. Islandia residents are willing to accept, or at least ignore, the behavior of other identity communities. In part, this tolerance is the result of a widespread emphasis on personal freedom. Most residents are willing to allow others to live as they will, in return for the knowledge that they also will be able to choose their own lifestyle.

The other common meme is a general respect for privacy. Invading someone else's privacy is not only illegal, it is considered to be extremely rude and ill-mannered. Islandia residents are more reluctant than most citizens of Fifth Wave nations to invade the privacy of others.

VISITING ISLANDIA

Islandia is proud of its status as a free port, and the IBC is determined that the habitat remain the commercial center of L4. Other than a quick and non-invasive check for dangerous materials, visitors are free to enter.

Biological visitors are charged a fee based upon the length of their stay. This fee, currently \$20.00 per day, covers air, water and other public facilities. Cybershells pay no extra fees (beyond any hotel, etc. costs). Some ghosts, shadows, and SAIs visit as digital intelligences, and lease space on Islandia mainframes or local 'shells.

While tourism and business is welcome, lengthy stays (over a month) require work or student visas. Islandia accepts working and resident immigrants, but they (or their parents, if minors) must either purchase Islandia property or investments valued at over \$100,000, or be guaranteed what amounts to a Comfortable or better job from a sponsoring business in the colony.

Citizenship can be earned following long-term residency (5+ years); the European Union allows its citizens to possess dual E.U.-Islandia citizenship, and vice versa.

Islandia has extradition treaties with all major powers; criminals are not welcome.

Law Enforcement

Islandia is so Earthlike that many residents, especially recent immigrants from Earth, forget that violence and vandalism can have consequences that are far more serious than similar acts on Earth. Older residents

vividly remember that riots on the Mormon New Kirtland colony resulted in a hull breach that killed or injured almost 3,000 residents.

As a result, Islandia uses psychological manipulation to keep the peace. Memetics, subtle murals, background music, and even aerosol scent dispensers are used to reduce violence in all public places. The IBC also strives to maintain a level of mutual tolerance and harmony between Islandia's many diverse communities. Since the current social climate is both peaceful and profitable, Islandia is an unusual example of a wide variety of human and parahuman subcultures peacefully coexisting in a relatively small area.

The Islandia Emergency Force

The IEF is the colony's police force; its organization is similar to most Fifth Wave police forces in jurisdictions of similar size on Earth.

Due to the diversity of environments found in Islandia, the IEF actually includes various special branches, including a microgravity unit (operating in the zero-gee factory spaces), an aviation unit (piloting a squadron of police air cars), an EVA unit (trained and equipped for zero-gee operations outside the colony), and even a diving squad.

IEF agents must undergo regular psychological testing – including brainscanning – to ensure their honesty and impartiality.

IEF stations are placed so that agents and their cyber-shell assistants can get anywhere in either cylinder within 10 minutes. IEF agents respond immediately to violent crimes, medical emergencies, fires, and any action that threatens the integrity of the habitat. Whenever anyone threatens or appears to threaten the integrity of either cylinder, IEF agents shoot first and ask questions later. While they attempt to use electrolasers or tangler warheads to take suspects alive, they can fall back on lethal force if necessary.

Equipment: Members of the IEF are all issued police armguns, loaded with tangler and hollow point missiles. They also wear light nanoweave armor equipped with IEF transponders and chameleon surfaces. All IEF agents are equipped with a distributed virtual interface.

Qualifications and Salary: IEF agents must possess Criminology at 12+, Beam Weapons and Guns at 12+, and First Aid at 11+. Working as an IEF agent is a Comfortable Job that pays \$5,000 a month.

Justice on Islandia

Anyone convicted by an Islandia court of theft or similar property crimes must pay a fine equal to twice the value of the goods stolen, or three times if the goods were damaged, destroyed, or if their value is otherwise reduced. Half of this fine goes to the Islandia Business Council, the rest to the owner. Offenders found guilty of relatively

minor violent crimes are reformed using memetic therapy. More serious criminals are given the option of exile or nanotherapy (p. TS166) to remove all mental disadvantages that contributed to their criminal behavior. Since few colonies or worlds accept convicted criminals as prospective immigrants, most convicts accept nanotherapy.

TRANSHUMAN SUBCULTURES

Islandia is inhabited by a number of unusual social groups. Two of the most experimental are the Hives and the Virts.

Hives

Hives are small groups of people linked together by a primitive form of mechanical telepathy. Using a combination of two-way slink links and mutual puppet implants, the members of a hive are all in constant contact with one another. Everyone in a hive can constantly perceive the sensory impressions, emotions, and surface thoughts of all other members of their group. Due to the difficulty of processing such a huge volume of information, hives with more than a dozen members are almost unknown. Most have between three and six members. At any time, individuals within a hive can focus on the experiences of a single member, in either “surface” mode, where they perceive this data as coming from an outside source, or in “immersive” mode, where they perceive that member’s experiences as their own.

The problem is that the distraction of constantly receiving everything experienced by all members of the hive is too great for any human mind. Through a combination of special software and experience, members of a hive normally receive only the surface thoughts and emotions of the other members, not their actual sensory experiences. Hive members who are resting or not otherwise occupied normally shift into “surface” mode with one or more members, or “immersive” mode with a single member. When otherwise occupied, hive members merely receive a constant background of their fellows’ surface thoughts, emotions, and occasional flashes of vivid sensory impressions.

Joining a hive is an incredibly intense experience, and most who try it are unprepared for both the sheer amount of data they receive from the other members and the constant intimacy involved. A number of gangs, families, and polyamorous networks have attempted becoming a hive, but most have their implants deactivated within a few days or weeks. Those who find that they actually prefer hive life usually experience substantial changes in their self-identity. Within a few months, they are so dependent on the hive experience that being cut off from the other members of their hive is extremely

Islandia Anti-Violence Memetics

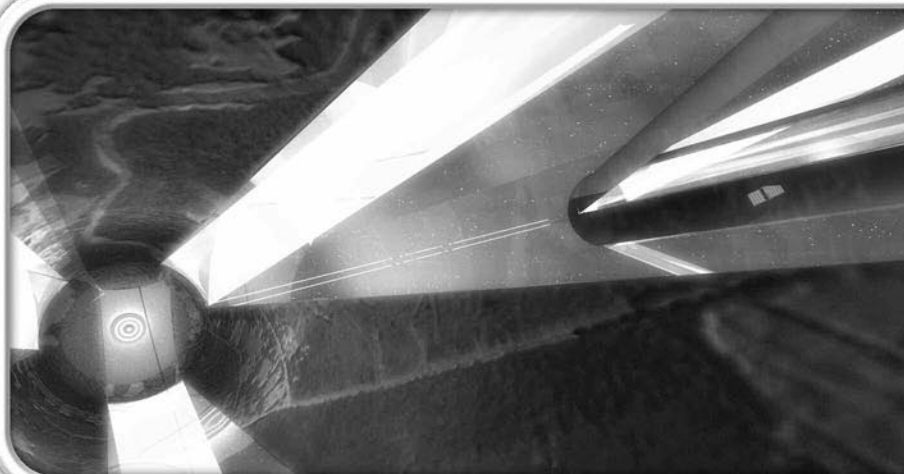
Islandic murals, background music, and video programming are designed to subtly discourage violence. Anyone who has lived in Islandia for a week or more is likely to be affected: +1 to Will to resist the effects of the Bad Temper, Berserk, Bloodlust, Bully, Fanaticism, or Extreme Fanaticism disadvantages, and +1 to reaction rolls for purpose of canceling any penalties resulting from the Intolerance disadvantage.

Spending six months or more in Islandia can provide justification to buy off or reduce any of the above disadvantages (including Intolerance).

Individuals aware of the anti-violence memetics can avoid their influence on a successful Will roll; it’s not a sinister mind control plot, but rather a calculated approach encompassing everything from elevator music to landscaping.

traumatic. On the few occasions where all but one hive member has died, the last survivor almost invariably joins another hive or commits suicide.

The members of most hives are fitted with puppet implants so they can take control of each other’s bodies. Each member can only be taken over if they wish it, but they can turn over control of their bodies any time they want to. This is commonly done if one member of a hive is faced with a task that could be better performed by another member. In this fashion, the members of the hive can fly planes, perform first aid, or program computers for each other. The only limit on using these implants is distance. Members normally only use their puppet implants when they are within 20,000 miles of each other, since greater distances involve a time lag that makes operating another’s body neither safe nor easy.



HIVE CHARACTERS

Being a hive member is an advantage that costs either 35 or 75 points, depending on how much time the members spend with each other. Because they are constantly exposed to the distraction of the sensory impressions of others, hive members are only at -2 penalty to their rolls when receiving another member's sensory impressions in "immersion" mode. When they are merely receiving emotions and surface thoughts from the other Hive members, they suffer no penalties.

Hive members also typically possess a number of advantages and disadvantages. Anyone who has voluntarily been in a hive for more than a few months will normally have all of these. All hive members have a Sense of Duty to the other members of their hive [-5]. In addition, if for any reason a hive member is cut off from communication with his hive, he will suffer from Chronic Depression (until reconnected -30%) [-11] and be Indecisive (until reconnected -30%) [-7]. Additionally, hive members act in an odd and distracted manner that many people find disturbing, and so all suffer from the Odious Personal Habit (Bizarre Behavior) [-10]. Many hive members increasingly find non-hive members somewhat confusing to deal with, since they cannot share those individuals' thoughts and experiences. As a result, most hive members also possess Low Empathy with everyone not in their hive (-20%) [-12]. Hive members also all have at least 4 points in Sense skill.

Hive members are purchased as an Ally Group, normally containing between two and five people. They are normally 150-point characters, and are available on either a 12 or less [for a total of 80 points] or a 15 or less [for a total of 120 points]. Among the other obvious advantages, hive members can use their puppet implants to allow other members to perform difficult tasks for them. Also, when making any Mental skill roll, hive members may ask another member of the hive with a higher skill total for advice. This process normally takes between 10 and 30 seconds, but allows the character to receive a +2 on the skill roll (+1 if the one being consulted has a skill level only one point higher).

Being in a Hive determines a great deal about an individual's career choice and lifestyle. Most hives have occupations allowing them to work together. Hives frequently become spacecraft crews, construction crews, search and rescue teams, research groups, or programming teams. Some even run their own InVid studios. The Iris Group on Islandia is a hive of six members who form an exclusive and highly paid private security company. In several hives, the members all work as artists, writers, or entertainers sharing their work and their inspiration.

Recently, a few hives have begun including SAIs, and several hives incorporate ghost or shadow recordings of deceased members. Also, while the practice is illegal in most Earth nations, several Islandian hives have had children who were fitted with a full set of hive

implants shortly after birth. Hives can be found throughout the Solar System, but are especially common on Islandia because they encounter relatively little prejudice.

Virts

Inhabitants of the late 21st century are bombarded with incredible amounts of information. Some are unable to cope with this vast mountain of data and have found unusual alternatives. While some retreat to low-tech enclaves and voluntarily cut themselves off from most facets of the web, others go in the opposite direction, and perform all of their personal and business interactions virtually. These individuals, known as Virts, can be found throughout the solar system, but are especially common on Islandia.

Many Virts are somewhat secretive about their true nature, especially since several popular InVids depict Virts as either dangerous sociopaths, criminal hackers, or as pathetic and terrified losers. As a result, few people will openly admit that they are Virts. When met online, there is no obvious way to tell if someone is a Virt; the only clue is that Virts tend to access the web even more often than ordinary people.

Virt Characters

All Virts have the Reclusive [-10] disadvantage, and most have either normal or severe Demophobia [-15 or -30]. Many also have the Shyness disadvantage, but with the limitation that they are only Shy in person (-30%) [-11].

An increasing number of Virts have been uploaded. Uploaded Virts generally don't have themselves placed in cybershells or bioshells. Instead, most become informorphs, permanently wired into the web. Not all Virts are interested in being uploaded, though; most are quite happy living in their physical bodies and have no desire to become pure information.

ISLANDIA EXTERNAL AFFAIRS

While somewhat independent of Earth, Islandia maintains free trade treaties with all nations, and has pacts of military assistance with both the European Union and the United States. Currently, its largest trading partners are the E.U., United States, Japan, China, and Mexico. But everyone who needs a secure and unmonitored place to trade comes to Islandia.

Islandia's largest commercial rival is Luna City. Relations with the Mormon colony of New Deseret have recently become quite strained since a small group of ex-Mormon atheists on Islandia began transmitting anti-Mormon propaganda, including encrypted subversive material illegally attached to education broadcasts. As a result, residents of New Deseret are now forbidden from visiting or having commercial dealings with Islandia, an embargo that is worsening New Deseret's already shaky financial position.

CLARKE-1

"The Vacs on Clarke-1 continue to undercut our bids in both time and cost. Unadapted humans simply can't compete in spacecraft construction, repair and maintenance; even the best space suits are too clumsy and slow. For now, we need to expand our use of cybershells. In the long run, we need to recruit some Vacs of our own."

—Thea von Etzdorf,
Vice President of Microgravity Construction,
System Technologies AG

In 2067, the German-owned firm Spitzbergen Vakuumfabrik purchased a small asteroid and had it towed into L4 orbit. Basing their vacuum fabrication and zero-g manufacturing operations on the asteroid they named *Das Luftschloss*, they began producing a wide range of industrial products, including foamed metals, advanced ceramic composites, and ultra-pure industrial crystals.

The initial workers were all ordinary humans, but in 2073, Spitzbergen commissioned Gen-Tech Pacifica to create a line of bioroids able to endure temporary exposure to vacuum without protection. By 2077 the first bioroids were ready. They took over the majority of the station's operations; by 2078, 75% of the

station's personnel consisted of these artificial humans, which proved highly successful.

Unfortunately, Spitzbergen Vakuumfabrik had invested heavily in industrial processes that proved to be less efficient than new nanofabrication procedures developed in the late 2070s. As the prices of foamed metals and various zero-g alloys continued to drop, the heads of the company attempted to cut costs. However, these measures resulted in significant quality control problems. In 2080, the company was investigated for the failure of several crucial components in a prototype European heavy lift rocket.

When the investigators arrived at *Das Luftschloss*, they were confronted with a factory run by more than 1,200 genetically engineered slaves. As the fortunes of the company had declined over the past few years, the bioroids' living conditions had been allowed to deteriorate and the rates of accidents, poorly treated injuries, and even malnutrition had all greatly increased. The resulting scandal was a major media event in Europe; outrage rapidly outstripped the initial purpose of the investigation.

The European Union seized *Das Luftschloss* and immediately began investigating the alleged abuse of the bioroids. Over the next few months, Joseph Rosen became the star of this media circus. Rosen, a vacuum-adapted bioroid, had been the leader of a movement to organize the bioroids into a union. Although the bioroids had been given simple alphanumeric designations, Rosen chose his name by combining the names of two modern Christian writers he admired, Joseph Ngoya and Elizabeth Rosen. His passionate faith and intelligent eloquence made him the natural spokesperson for the bioroids that were popularly known as "Vacs." He became a media celebrity, and his hairless, monochromatic face was widely seen on E.U. media.

Standing Extraterrestrial Force Cis-Lunar (STANEXFORCISLUN)

The European Union's ESCA space forces regularly patrol Lagrange 4. The forces assigned to L4 are part of STANEXFORCISLUN, a unified European Union military command that consists of space and ground forces tasked with operations in cis-Lunar space, i.e., Luna, Earth Orbit, and the surrounding Lagrange points.

The space component is composed of two squadrons of vessels, one provided by Germany's *Bundesraumwaffe* (p. SSS26) and the other a rotating contingent from other ESCA space forces, mostly French and British. The heart of the force is a half-dozen *Konigsberg* and *Herman Oberth*-class SDVs and LSDVs. Since they patrol over relatively short distances, the vessels making up these squadrons have high-impulse fusion drives that permit faster acceleration at the cost of somewhat less delta-V.

STANEXFORCISLUN has basing privileges at Islandia and Luna's Port Tranquility. There is also a small ground component based at Grimaldi Base on Luna.

A total European Union ban on all bioroid creation and ownership took more than a decade, but the events on Clarke-1 are widely acknowledged to be the impetus for the passage of the European bioroid rights laws.

While Rosen appreciated the exposure, he did not welcome the E.U.'s proposals to either help the Vacs adapt to life on Earth, or move them to a specially made facility on Islandia. In January of 2081, Rosen proposed that the bioroids be given Das Luftschloss as restitution for the wrongs done to them. Public support for Rosen continued to grow on Earth. Private donations to the newly freed bioroids began to pour in, and with the aid of some of the European Union's best sapient's rights advocates, Rosen won his case. Das Luftschloss was turned over to the Vacs as compensation for the losses they had suffered. A total European Union ban on all bioroid creation and ownership took more than a decade, but the events on Clarke-1 are widely acknowledged to be the impetus for the passage of the European bioroid rights laws.

As the new owners of an aging factory, the bioroids elected Joseph Rosen president of the newly independent colony and renamed it Clarke-1, after Arthur C. Clarke, Rosen's favorite author. His suggestion that the colony be run collectively was adopted, and the residents began looking for work to improve both their home and themselves.

Over the last decade, the colony has thrived. Charitable donations from various pan-sapient rights groups have allowed the Vacs to repair the worn and dangerous equipment on Clarke-1. Using money they earned performing orbital construction, they were able to upgrade and expand the facilities and purchased a number of biomods to improve their quality of life. Most controversially, they have begun producing more bioroids – something that has led to a minor conflict with their European Union patrons, and in 2092 saw Clarke-1's de-facto secession from the E.U. The E.U. did not recognize this secession, but did not contest it either. However, in 2093, Clarke-1's independence was recognized by Islandia – the first time that the colony had displayed a “foreign policy” of its own, and one that represented a watershed for it as much as for Clarke-1 itself.

Today, all of the inhabitants of Clarke-1 are vacuum-adapted bioroids: about 1,200 original bioroids and a further 1,700 that have been created since then. Every member of the colony can survive in the vacuum of space with only a small air tank.

CLARKE-1 HABITAT

Clark-1 is a stony-iron asteroid 1,200' in diameter. The asteroid is a “beehive habitat.” The surface is covered with radiators, solar panels, and three large landing cradles. The interior is riddled with tunnels and chambers.

Clarke-1 has a population of 2,980; the wealth level is Comfortable. It has a small spaceport, and is CR 2.

Design: Spherical Hull (4.91 million spaces, rock); cDR/cPF 13/500,000 (393,785.57 waste rock spaces). Solar panels (4,000 ksf). Hull radiators (6 ksf).

Modules: Old control center; 2 small PESA; 2 small radar; radiocom; 2 lasercom; 13 new fusion reactor; new fusion reactor core; 100 tanks (MOX); 2 2.5-MJ light laser towers [S]; 30 factory; 29 farm; 35 housing; 10 open; 5 park; 12 plaza; 60 vatfac; 5 large entry modules; 10 labs; physics lab; 10 minifac workshop; 2 large robot arm; 15 surgery; hanger (300' long, 300' wide, 300' high, 54,000 spaces); 3 external cradles (2,500 tons each); 10,000 cargo (50,000 tons).

Statistics: EMass 11,996,804; CMass and LMess 12,056,405. Cost M\$733.1. cHP 67,500. Size Modifier +14. HT 12. Maintenance Interval: 0.74 hours (130 man-hours/day). RRA 6.

Performance: None.

The station is a typical beehive colony. The interior tunnels range between eight and 30 feet in diameter and form a complex network of corridors and public spaces. Small private rooms and sleeping areas are carved into the rock on the sides of these tunnels. Since Vacs still breathe, eat and drink, the colony has an Earth-normal atmosphere. Instead of the ubiquitous emergency rescue balls and space suit lockers found in every airlock and large public space on other colonies, there are many small hemispheres fitted with a dozen short flexible tubes. A tube, when activated, provides pure oxygen to allow a Vac to rapidly recharge his internal oxygen stores and so better survive emergency decompression.

Like most colonies designed and inhabited by people who have grown up in zero-gravity, there is no defined up or down. Most public spaces are spheres or ovals, fitted with various fixtures on every available surface. A typical restaurant consists of a spherical chamber between 20 and 30 feet in diameter, with a place to

order food or beverage bulbs along one side of the sphere. Normally, the patrons float in the middle of the room, or hook their arms or legs around one of the many sets of handholds covering most of the walls. Being comfortable in space, the Vacs use the outside of their asteroid as readily as the interior. Much of the asteroid's surface is covered with telescopes, vacuum manufacturing equipment, and tether clips for Vacs to hook themselves to as they meditate in the endless void.

Clarke-1 is an exceptionally colorful colony. As a reaction to growing up in a sterile factory, the older Vacs covered both the inside and outside of Clarke-1 with elaborately painted murals and similar forms of decoration. This habit has been picked up by the younger generation of Vacs and is now a permanent feature of Vac culture. Also, to offset their stark monochromatic skin, and to help make them more visible in space, most Vacs use bright reflective body paint. Many Vacs paint themselves with abstract designs, but others cover their arms, heads, and torsos with reproductions of famous works of art or images taken from various cultures. Some Vacs also indulge in elaborate luminous tattoos.

GOVERNMENT

Clarke-1 now has a population of almost 3,000 space-adapted citizens, who all belong to the Clarke Governmental Union. The CGU is a consensus-based direct democracy that is also a corporation that owns Clarke-1 and all its assets. Every citizen-shareholder has one vote and decisions are not final unless one side takes at least 75% of the votes on an issue. A lack of such a majority means that the issue is subject to further debate.

In practice, the strong consensus-based ethic shared by most residents means that decisions are regarded as somewhat suspect unless at least 90% of the population agrees. Therefore, important issues can require several weeks of discussion, and both politics and voting are extremely common topics of conversation.

67% of all income earned by residents is paid directly to the CGU, to be used to improve Clarke-1 and provide for the welfare of all of the inhabitants. On Clarke-1, all inhabitants have free access to food, housing, communications, education, and medical care.

Most contracts between an external corporation or government and one or more residents of Clarke-1 are handled by the CGU, after the individuals involved have approved them. However, some of the residents of Clarke-1 regularly engage in smuggling and other profitable, non-violent illegal activities. Contracts for such work are always made solely between the individual residents and their employer. The CGU is never involved in these negotiations, to protect the colony from prosecution. Smugglers and other criminals are still expected to contribute two-thirds of their earnings to the colony, and most do so.

THE ECONOMY

The Vacs are one of the most highly trained orbital construction forces in either L4 or L5. As such, they make the majority of their income building and repairing spacecraft and space colonies.

Many also earn money by carrying packages and secure data stores between various L4 colonies. Using rocket packs and "broomsticks" (p. 135), the Vacs can reach almost any L4 colony within a few hours. Since the Vacs require little radiation shielding and minimal life support, these courier services can often underbid competitors like Solar Express – the Vacs are the "bicycle messengers" of Lagrange 4 and they control most small-scale package deliveries between the various colonies there. A few Vacs also crew stripped-down OTVs to make rapid, small-scale deliveries between L4, L5, and Luna.

Not unexpectedly, some Vacs supplement their income through smuggling. Although trade in weapons of mass destruction, sapient beings, or genetic material designed to produce uplifted animals or bioroids is considered to be unacceptable by almost every Vac, a number of them trade illegal software, pirated nanotech, and even xoxes.

RELIGION

Faith helped inspire Joseph Rosen to lead the fight for freedom for the inhabitants of Clarke-1. Using the limited, read-only media access the enslaved bioroids were permitted in their free time, Rosen studied both religion and revolutionary politics. He became a devout Christian hyperevolutionist, although he never actually met or communicated with another member of his faith until after the colony was freed.

Between his own preaching and visits by missionaries Rosen invited, this faith has spread to more than half of the inhabitants of the colony. As a result of Rosen's impassioned early speeches, the Algernon Foundation and several Christian groups became the Vacs' first supporters. However, the Vacs' unique lifestyle has produced some distinct modifications to their faith. Following some of Joseph Rosen's early revelations, many Vacs believe that space itself is sacred and that meditating in the vacuum of space is a holy act that helps induce religious enlightenment. In their free time, many Vacs attach themselves to the colony by long tethers and experience the ecstasy of the void for lengthy periods of time, a practice the media have dubbed "cosmic communion."

Rosen's followers are not aggressive in their faith, but they are evangelical, and Vac religious programming and missionaries are a not uncommon sight in L4 and L5. Clarke-1 is also home to a small chapter of the Society of Isidore (p. DB102), digital creationist activists who sometimes use direct action to liberate "enslaved" SAIs from their owners.

LOCAL MEMES

A strong community spirit and a general belief in the importance of the common good are also nearly universal on Clarke-1. Residents are normally willing to give large portions of their time and money to support the colony as a whole. This dedication to community also includes a belief that the proper way to make important decisions is through consensus.

The Vacs – especially the first generation – hate all forms of slavery. While opinions on the definition of sapience differ, almost everyone agrees that no sapient being should be owned by or forced to work for another. While such feelings are not uncommon on many Fifth Wave nations, Clarke-1's populace are more outspoken about this belief.

Only about half of Clarke-1's residents follow Joseph Rosen's brand of Christian hyperevolutionism, but there is a general emphasis on religion and personal faith. 70% of the Vacs consider themselves Christians of various sorts; most of the rest follow other faiths. The Vacs possess a high degree of tolerance for different religions, but anyone openly atheist is usually considered to be a poor soul in dire need of salvation.

CLARKE-1 CHARACTERS

There is a significant difference between the younger Vac bioroids and the original generation. The newer bioroids have been modified with various "quality of life" upgrades. All Vacs are fitted with implant communicators shortly after they are born.

These radios permit them to communicate in space and help locate them in emergencies.

VAC BIOROID

1 POINT

Attribute Modifiers: ST -2 [-15].

Advantages: 3D Spatial Sense [10]; Bioroid Body [0]; Breath Control 1 [4]; Oxygen Storage [14]; Disease-Resistant [5]; Free Fall +1 [4]; Prehensile Toes [7]; Radiation Tolerance 5 [10]; Vacuum Adaptation [27].

Disadvantages: Delicate Metabolism [-40]; Reduced Hit Points -1 [-5]; Skinny [-5]; Unnatural Feature (Color-changing, hairless dolphin-like skin) [-5]; Vow (Give 67% of wealth to Clarke-1) [-10].

Features: Home gravity of 0 G. Increase height by up to one foot over the norm for the lowered ST, but weight is 50% of normal. Taboo Trait (Genetic Defects).

Availability: 2073. **Cost:** \$81,000.

Vacs are quite striking in appearance. They are all tall and skinny. Their skin is very smooth, completely

hairless, and feels unusually slick, much like plastic or the skin of a dolphin. As part of their temperature control mechanism, their skin changes color, going from jet-black in darkness to white in bright light. Vacs have long, slender arms and legs and somewhat enlarged rib cages. Individuals who are uncomfortable with parahumans have described them as looking like bloated spiders.

The adaptations used on the Vacs were at the absolute cutting edge of available biotechnology. As a result, there were a few problems, the most serious of which is that their metabolism is unusual enough (primarily due to the inclusion of mechanisms patterned on cetaceans) that they require a carefully-monitored diet to remain healthy.

VISITING CLARKE-1

Clarke-1 is open to all visitors and especially welcomes pilgrims and potential clients. Visitors are given the same type of routine weapons and hazardous materials inspection as on Luna City. Currently, long-term immigration is only open to individuals capable of surviving in vacuum, but others may stay up to three months. Visitors unable to survive in vacuum are warned to keep their suit nearby at all times, since emergency suits and rescue balls are only located in the visitors' sections and the hospital. Many Vacs view normal humans as extremely fragile and can be somewhat over-protective of non-vacuum adapted visitors.

JOSEPH ROSEN

243 POINTS

Age 29; 6'6" tall. 110 lbs. He has no hair, green eyes, and color-changing monochromatic skin. Rosen typically wears a loose, but high-quality sleeveless jumpsuit, and a small gold cross. Like many Vacs, he paints his scalp and arms with brightly colored, reflective body paint. Rosen prefers a mixture of starscapes and scenes from Christian iconography.

Joseph Rosen is the elected president of Clarke-1. He is a hero to his fellow Vacs and is exceedingly popular with most pan-sapient rights activists. Rosen is a deeply religious Christian Hyperevolutionist who believes spending time in open space brings him closer to God. His faith and his experiences as a bioroid slave have convinced him of the evil of slavery and bioroid exploitation. He is a passionate advocate for pan-sapient rights throughout the solar system.

ST 8 [-15]; **DX** 13 [30]; **IQ** 14 [45]; **HT** 12 [20].

Speed 6.25; Move 6.

Dodge 6; Parry 5.

Advantages: Charisma 2 [10]; Comfortable Wealth [10]; High Pain Threshold [10]; Intuition [15]; Mathematical Ability [10]; Programmable Ally (-5-point VII housing an NAI-5, available 15 or less) [3]; Reputation +3 [15]; Status 3 [15]; Strong Will 1 [4]; Vac Bioroid [1]; Voice [10]. **Biomods:** Artery Cleaners [0]; DNA Repair [4]; Immune Machines [5]; Respirocytes [14]; Spleen Augmentation [10].

Disadvantages: Disciplines of Faith [-5]; Obsession (End slavery) [-5]; Sense of Duty (Bioroids) [-10]; Vow (Give 67% of wealth to Clarke-1) [-10].

Quirks: Congenial; Dislikes libertarians; Imaginative; Vocal socialist; Spends as much time as possible in vacuum. [-5]

Skills: Acrobatics-12 [2]; Area Knowledge (L4)-14 [1]; Artist-13 [1]; Astrogation-15 [1]; Bard-17 [4]; Breath Control 14 [8]; Diplomacy-16 [4]; Electronics (Communications)-14 [1]; Electronics Operation (Communications)-13 [1]; Engineer (vehicles)-13 [1/2]; First Aid-14 [1]; Free Fall-15 [8]; History-12 [1]; Knife-12 [1/2]; Mathematics-12 [1/2]; Mechanic (Robotics)-12 [1/2]; Politics-16 [4]; Psychology-15 [6]; Savoir-Faire-15 [1/2]; Theology-15 [6]; Vacc Suit-12 [1/2]; Writing-16 [6].

Language: Chinese-13 [1]; English-14 [2]; German-14 (native) [0]; Spanish-13 [1].

Equipment: Like all Vacs, Rosen is fitted with an implant communicator. He also possesses a Virtual Interface Implant, fitted with a Complexity 4 computer and an implantable infomorph for an NSAI-5. He habitually

carries an air mask, a hand thruster, and a Bible. For public appearances, his security advisor usually convinces him to wear a suit of light nanoweave armor.

CLARKE-1 EXTERNAL AFFAIRS

Clarke-1 is still officially a part of the European Union, but in practice it is a sovereign state under the European Union and Islandia's protection. Clarke-1 is closely allied to Islandia.

Clarke-1 has cool but correct relations with those nations that continue to indenture bioroids, such as the U.S., China, and Japan. Rosen has specifically forbidden all Vacs from having any commerce with any corporation that continues to manufacture or employ indentured bioroids, although this directive is sometimes ignored by Vac couriers unwilling to lose a commission. Vac delegates to the Lagrange Construction Union have been working to make the embargo an LCU policy, but so far have not succeeded.

Recently, Joseph Rosen has been cultivating secret ties with a few infosocialist groups. Rosen's own philosophy parallels many of the principles of infosocialism, although he despises the general lack of freedom and the mistreatment bioroids face in many TSA states. Currently, Rosen is working with the more moderate infosocialist parties in Europe and Mexico, and some moderate nanosocialists in the TSA. These latter connections are also a source of illegal goods that the Vacs smuggle.

Last year, Rosen and several of his assistants made contact with the IA infosocialists who secretly control *die Sonnenspinnerin Sieben* (below). Rosen greatly admires the work the IAs have been doing and is now actively working with them. Currently, several Vacs are acting as secure couriers for IA operations based on L4 and L5, carrying data and other discreet packages.

DIE SONNENSPIINNERIN SIEBEN

A revolution takes place only when there is no other way out.

— Leon Trotsky,

The History of the Russian Revolution

Among the many glistening monuments to corporate grandeur and national pride gliding along in the L4 cluster, few stand out as much as *die Sonnenspinnerin Sieben*. Its great, shining solar sails announce its presence from thousands of miles out; in fact, local pilots often use it as an informal navigational reference. Everyone on Earth with even the remotest interest in current affairs knows its once-proud heritage.

At least, so they think.



HISTORY

Die Sonnenspinnerin Sieben began its storied existence as the brainchild and crowning accomplishment of Herr Win Herzberg, chairman, chief executive, and majority shareholder of the Maxim-Herzberg LIC empire.

As the grandson of the only surviving Maxim-Herzberg founder, Herr Herzberg made his mark early and prominently. His 2087 decision to pull the plug on the flawed ghost of his grandfather both salvaged the company and electrified the news channels. His vigorous, gambling forays into microflexible-materials construction for electromagnetic applications transformed Maxim-Herzberg from a simple industry leader to market maker in advanced weapons and rail-transit construction. Among its most lasting accomplishments was the building of the Lunar Guideway mag-lev system (p. 54).

Other than his business, Herr Herzberg possessed only one outlet for his passions: solar yacht racing. His *Sonnenspinnerin*, or Sunspinner, series of racing yachts dominated this rarefied sporting circuit just as Maxim-Herzberg did its markets.

By 2088, Herr Herzberg had enjoyed his fill of navigating precise, elegant loops around the Earth. Jaded by his strings of victories, both in orbit and the marketplace, he retired his last yacht, *die Sonnenspinnerin Sechs*, and reached for something more.

That something became *die Sonnenspinnerin Sieben*, an orbital Maxim-Herzberg installation that would serve to define the state of the art – and not incidentally stand as a shrine to Herr Herzberg's unprecedented successes.

For the next nine years, Maxim-Herzberg spared no expense in designing and building this edifice. Herr Herzberg personally supervised every aspect of construction down to a painstaking level of detail, his cybershells (see the *Herzberg* cybershell and infomorph, p. 100) scrambling about the immense installation constantly querying, commanding, and leading.

Like many admirals of industry, Herr Herzberg trusted his cybershells no more than any other valued employees, preferring to review their work. His attention fragmented by digesting more than 1,000 of his own points of view – the majority of them on *die Sonnenspinnerin Sieben* – Herr Herzberg began to lose his laser focus on Maxim-Herzberg's dealings. Thai competitors discreetly copied the German company's leading technology, and Maxim-Herzberg failed to innovate enough to defend its decisive lead.

In the meantime, the first of the astronomical bills for *die Sonnenspinnerin Sieben* came due. Maxim-Herzberg paid the first wave of invoices by scavenging funds from core operations, thus impairing its ability to generate

future profits to meet the further expenses of the orbital station. Sniffing out the early signs of a vicious spiral, Herr Herzberg at last turned his attention back to ground level, but even as his cybershells idled along the lengths and stretches of *die Sonnenspinnerin Sieben*, it was too late.

The 2088 projections of a 20% increase in market share just paying for *die Sonnenspinnerin Sieben* seemed like so much drug-addled dreaming in the 2094 reality of a 41% decline in share. The next wave of construction bills broke over Maxim-Herzberg like a tidal wave, drying up cash flow and operating capital. Herr Herzberg took his own life with a 17th century dueling pistol. The surviving directors of Maxim-Herzberg filed for bankruptcy protection, then watched helplessly as creditors dismembered the company and picked over its remaining assets.

The Maxim-Herzberg story ends here, at least as far the fleeting attention of most of Earth's citizens are concerned. Those with an interest in corporate affairs will recall the 2097 purchase of *die Sonnenspinnerin Sieben* by one of the primary contractors in its construction, Materials Application Geosynchronous, Inc., in some sort of debt-exchange transaction for which the full details never fully emerged.

Someone, presumably MAG, financed the finishing touches on *die Sonnenspinnerin Sieben's* construction, and someone, presumably MAG, now inhabits this almost eerily grand monument to an extinguished pride.

DIE SONNENSPIINNERIN SIEBEN HABITAT

It looks like it should hang not from its gauche sails, but rather from a trio of heavenly golden chains, swaying in the hand of the Cardinal of all Cardinals as he makes his way down the aisle of his own grand cathedral.

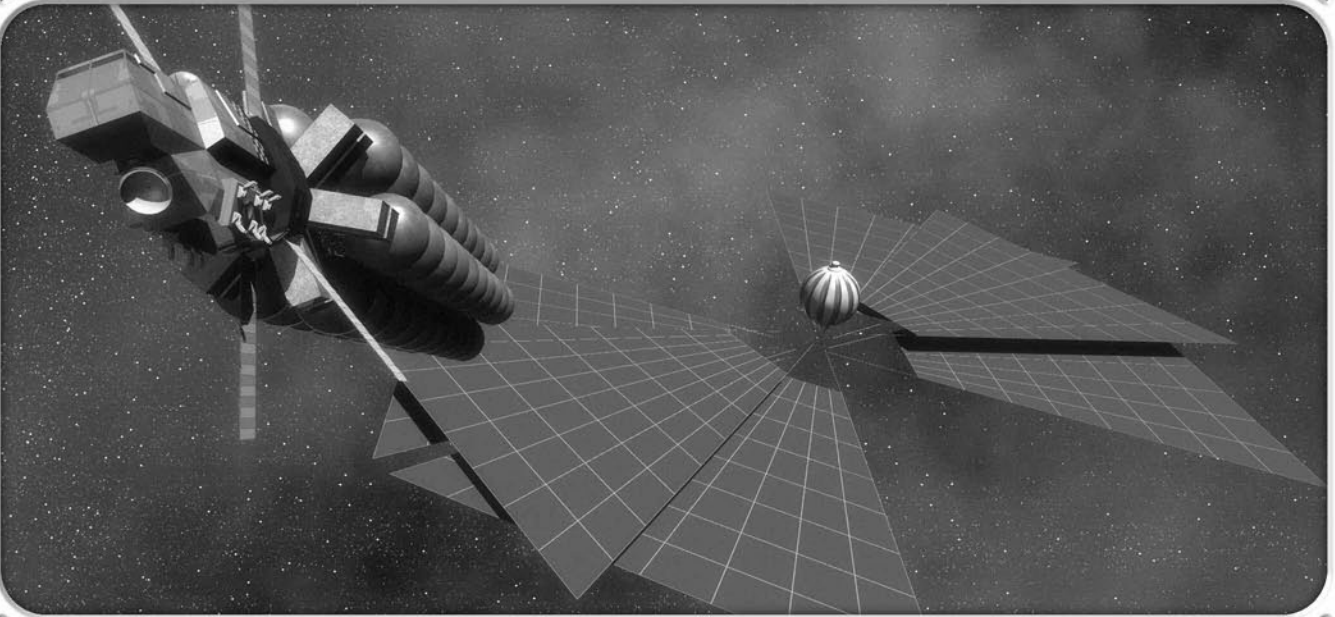
– Diego Sansuria,

Times orbital-architecture critic

Die Sonnenspinnerin Sieben's 700'-diameter spherical hull is dominated by the two immense solar-panel arrays that extend from the station like the sails of a futuristic clipper ship. The panels sweep away from the station proper in a grand arc that can be literally blinding when sunlight hits the panels at the proper angle. Designed as much for aesthetic sensibility as for power generation, the arrays give the already large station an almost unreal sense of scale.

The arrays are designed to be stowed if necessary, although the process will take a minimum of 24 hours. No one has ever attempted to actually stow them, however; the potential repair bill for the \$1 billion array should anything go wrong has intimidated all station commanders to date.

The arrays are spin-mounted so that they do not rotate with the station proper.



The station's hull has an intricate fluted pattern and is coated with liquid crystal, enabling it to change its color and design at will. The station typically takes on a pearly white color. On either end of the station are two large spacedocks, each capable of handling a *Pegasus*-class TAV or several smaller craft. As a general rule, most vessels dock with one of the external cradles along the hull and enter the station through integral entry modules.

Though it could maintain 1.167 Gs, the station's slow spin imparts 0.81 Gs between the hull's "tropics," which places a spring in the step of residents from Earth without causing any noticeable orientation difficulties. Most of the living quarters are placed near the outer equatorial zone for this reason, with a small portion of them located axisward to provide Mars-normal and Luna-normal "colonies." The station could house up to 1,000, though Maxim-Herzberg never intended to assign so many employees within it.

As it stands, much of the station is left empty, although the farms are fully functional and tended. The station does not export large amounts of food, however, largely because the farms currently only produce low-yield delicacy fare – notably the finest olives and truffles found off-Earth.

While Herr Herzberg envisioned the station as a heavenly showpiece for his business empire, it was also intended (at least on paper) to pay its own way through orbital manufacturing. Along the station's axis lies a substantial robofac complex that takes advantage of the micro-gravity conditions to produce a variety of sophisticated products, specializing in custom orders and small production runs. Several research labs and minifacs scattered around the station provide basic testing and prototyping. There are 1,985.35 spaces empty and unpressurized, for

future expansion. The station's batteries can keep full operations running for a bit over three hours, or for 150 hours if the factories are idled.

The colony has a population of 430 people, with an average wealth level of Wealthy. It has a small spaceport, and is CR 2.

Crew: Ideally, a command crew of three sapient monitors the station's functions at all times. In practice, two infomorphs run the station from the mainframes located in the control center. A backup infomorph can also be brought on-line from the unmanned controls, if necessary. Most routine maintenance, farm-tending, and factory work is conducted by the modified *Herzberg* cybershells (p. 100).

Design: Sphere hull (343,000 spaces, carbon composite, light frame, smart); cDR 5, cPF 100 (slag armor). Hull radiators (100 ksf). Folding solar panels (15,000 ksf). LCD coating.

Modules: New control center; 2 large PESA, 2 medium radar, 4 medium ladar; 200 HI fusion torch; 3,000 tanks (hydrogen); 150 battery; 3 2.5-MJ light laser towers [S]; 10 radiocom, 5 lasercom; 15 large entry modules; 30 lab; 5 minifac workshop; 2 large robot arms; 10 farm; 10 housing; park; reconfigurable plaza; 10 robofac; intrastation transport (1,000-person capacity); 10 external cradles (625 tons each), 2 spacedock hangar (120' long, 120' wide, 120' high: 6,912 spaces each), 5 surgery, 10,000 cargo (50,000 tons).

Statistics: EMass 1,402,972; CMass 1,456,473; LMass 1,457,973. Cost M\$14,317.23. cHP 11,484. Size Modifier +13. HT 12. Maintenance Interval: 0.336 hours (287 hours/day). RRA 100.

Performance: sAccel: 0.00005 G. Burn Endurance: 375 hours. Burn Points: 68. Delta-V: 0.2 mps. No air speed.

INSIDE DIE SONNENSPIINNERIN SIEBEN

The grand confines of die Sonnenspinnerin Sieben do, indeed, house Materials Application Geosynchronous, Inc., a corporate “colony” engaged in orbital construction with ventures into deeper space. Inside, visitors will find a capitalistic money engine busily humming away among expensive but tasteful furnishings. The well-appointed docking-station “greeting rooms” lead to a maze of well-appointed corridors that lead to a maze of well-appointed offices. Space is delegated in surprisingly liberal amounts, but then there are many fewer MAG employee-residents than Maxim-Herzberg originally intended in what was already a generous plan.

Visitors to die Sonnenspinnerin Sieben are fairly rare, and invitations beyond the equatorial reception and visitors quarters even rarer, so the majority of those that do set foot on die Sonnenspinnerin Sieben will come away with little more than the impression above, of a competent and busy company hustling about in a luxury into which it happily fell.

That’s exactly the impression that those behind MAG want to leave.

In short, if the lower classes never possess an opportunity to catch up, all they’ll ever do is sink relatively lower in relation to the leading edge.

BEHIND THE FACADE

What no one – save just possibly the most elite intelligence agencies – knows is that die Sonnenspinnerin Sieben and MAG serve as cover for the IAs, a radical organization with loose ties to the nanosocialist movement.

A rather assorted collection of socialists and humanists, the IAs are bound together by a deep distrust of the Fifth Wave’s underpinnings – and a willingness to go to great lengths to oppose them.

For the moment, the IAs do not attempt to legitimize intellectual-property piracy – they simply engage in it wholeheartedly, sowing chaos and diverting profits where transhuman pioneers would attempt to monopolize technology’s leading edge and further marginalize the mass of humanity.

The IAs base a variety of confidence schemes, grand thefts, and borderline acts of technoterrorism out of die Sonnenspinnerin Sieben, shuttling agents to and from groundside on MAG’s regular shuttle flights out of Quito.

The Birth of the IAs

When nanosocialism emerged among several developing nations (see p. TS22), a variety of left-leaning groups and individuals among the Western wealthy nations took notice. Most of these lapsed infosocialists left the nanosocialist bandwagon even more quickly than they joined it, once the Transpacific Socialist Alliance’s copyright piracy began to make inroads into their own economies. More left after the Pacific War began.

Others, holding their convictions closer to their hearts, watched and waited, learning from the TSA’s mistakes in both policy and execution. Even as the TSA was still stirring up Chinese and Australian ire, these mostly Western leftists began making sporadic, limited forays of an international nature, ignoring any pretense of law in committing carefully selected acts of data piracy and copyright stripping. These pioneer technoterrorists dubbed themselves the Intellectual Artistes, or IAs. They probably would have remained a motley assortment of underground computer programmers and web reweavers had not several exceptional individuals began coalescing their Brownian antics into an organized movement (see *die Sonnenspinnerin Sieben Characters*, p. 98).

IA Principles

A dog with a silver dish is still a dog.

– Dr. Hermann Fraks, IA philosopher

The organizational process began with a codification of the IA principles. Foremost among these is a belief in sapient rights. Most of the IAs recoil in horror at the use of bioshells and enslavement of bioroids. They often specifically target their “revolutionary” actions toward corporations that develop these technologies and governments that deploy them.

On a broader scale, the IAs have deep misgivings about some of the underpinnings of the transhumanist movement. Avowed egalitarians – “What excuse now exists for all persons not to be equal?” is one of their catchphrases – the IA’s homegrown Bytaki Theorem attacks the growing social inequities of the hyperdeveloped nations. The theorem states that, while socioeconomic inequities can be philosophically forgiven in transitory periods of change that improve living conditions for all, they cannot be forgiven in a society in which change is a constant. In short, if the lower classes never possess an opportunity to catch up, all they’ll ever do is sink relatively lower in relation to the leading edge. While modern apologists point out that these lower classes live very well compared to the unwashed masses before them, the Bytaki Theorem

argues that a marginalized life is a social crime, no matter how well fed.

By choice, the IAs lack the organizational discipline to form a consensus on many of the finer points of transhuman philosophy. Most IAs reject movements that willingly limit their own or their children's potential – the general IA goal is to uplift everyone at once, not drag everybody down in the wake of religious or philosophical objections. They are more fragmented on the life-extension technology at the center of much transhuman thought – some argue that the human race as a whole is the true organism, with individual humans as cells within it, and those humans that achieve near immortality become akin to cancer cells, harming the organism via their slow adaptation to environmental change.

Given their agenda of leveling the existing social forces, the IAs set out to develop a plan of attack. Their favorite such plan derives from their AntiSingularity Principle, in which IA theorists argue that the transhuman belief in a singularity beyond which change becomes too rapid for human forecast is completely erroneous. The principle argues that human advances have steadily substituted invention for discovery, and that eventually advances will depend almost completely upon the implementation of preconceived notions. How can advances that spring from human/transhuman invention possibly outstrip human/transhuman awareness, especially given that intelligence augmentation has so far allowed the human mind to keep pace with its own creations?

Perceiving this as a blind spot in the transhuman philosophy, the IAs have taken to meme mining (see p. TS112) with a vengeance. They hope to subvert the transhuman movement from within, by carefully sabotaging the thought constructs and perception models framing it. They have taken to calling their process “web reweaving” in that it involves discreetly altering the information at hand to force subtle but important shifts in its reception. IA experts have become some of the leading memetic engineers of 2100. The quality of their theoretical work has advanced less rapidly, however, primarily because they conduct their research in utmost secrecy.

Such a grand agenda required a great deal of funding. The antics of the original IAs almost naturally evolved from simple technoterrorism to data piracy for profit. Once coupled with the early IA memetic research, these operations extended into confidence games and subterfuge of a more sophisticated nature. The IAs became politically motivated con artists, both funding and implementing their agenda behind the myriad false walls of an overly complex transhuman world.

Many of these operations were fronted by the commercial practices of Materials Application Geosynchronous, Inc., an orbital contractor owned by one of the IA principals. MAG's own finances began to falter at about the same time that the IA memetic research

began to demand incredible investments in the most cutting-edge computing technology.

In typical fashion, the IAs developed a bold initiative that would take care of both problems in one stroke.

The Taking of die Sonnenspinnerin Sieben

As with the majority of IA regulars, Colleen MacIntosh held a day job – having climbed by 2087 into a leading executive position in the Maxim-Herzberg empire. Though many Maxim-Herzberg initiatives – including its weapons proliferation and use of bioroid labor for space operations – ran counter to her sensibilities, and she regarded Herr Herzberg himself as only marginally sane, she held onto the job relentlessly. Her position provided a great deal of sensitive data invaluable to IA efforts.

Consulting with Dr. Hermann Fraks and other IA memetic engineers, MacIntosh proposed running a confidence scheme on Herr Herzberg on a scale far greater than anything the IAs previously had attempted. She then pulled it off almost singlehandedly. Insinuating herself into Herr Herzberg's personal life, she fed his already formed but hazy notions for die Sonnenspinnerin Sieben, using some of the oldest persuasion techniques on record. Once Herr Herzberg decided to build the station, in her official capacity MacIntosh steered some minor MAG construction contracts to other Maxim-Herzberg executives for approval, in order to conceal her own role in the affair. These contracts received approval despite some unique and arcane language deep within them dealing with the possibility of a Maxim-Herzberg default. None of the reviewing executives took seriously the possibility of a Maxim-Herzberg default.

Once the construction reached a point of no return, MacIntosh began feeding key proprietary technology to extranational Maxim-Herzberg competitors through several cutouts. As this espionage impacted the marketplace, she did her surreptitious best to delay Maxim-Herzberg awareness of its impending peril.

Her efforts proved enough. Maxim-Herzberg defaulted, and the provisions in the MAG contracts came into play. MAG became a primary creditor with special privileges in the ensuing dismemberment of the German giant, and through several sleights of hand ended up purchasing die Sonnenspinnerin Sieben for 0.43 cents on the dollar.

The one major setback in her coup was Herr Herzberg's suicide. Despite her great distaste for much of what the magnate represented, MacIntosh had come to appreciate the finer points of his character. The IA operative fell into a deep depression when she learned of the death, and the leading IA minds spent a great deal of time debating whether they had gone too far in the die Sonnenspinnerin Sieben operation.

In the meantime, they moved in and set up shop.

LIFE IN DIE SONNENSPINNERIN SIEBEN

Nature has a finite number of secrets.

– Dr. Hermann Fraks, IA philosopher

Currently, die Sonnenspinnerin Sieben houses 430 MAG employees and 785 *Herzberg* cybershells (see p. 100). Of the former, 87 know of and actively participate in IA activities. The remaining 343 have no knowledge of the IA, believing they work for a perfectly legitimate construction company. (At least, the IAs hope so.) Most of the MAG employees work in AI-assisted design of inventory to be produced by the station's robofac. Most of this work tends to be custom parts for Earth-orbit construction, but MAG holds several contracts on Mars and two in the belt, and is installing the hard data network on a Jupiter orbital.

MAG also has a rather large-scale product in development, called "Black Blood" in informal discussions. Black Blood would be leading-edge microbot technology that would deconstruct select asteroids into billions of tiny, impact-resistant bots that would circulate along the asteroid belt's orbit much like the ice particles in Saturn's rings. While information already travels freely among the asteroid communities, these bots would carry *raw materials*, colliding with one another in predetermined patterns and exchanging content, carrying commodities from one asteroid to another.

Black Blood would, in effect, provide the asteroid belt with a circulatory system, allowing one community to almost reflexively provide a surplus commodity to another, in exchange for a needed commodity that likely would come from yet another community.

The logistical difficulties of creating infrastructure on this scale – much less directing the bots' mostly free-floating movements – have so far proven more than MAG's engineers can overcome, but research continues. The IA memetic researchers hold a particular interest in what effect this would have in bundling the scattered asteroid communities into a social whole.

A small percentage of the MAG employees supervise station operations, including a command section of 15 that maintains an all-hours, three-person staff in the command center. All of these personnel are IAs. The cybershells

conduct most of the menial labor – both in station operations and MAG enterprises.

MAG maintains a small groundside office in Quito, from which it transfers personnel to and from Earth, but a MAG employee can expect to spend 90% of his career in orbit or out in the system. Overall, the company employs 875, but most of these personnel are housed and working at client sites. In general, the outstation workers rarely spend more than brief turnaround periods at die Sonnenspinnerin Sieben, and the station personnel tend to spend most of their time at the station itself.

VISITING DIE SONNENSPINNERIN SIEBEN

Most visitors to the station are MAG employees, but that covers a wide variety of personnel: ex-military for security and researchers and engineers of all stripes. Just about any sort of adventurer could find himself considering an opportunity with the company.

A MAG employee will have access to most portions of the station, but those who aren't IA members will find themselves locked out of certain portions of the robofac and cargo holds.

The station also hosts a small but steady stream of customer representatives. They are carefully monitored during their stays.

In the event of a hostile visit, the station ostensibly possesses no defenses. In reality, the IAs have a host of non-lethal measures prepared to resist an invasion, including a variety of targetable devourer and gremlin swarms (see p. TS167) and sleep agents. These aren't meant to stop a hostile entry so much as to delay it long enough to allow time to eradicate all incriminating evidence.

DIE SONNENSPINNERIN SIEBEN CHARACTERS

Key IA personnel hold most of the leading positions in MAG, and thus in die Sonnenspinnerin Sieben. Some of them include:

Shane Anderson, MAG CEO and Chairman

Though the IAs run their affairs mostly by rough consensus among an executive panel, Anderson would have to be considered as the "first among equals." His company serves as the organization's base of operations, and his opinion carries great weight in all decisions.

The scion of New York socialites, Anderson enjoyed the latest in genetic upgrades and the best education, but witnessing the radical economic polarization of the U.S. Eastern seaboard throughout his young life branded him with a deep disgust for transhumanist practice, if not all aspects of the philosophy.

Looking for an outlet in which to express his budding political dissatisfaction, Anderson stumbled across the early IAs. Given his outstanding personal charisma and leadership, he quickly coalesced this loose-knit group under his own banner. Even as he did so, much of the old IAs' roguish methods and mannerisms began to take root in Anderson himself.

He developed a taste for the grand stroke and audacious planning. Upon his father's death, Anderson inherited a controlling percentage in MAG. He rapidly integrated his new wealth with IA operations, to the point where MAG and the IAs are now inextricably linked. Anderson is a 31-year-old Ishtar upgrade with an excellent education and Multimillionaire wealth. He spends most of his time in New York City, but frequently shuttles to Quito and die Sonnenspinnerin Sieben. Even when not physically present on the station, his cybershell serves as his limited proxy. No one has yet explored all the capabilities of this fantastically expensive, custom creature. It is a bush robot (see p. TS73), undoubtedly equipped with a host of self-defense and escape-and-evasion capabilities; however, it probably does not possess many lethal features. Anderson is an avowed believer in the sanctity of life, and will condone killing only under the most extreme circumstances.

Dr. Fraks would place bioroids, uplifted animals, and higher-order AIs. In person, Dr. Fraks can barely hold a coherent conversation on bioshells, so deep are his convictions. On paper, he can quite elegantly condemn the practice.

Several early IA leaders took an interest in the Bytaki Theorem and other Fraks papers in the 2090s, and discreetly established a dialogue with the controversial researcher. In doing so, they underestimated Dr. Fraks' exceptional ability in meme engineering; he rapidly determined who they were and what they were about, and just as rapidly offered to join their efforts. In short order, he became the leading mind behind the IA agenda. On record, he works for MAG as a sort of metamarketing executive, identifying long-range trends in customer demand and how MAG can best position itself to be the company selected to satisfy those needs. In reality, he spends the majority of his time on IA affairs.

Dr. Fraks is a genefixed man in his early 50s who, despite his genetic predisposition otherwise, manages to maintain a small paunch. He rarely employs cybershells or other alternate point-of-view technology, though he is quite familiar with the psychological implications of their usage. He has very high skills in Artificial Intelligence, Intelligence Analysis, Philosophy, and Psychology.

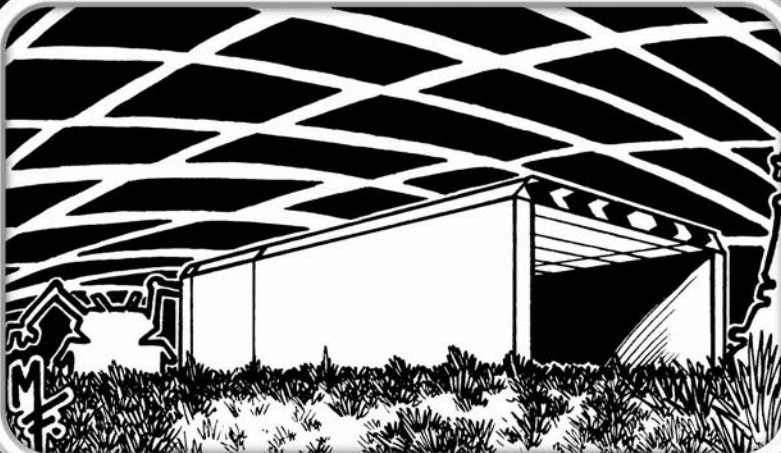
Colleen MacIntosh, MAG Vice President of Operations

After the collapse of Maxim-Herzberg, MacIntosh took a position with MAG, a company with which – most data miners would swear – she had no previous contact. She has suppressed her depression over Herzberg's death with a constant dosage of Nepenthe (see p. TS164), which has restored her previous persona as an ubercompetent, crisp businesswoman. Thus empowered, she easily juggles her very real responsibilities as MAG's chief operations officer and her identical role in planning IA actions. The self-diagnosed and -administered medication has had a potentially troubling side effect, however. Her Nepenthe-steered conclusion that Herzberg's death was simply a cost of doing business has made her a bit callous about considering IA operations that would result in other fatalities. The other leading IA leaders have yet to recognize this. If left unresolved, her personality shift could lead the movement into a very damaging situation.

MacIntosh is an attractive woman in her early 40s, of a genetically updated stock that she refuses to identify. She has very high skill in Administration, and is competent in most aspects of commerce. MacIntosh spends almost all of her time on die Sonnenspinnerin Sieben, where she employs an army of datalinked robotic underlings to keep her apprised of just about everything that goes on.

Dr. Hermann Fraks, MAG Chief Market Definition Officer

Dr. Fraks began his career in Munich, where many of his early theories met with skepticism and even ridicule. An avid infosocialist, he endorsed the early nanosoc movement until its tactics began to turn lethal. Though the Pacific War did not cost a huge number of lives relative to other conflicts of similar scope, some of the strategic decisions displayed a callousness toward sapient rights that dismayed Dr. Fraks. He was already forming the Bytaki Theorem on his perception of the Fifth Wave's refined exploitation of the lower socioeconomic classes, a category into which



Aynna Píclov, IA Disinformation Specialist

Aynna and the IAs crossed paths when a 2096 IA operation targeted a Uruguayan xoxnapping ring that owned Aynna and used her for security. Rather than neutralize the IA agents that she encountered, she used them as an opportunity to find a better life.

She feels she has done so in the IAs, and is a fiercely loyal member of the movement. The IAs have entrusted her as their primary agent in covering their tracks on the web. Aynna spends most of her time searching out clues to the IA's existence, neutralizing them, sprinkling red herings throughout the data network, and generally sowing the information-overflow chaos behind which the IAs hide. It was her decision to retain the IA acronym even though it became commonly used to mean "intelligence augmentation" – the more confusion, the better. Aynna feels confident that most of the IA's victims think that they fell prey to some unidentified criminal ring.

Her cover identity is as a MAG security officer on die Sonnenspinnerin Sieben.

ADVENTURE SEED: HERR HERZBERG REBORN

This scenario presumes Herr Herzberg had a ghost made before staging his suicide scene (see p. 97). Lying low for several years – perhaps hidden away in a computer in die Sonnenspinnerin Sieben itself – the ghost has been harboring suspicions that someone led his hubris astray, and has worked diligently (and discreetly) on discovering who.

At last confident that he has identified those responsible (whether or not he is actually right, a man/machine of Herr Herzberg's nature is almost *always* confident of his conclusions), the ghost financier makes plans to seek his revenge and regain his fortune. These plans will require him to recruit an eclectic assortment of agents.

Even if the ghost sends these agents after the wrong target, eventually the IAs will realize that Herzberg lives on – and will take drastic countermeasures, since they can't be sure what the ghost knows. These measures probably won't include killing Herzberg or his agents – the IAs already have enough institutional guilt over the suicide – but these technoterrorists know plenty of dirty tricks, including public embarrassment, discrediting, and even false imprisonment.

Aynna is a Felicia-series combat bioroid with fairly good combat skills, but even better Intelligence Analysis and Computer Operation. She has only a few years left in her life span. IA scientists had already been researching means of extending bioroid lifespans through a highly infectious nanovirus; those who know Aynna are working feverishly.

TECHNOLOGY

MAG is in the business of creating new technology. Beyond Black Blood (see p. 98), any of a number of mundane (from a game perspective) industrial and commercial technologies will also be in development or production at any time on die Sonnenspinnerin Sieben. The station's inventory also includes the *Herzberg* cybershells:

HERZBERG CYBERSHELL 212 POINTS

Attribute Modifiers: ST -1 [-10]; DX +2 [20]; HT +1 [10].

Advantages: Absolute Direction [5]; Alertness +1 [5]; DR 10 [30]; Flexibility [15]; Infravision [15]; Machine Body [37]; PD 3 [75]; Radio Speech (Radio and laser, +40%) [35]; Vacuum Support [40].

Disadvantages: Dependency (Maintenance: common, monthly) [-5]; Invertebrate [-20]; Limited Endurance (6 hours) [-10]; Mistaken Identity [-5]; One Fine Manipulator [-15]; Social Stigma (Valuable Property) [-10].

Features: Complexity 5-7 small computer.

Date: 2088. **Cost:** \$52,000 + computer.

The *Herzberg* cybershell is a multisegmented, serpentine cybershell designed for zero-gee operations. The cybershells can be found scurrying all over die Sonnenspinnerin Sieben, including the upper reaches of the solar-panel arrays. Like the Naga snakebot (see p. TS124), the *Herzberg* cybershell can transform its entire body into a robot arm by clamping one end to a heavier object. It can also work its way into an opening as little as 8" across. 70 lbs., 6' long.

HERZBERG INFOMORPH 75 POINTS

The *Herzberg* infomorphs are essentially standard LAI-6 systems trained to a standard level. The station computers can also download new Skill Sets (see p. TS145) to individual infomorphs as necessary.

Attributes: ST varies*; DX varies*; IQ 9 [0]; HT varies*.

Advantages: LAI-6 [40]; Varies*.

Disadvantages: Varies*.

Skills: Agronomy-10 [4]; Area Knowledge (Die Sonnenspinnerin Sieben)-9 [1]; Climbing DX+2-14* [8]; Electronics (M/H)-13 [12]; Freight Handling-9 [2]; Mechanic (any)-12 [8].

Date: 2088. **Cost:** \$13,500.

* As per the cybershell they are inhabiting.

Originally intended to host a ghost of Herr Herzberg himself, the cyberbots have been repurposed with a LAI.

WIPER TREATMENT

The IAs also develop new technology outside of MAG channels and keep it secret for their own purposes. The Wiper Treatment is just one example. Undergoing Wiper involves an uncomfortable, 90-minute process in which microbots swarm across the subject's skin, removing dead cells, buttressing hair follicles, and scouring the finger pads. Meanwhile, associated nanoviruses induce random red pigmentation in the eyes, strip down the genetically encoded contents of breath exhalations, shut down the oil glands, and reduce sweat output to a minimal amount that is free of genetic content.

Once the subject endures the Wiper treatment, the microbots are removed, though the nanoviruses remain resident. For the next 24 hours, the subject will leave almost no genetic evidence of his presence unless he spits, engages in sexual activity, relieves himself, or bleeds. The first three are generally voluntary, and most IA agents hope to avoid the last one.

While Wiper is in full effect, it imposes a -8 penalty on all appropriate Forensics rolls. It causes the same penalties on Discriminatory Smell and attempts to track the subject by smell. After the 24 hours expire, the treatment gives a -4 to any appropriate Forensics rolls to detect the subject's presence. The penalty lessens by 1 every three hours afterward (-3 from 27 to 30 hours after treatment, etc.) until it reaches 0.

The treatment has a potentially dangerous side effect, in that the reduced sweating effectively lowers the user's upper extreme of temperature tolerance by 20°, making heat-related illness a considerable concern. Wiper also is rough on the subject's skin. Each repeat usage without at least three days for the skin to heal will cause a -1 penalty to Manual Dexterity and Will per repeated usage, because of scaly fingertips and rampant itching.

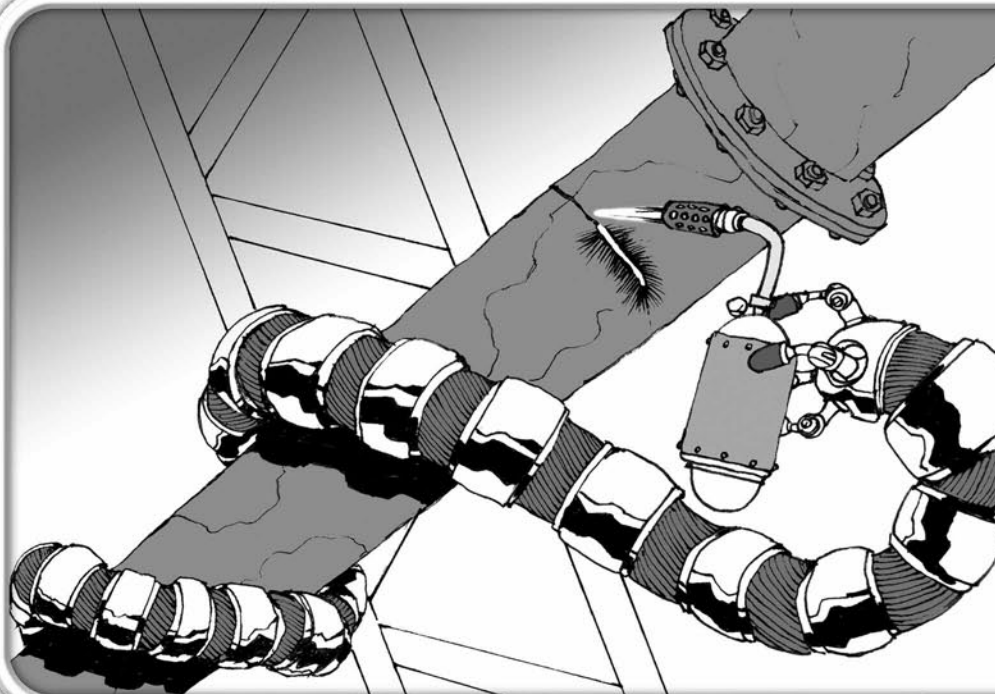
ADVENTURE SEED: THE IAs WANT YOU

The IAs are an eclectic set of adventurers with a common goal. As such, they might attempt to recruit any PC they encounter who expresses similar political leanings.

The IAs carefully compartmentalize recruits for a lengthy period, as they subtly double-check and test their loyalties. But, from the beginning, recruits will take part in operations – after all, that's what the IAs do . . . raid companies and governments to either steal funds or implement their social agenda. (Preferably both at the same time.) This provides plenty of opportunity for stealthy adventuring and a crime-based campaign, and even a noble motive for all the mayhem (depending on the adventurers' perspective).

Anyone seeking to infiltrate the IAs should not have too much trouble getting in, but once they're in they'll have a hard time keeping their motives concealed. The IA psychological research is that good. That said, a PC more interested in personal profit than political philosophy who managed to conceal his motives from the IAs would not be the first member to do so.

One potential problem is the IA distaste for lethal violence. Any recruits who display a disregard for sapient life will find themselves in hot water – and shortly afterward could find themselves awakening on some South American dockside with absolutely no recollection of the past few months . . .



The purpose of Wiper is to provide plausible deniability in case a live operation goes wrong. Given the myriad microscopic cameras and remote laser-identification devices found in most 2100 settings, an IA agent (or any other covert agent) must assume that he may be photographed without his knowledge. Remote retina-scanning is far less common, but a risk nonetheless. In an age of perfectly manipulable digital-imaging technology and cosmetic enhancements, courts generally refuse to accept a person's image alone as evidence of a crime. (Retina scans have yet to fail similar challenges, though alternate means of misleading the technology do exist outside the Wiper treatment.)

Judges and prosecutors greatly prefer forensic evidence that includes genetic content. Conversely, they interpret lack of any such evidence as a strong indication that a real, live human being was not present, and that any visual evidence portrays a cybershell duplicate or is a digitally altered hoax.

To date, non-Wiper methods of "locking in" genetic evidence have failed in court. Even microscopically thin body suits can be detected visually. Visual evidence of such special apparel voids the "genetic evidence suggests digital trickery" argument in most courts. Other covert agents have tried spiking their area of operations with millions of genetic tags – a "shotgun" approach that can be as easy to implement as carrying along a few pounds of dust obtained from a public place's ventilation system. Courts generally find that, not only do these genetic chaff clouds negate any argument based on digital manipulation, they also shoot down any argument that the crime was not premeditated!

The idea of a non-detectable means of withholding genetic evidence has been around for a long time, but no one has developed an effective technology prior to the IAs. The bottom line is that an IA agent who has undergone Wiper can legally "hide in plain sight" as long as the investigating parties don't dig too deeply. IA agents going

out on live ops routinely undergo Wiper; however, they are taught to *never* rely upon it. It's a last-ditch measure that has only once come into play.

As far as they know, the IAs have exclusive knowledge of this combination of microbot and nanovirus technology. The organization's continued refusal to release the technology to the public domain offends some of the more stridently infosocialist members. This is a shortsighted stance, because – should the courts ever become aware of Wiper – it probably would make conviction much easier by removing any need for genetic evidence to buttress video-based allegations. The prosecution could allege that any defendant they lacked genetic evidence against had simply obtained access to Wiper.

MARGARET

"I just got back from Margaret. It's wonderful, you simply must go. It's just like the old-style womyn's communes up there, but with a lot more money. The anti-patriarchal memetics workshop I took did me a world of good. And I'm pregnant now! Imagine, at my age, 75 and I'm going to be a mother again. This one is a modified clone, she's going to be better than I ever could be – smarter, tougher and more able to take care of herself than any man.

"Lots of folks say this sort of thing doesn't matter anymore, but for all our alleged advances, the patriarchy is still firmly in place. I'm going to send her up to Margaret for schooling too. Janine still refuses to reverse those damn hermaphrodite mods she got, despite me telling her I'll quit putting money in her trust fund if she didn't stop trying to become a freak. I want my next daughter to grow up to be a real woman."

*– Sachiko Tanaka, in an e-mail to her friend
Lisa Jawara*



The all-female colony Margaret is a medium-sized L4 habitat, but one of the largest and most successful to have been established by a non-governmental organization.

HISTORY

In 2059, a consortium of U.S. and European feminist and lesbian organizations, working with several British and American neo-pagan groups, drew up a plan to create an all-female space station in L4. This station, which they named Margaret after early 20th-century contraceptive pioneer Margaret Sanger, was originally conceived as a home for women seeking to live apart from men. Margaret was designed to support itself by selling real estate to wealthy women who wished to live in an all-female environment, and offering workshops and vacations to those who wished to experience it for a time.

One of the major contributors to Margaret was Dancing Crane Studios. Founded in the U.S. in 2018, Dancing Crane had, by the late 2050s, become a billion-dollar business leader in women's fitness, health products, and self-defense training, with a global network of gyms, clinics, and studios. Dancing Crane's founder Sylvia Vigil was (and is) deeply committed to the principles of feminism, and saw the need for a place where women can get away from the pervasive institutions of the "patriarchy." In 2066, Ms. Vigil moved to Margaret herself, and opened what became the largest extraterrestrial fitness and martial arts studio in the solar system. This studio offers conventional exercise programs and martial arts training while also serving as the center for the development of new styles of zero- and low-gravity martial arts.

Having recruited some of the best-known female fitness trainers and martial artists in the system, the Dancing Crane fitness studio on Margaret soon became the single most famous institution there, and one of the colony's primary attractions. Its prestige was further enhanced when the Amethyst Games, the prestigious all-female sports, endurance, and martial arts competition, was moved to Margaret in 2072. Once every two years, a hundred million sports and martial arts fans throughout the solar system watch these games, and millions of young girls dream of making their country or colony's team and competing on Margaret.

Although it continues to derive much of its income from luxurious vacation packages featuring everything from low-gravity team sports to empowerment workshops, Margaret is now best known as a center for women's fitness and martial arts. Today, having an instructor trained on Margaret is a mark of prestige for any gym or martial arts studio.

MARGARET HABITAT

Margaret is a wheel-shaped colony – a Stanford Torus – about 10,000' in diameter and 1,900' across, with a hub cylinder 1,500' long and 300' in diameter. The cylinder is attached to the hub with six 50' wide spokes through which run high-speed elevators.

The torus has a land area of over 1,200 acres, and spins to produce 0.95 G.

Attached above the torus is a large solar mirror and power array.

With the torus ceiling located 1,500 feet above the floor, its interior has an open airy appearance and a warm sunny climate similar to Greece or Southern California. Abundant parkland and attractive housing give it the earthlike feel preferred by older residents. There is a population of 47,000 humans and parahumans (closer to 51,000 when visiting tourists are included).

The hub cylinder houses about 300 people, most of them Tennin parahumans, and also contains the majority of the colony's factory space, warehouse and docking facilities, tanks for refueling spacecraft, plus the colony's command center and sensors.

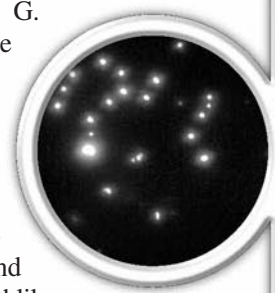
Margaret has a total population (including guests) of 51,400 with an average wealth level of Wealthy. It is CR 2 (CR 4 for weapons), and has a small spaceport.

Design: [Torus]: Torus hull (1.44 billion spaces, steel alloy, light frame), cDR/cPF 7/500 (slag armor). [Hub]: Cylinder hull (216,000 spaces, steel alloy, light frame), cDR/cPF 10/10 (steel armor). [Six Spokes]: Cylinder hulls (each 4,275 spaces, steel alloy, light frame), cDR/cPF 1/1 (steel armor). Solar panels (35,000 ksf).

Modules: [Torus]: Biofactory; 500 farm; 560 housing; 120 park; 140 plaza; 151,000 open; 3 external cradles (1,250 tons each); 6 large entry modules; 100 surgery; 50 labs; 50 minifac workshops; interstation transport (50,000 people). [Cylinder]: Old control center; 2 medium radar; 2 medium PESA; medium ladar; 2 radiocom; 10 lasercom; 2,000 tanks (1,000 MOX, 1,000 water); 2 2-MJ light laser towers [S]; 100 battery; 5 housing; 5 robofac; 200 vatfac; intrastation transport (1,000-person capacity); 4 large entry modules; 30 labs; spacedock hangar (300' long, 300' wide, 150' high, 27,000 spaces); 1,000 cargo (5,000 tons). [Each Spoke]: Interstation transit (12,750 people).

Statistics: EMass 1,440,991,146. CMass and LMass 1,441,324,350. Cost M\$939,305.93. cHP: [Torus] 5,700,000, [Cylinder] 11,880, [each Spoke] 12,030. Size Modifier [Torus] +21, [Cylinder] +10/+15, [Spokes] +20/+6. HT 12. Maintenance Interval: [Torus] 0.02 hours (4,634 man-hours/day). RRA 0.

Performance: None.



Economy

Much of Margaret's money and prestige comes from the central role it plays in women's health care, fitness, and martial arts products. The money gained from both local and online classes, licensing fees for new martial arts techniques, and sales of licensed Dancing Crane fitness products, combined with the viewing and advertising fees from the widely popular Amethyst Games, makes up 38% of Margaret's yearly budget.

Most of the rest of its income comes from genetic engineering, reproductive technologies, and women's health care products manufactured by the biotech arm of Dancing Crane, and by other companies (such as SpaTek and the Wymins' Pantropic Collective) that also have branches in the colony. In addition to financing clinics on Earth where women can reproduce using artificial wombs, Margaret also maintains extensive genetic engineering labs. Women from nations where radical genetic alterations are illegal or difficult to obtain can come to Margaret to have female children designed to their specifications. The Ariadne (p. FW116) parahuman design is popular on Margaret, and the colony's geneticists have produced an enhanced version, the Ariadne II (p. FW117). The colony's own subculture of physical fitness also led to some unique designs, such as the Hippolyta (p. 106).

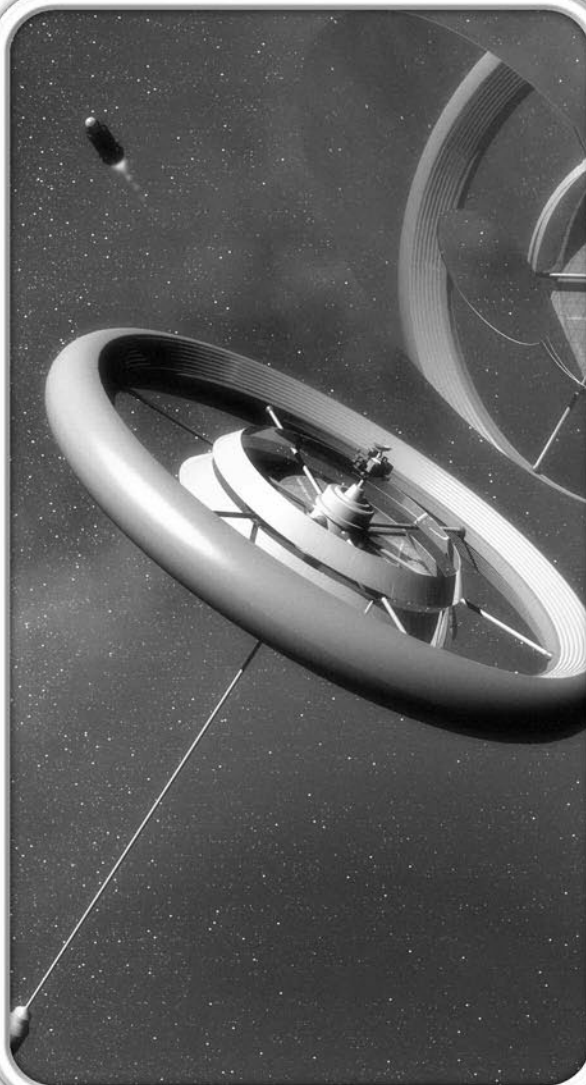
Margaret also remains a popular destination for wealthy female tourists. It offers online and in-person empowerment workshops and classes in meditation and shamanic techniques, as well as workshops in neo-pagan history and practice.

Because of their renown as expert martial artists, a number of Dancing Crane's more accomplished students have become well-paid bodyguards for important corporate and political figures. In 2087, the Dancing Crane studio on Margaret began offering specialized bodyguard training, and it is rapidly becoming the most prestigious source for female bodyguards in the entire solar system.

The prestige of Margaret bodyguards was further increased in 2095, when Jenissa Crow, assigned to protect the CEO of the U.S.-based company Fatima Biotechnology, saved the life of her employer, Mr. Falazai, and his companion, when they were attacked by a pair of nanosocialist terrorists during a tour of a company subsidiary in East Timor. Despite having been shot, Ms. Crow disabled one gunman, then broke the second attacker's neck with a kick. Since the entire incident was caught by a bystander's Virtual Interface and sold to Teralogos News, the action was seen across the solar system. Demand for Margaret-trained bodyguards has quadrupled since that incident.

Some of the bodyguards trained on Margaret occasionally work as assassins and enforcers for various criminal organizations, although the colony does not advertise this fact. The most infamous alumna is the martial artist Irene Sutowo, with a reputed 21 kills. After her

disqualification from a transpacific kickboxing circuit following a fight that left her opponent dead in the ring, Suwoto ended up working for the Thai-based Prasong-Lao crime syndicate. Some other Margaret-trained fighters have ended up working for Duncanite security companies. However, the vast majority of Margaret-trained bodyguards have no connection with illegal activities.



SOCIETY

Margaret's population is all female. About one-third are baseline humans (most of them genefixed), one-third are genetic upgrades, and the remaining (and youngest) third are parahumans. The most common parahuman model is the Ariadne (p. FW116), but parahumans of various other types, notably the indigenous Hippolyta, are also present. There is also a small population of emancipated female bioroids (under a hundred).

About half the population live in traditional nuclear families with two (female) parents and, usually, children. Most children of female couples are produced through DNA blending technology (p. TS72), although about 15% are simple parental clones.

While Margaret is large, prosperous, and backed by several exceedingly wealthy individuals, it is also well on its way to becoming an anachronism. The people who founded Margaret grew up amidst the gender inequalities of the 20th and early 21st centuries. Such inequalities have now largely vanished in the vast majority of Fourth and Fifth Wave nations. Today, many younger women see Margaret as an excellent place to receive fitness instruction, martial arts training, or high-quality, no-questions-asked genetic engineering, but they regard its women-only policy as archaic and somewhat silly.

In addition, when Margaret was founded, changing gender was still a difficult, lengthy, and expensive surgical process. Now, it is inexpensive, quick, and relatively painless. Currently, more than 5% of the population of the Fifth Wave nations has changed gender as an experiment, and the numbers continue to increase as body-sculpting procedures become easier and less expensive. Today, the very definitions of male and female are far from certain, and the highest-quality sex-change procedures require a detailed medical exam to detect.

These technologies have had a dramatic impact on the rules about visiting Margaret. To avoid excluding women with genetic anomalies, and to include people who wish to become women, anyone is free to come to Margaret if they can pass a blood test that indicates they have the correct range of hormones and a physical test to determine that they possess female anatomy. The recent fad for exotic and hermaphroditic sexual characteristics has caused considerable controversy on Margaret. Currently, the rules allow hermaphrodites and other exotic types if their blood tests are within the acceptable range. Some of Margaret's older residents worry that if present trends continue, terms like male and female may cease to have any real meaning.

Many of the younger residents and most visitors would happily eliminate the women-only policy as an archaic reminder of an irrelevant past. However, almost two-thirds of Margaret's permanent residents are over 60 years old and have not fully adapted to modern attitudes about gender. Today, few young women immigrate to Margaret, but older women continue to move there. Demographic predictions by the advisory SAIs indicate that it is unlikely that the women-only rule will be revoked any time in the next decade.

Local Memes

As one might expect in an all-female colony, many residents consider women to be morally, emotionally, and occasionally even intellectually superior to men. Also, a substantial minority of residents are uncomfortable around men and consider them innately threatening. Many of the women on Margaret learn martial arts or other self-defense techniques for the express purpose of learning to protect themselves from men. Such feelings are mostly confined to older residents who grew up in eras with far greater gender prejudice.

The colony's focus on fitness and martial arts means that many residents are highly concerned with health and exercise. Almost everyone on Margaret performs regular physical activity. Tai chi, aerobics, boxing, weightlifting, and swimming are all extremely popular. Residents who do not actively keep in shape are normally regarded as lazy and weak-willed.

In keeping with the colony's feminist principles, egalitarianism is a dominant local meme. While a number of ex-students have gone on to become bodyguards and security personnel, over half of the residents are ardent pacifists. As a result, even individuals who are not pacifists strongly believe that violence should be a tactic of last resort.

GOVERNMENT

Based upon late 20th and early 21st-century feminist theory, Margaret is governed by consensus, aided by advanced SAI social modeling programs. Every permanent resident is expected to vote on all issues, advised by the SAIs' recommendations. If anyone registers strong objections to the results of a vote, the issue is discussed in various open forums until the disagreement is resolved.

In practice, most highly controversial issues are settled through compromise, which is quite practical in a station the size of a mid-sized town. Less critical issues tend to be resolved when the opponents grow tired of objecting. Since forums for discussing these issues are open to all citizens, the few opponents of otherwise popular measures can face significant social pressure to remove their opposition.

Like many of the mainstream L4 colonies, Margaret is at the forefront of pansapient rights. Ownership of uplifted animals and SAIs is illegal on Margaret. Dancing Crane founder Sylvia Vigil has been experiencing health problems and has stated that she will become a ghost when medical science can no longer maintain her health and quality of life.

HIPPOLYTA PARAHUMAN 140 POINTS

Attributes: ST +2 [20]; DX +1 [10]; IQ +1 [10]; HT +1 [10].

Advantages: Alertness 1 [5]; Attractive [5]; Combat Reflexes [15]; Early Maturation [5]; Easy Childbirth (p. BIO48) [1]; Extended Lifespan 1 [5]; Fit [5]; High Pain Threshold [10]; Hyper-Reflexes [15]; Immunity to Disease [10]; Less Sleep 1 [3]; Longevity [5]; Night Vision [10]; Rapid Healing [5]; Recovery [10]; Reproductive Control [2]; Sanitized Metabolism [5]; Toughness (DR 1) [10].

Disadvantages: Gluttony [-5]; Increased Life Support [-10]; Light Sleeper [-5]; Overconfident [-10]; Proud [-1]; Stubbornness [-5].

Features: No Appendix [0]; Taboo Traits (Genetic Defects, Male).

Availability: 2081. **Cost:** \$190,000.

The Hippolyta genotype is a modification of the Ziusudra parahuman, produced under license from Biotech Eurphrates by Crane Genetics. Hippolytas are physically similar to Ziusudras, although their heightened metabolism can sometimes give them away. Hippolyta-series parahumans must eat twice as much as normal humans to maintain their health.

Hippolyta parahumans are fast, strong, and extremely durable. They excel as fitness instructors, athletes, intelligence agents, law enforcement officers, and security personnel. However, almost half of the customers who request this genotype are extremely wealthy women who simply wish their daughters to be strong, powerful, and able to defend themselves in all situations. There are currently around 4,000 Hippolyta parahumans, about half of them living in Margaret.

VISITING MARGARET

All visitors must undergo moderately thorough searches and medical tests. These tests determine if the individual is carrying any dangerous technologies, and to establish if the visitor meets the current criteria for being considered a woman. Margaret is registered as a U.S. corporation and private club; as private property, the company is free to exclude males from residence. Men may come no further than a special chamber in the hub, where they can meet with residents in high-security meeting rooms. Any woman who agrees to abide by Margaret's laws can visit or immigrate here.

MARGARET EXTERNAL AFFAIRS

Margaret is U.S. territory, and tries to stay on the good side of the American government, though this depends on which administration is in power. Margaret gets along fairly well with Islandia and the E.U. in general. Devout neo-pagans regularly travel to the Wiccan colony of Ravenstar (p. 133) to hold large public solstice and equinox rituals. Ravenstar is not gender segregated, and most of its younger residents are puzzled by Margaret's continuing female separatism, but otherwise, ties between these two colonies are quite close. Margaret has a cordial relationship with the MacLarren Unity.

The residents of Margaret regard the Mormon colony of New Deseret as an abomination, and there is a special organization on Margaret devoted to sending coded e-mails to young women on New Deseret who express an interest in leaving that colony. Some of the most extreme residents of New Deseret have made threats against both Margaret and Ravenstar, but so far these threats have proven to be empty. However, some radicals on Margaret are working to help a small group of female rebels on New Deseret seize control of that colony.

THE MACLAREN UNITY

"It was an odd place to grow up, a lot like a really large family, but all us kids were the same age. I think it's true that your clones understand you like no one else ever can. Heck, even Eldest, I mean Hiroshi, knew that we'd all likely be at our most rebellious when we were between 13 and 15, and then would mostly settle down. It was damn hard to get away with anything, but you also knew that when you screwed up everyone would truly understand. I remember the time when I was 13 and Hiroshi came to me about the warning he'd received from some Euro-cops about my unauthorized web access. He was mad at me, but he also told me about how the Japanese police gave his guardian a similar warning when he was 14. It's hard to be really mad at someone when you know deep down that you'd likely do the exact same thing in their place."

– Sasha MacLarren,
1,200 Brothers (Luna City, 2099)

The MacLarren Unity is a mid-size Bernal sphere colony, a testament to a billionaire's eccentric vision, and the home of the single largest clone family in the solar system.

HISTORY

Hiroshi MacLarren was born in 2053, the child of billionaire industrialist Kiko MacLarren and her husband Colin Lewis-MacLarren. Using the most advanced genetic engineering of the time, Ms. MacLarren was determined that her child would be the most genetically perfect human ever created. She hired the best technicians to create a modified parahuman genotype that would later form the basis for the Ziusudra (p. TS118).

Although the new genotype had a few problems, mostly corrected through gene therapy, Hiroshi was an unusually brilliant child. His parents paid close attention to his development and did their best to insure that he would live up to his full potential. Unfortunately, in 2065, when he was only 12, both his parents died when their private jet crashed following an engine malfunction. Deprived of his parents, MacLarren lost himself in his studies.

Taught by highly skilled private tutors, he excelled at school and received the equivalent of both an MBA and a Ph.D. in computer science by the time he was 20. At this point, he ceased his schooling and took control of his vast fortune. Within two years he had nearly doubled the assets of MacLarren Consolidated through stock and currency speculation, using market prediction software of his own design. He now had funds sufficient to begin the construction of his greatest dream: a world composed only of himself.

After being raised by parents and tutors who constantly assured him that his was the best genotype money could buy, Hiroshi MacLarren was determined to create a place where he and his clones could live in narcissistic harmony. When he was 22, he purchased several thousand artificial wombs and created 2,500 clones. He then hired nurses and tutors to raise his huge extended family. Five years later, he commissioned the construction of a Bernal sphere capable of holding up to 10,000 residents.

In 2082, when the clones were seven years old, the habitat was completed and Hiroshi MacLarren and his 2,500 clone-children moved in. Not wanting his younger siblings to be spoiled by further contact with inferior beings, MacLarren had the children raised by several hundred LAI bioshells, along with as much personal attention as he could manage. With the exception of a few physicians and highly select visitors, the clones saw no one who was not genetically identical to them for the next decade. During this time, two additional generations of clones were created, one in 2084 and another in 2091. Each generation was half the size of the initial 2,500 and was raised by both their older siblings and the bioshells. By 2092, the first generation of clones was 17 years old, and a sizable minority wished to leave. Some wanted to travel and see the rest of the solar system, while others had fallen in love with individuals they had met online and wished to leave to meet them.

He now had funds sufficient to begin the construction of his greatest dream: a world composed only of himself.

MacLarren had not anticipated this last desire. He had attempted to provide for all of his clones' needs, and had not considered that they would ever need to look beyond each other. However, he could not bear to forcibly restrain his own siblings, so he permitted all clones over the age of 15 to travel if they wished. He also allowed visitors to come to the station, in an effort to keep clones who merely wanted outside contact from leaving. Although around a third of the older clones left, most returned within two years. Only 10% of the initial batch of clones decided to take up permanent residence elsewhere.

MACLAREN UNITY HABITAT

The space colony is a Bernal sphere 2,000' in diameter. The colony spins to produce artificial gravity, strongest (1 G) along the equator, and gradually decreasing to zero gravity at the poles. Much of the colony interior is open park, housing, and farm land, giving a fair sense of space.

The MacLarren Unity is, first and foremost, a home and community. The colony is largely self-sufficient in terms of industrial products and foodstuffs, but does import various luxury and brand-name goods, as well as raw materials and fertilizer.

The colony has a population of 4,600, with an average wealth level of Wealthy. It has a small spaceport and is CR 1 (4 for non-MacLarren visitors). There's about 663 spaces left unpressurized for future expansion.

Design: Sphere hull (8 million spaces, steel alloy, light frame), cDR/cPF 5/100 (slag armor). Solar cells (8,000 ksf); solar panels (12,500 ksf).

Modules: New control center; 2 medium radar; 2 medium PESA; 5 lasercom; radiocom; 30 battery; 1,000 tanks (500 water, 500 MOX); biofactory; 100 farm; 100 reconfigurable housing; 536 open; 25 park; 25 reconfigurable plaza; 10 robofac; intrastation transport (10,000-person capacity); 10 large entry modules; 20 surgery; 100 labs; 20 minifac workshops; spacedock hanger (300' long, 300' wide, 100' high; 18,000 spaces); 3 external cradles (3,125 tons each); 5,000 cargo (25,000 tons).

Statistics: EMass 12,630,963; LMass and CMass 12,673,964. Cost M\$16,972. cHP 93,750. Size Modifier +15. HT 12. Maintenance Interval: 0.15 hours (625 man-hours/day). RRA 0.

Performance: None.

VISITING THE MacLarren Unity

Visiting MacLarren is often a somewhat surreal experience: Everyone looks the same. They are all skinny, Eurasian men who are 5'9" tall. The only difference is that the original MacLarren is 47, and the clones are all either 25, 16, or 9 (a new generation of clones is planned in 2101 to celebrate the new century). All of the residents are obsessively brilliant mathematical geniuses. However, they are also children, teens, or young adults, and many are eager for contact with outsiders and experience with the wider world.

Most visitors come to take advantage of the collective genius of the inhabitants. While ordinary requests for data analysis, mathematical modeling,

computer programming, or similar tasks can be handled online, some requests are so sensitive or secret that they are dealt with in person. Since MacLarren clones seldom leave the colony, clients come to them. Occasionally, individuals come requesting aid on illegal endeavors. While few of the clones are willing to personally perform obviously illegal acts, some of them are happy to provide information that will aid others in their illicit endeavors. Spies and thieves often watch clients going to MacLarren, since many people who go there are seeking help with potentially valuable projects.

INSIDE THE MacLarren Unity

MacLarren is one of the most luxurious space colonies ever constructed. All public and private areas are nanotechnological marvels that can be restructured at a whim. In addition to advanced robofactories capable of providing for the residents' every need, the colony also contains extensive laboratory space, state of the art computers, and similar amenities for those clones who wish to pursue special projects.

Physically, the colony's climate and parklands are designed to resemble central Japan, where Hiroshi MacLarren spent his childhood vacations.

GOVERNMENT

The colony is run by its founder, Hiroshi MacLarren. His role is somewhere between that of a benevolent despot and a loving parent. He submits all major changes to a popular vote, and the clones can also vote independently to challenge any of his decisions.

Although MacLarren is not formally bound by any of these votes, he normally abides by them to insure harmony. Serious disagreements are rare. While the clones may not all agree on a given issue, they can almost always fully understand the opposing point of view.

The MacLarren Unity operates under a "flag of convenience" arrangement with the free city of Montreal, where MacLarren Industries is a registered corporation.

THE ECONOMY

More than one journalist has referred to The MacLarren Unity as "the smartest place in the solar system." Since every resident is a mathematical genius who has the backing of a multi-billionaire, money is little problem for this colony. Many clones work directly for MacLarren

Consolidated, tracking investments, searching out new investment opportunities, or creating advanced software for company use or for sale.

While Hiroshi MacLarren is an expert at both computer programming and financial analysis, many of his clones have different interests. There are musicians, mathematicians, actors, engineers, lawyers, meme miners, and authors.

The colony's vast wealth and MacLarren's desire to indulge his clone-children's whims and passions means that none of the clones actually need to work. Every clone is supported by a sizable trust fund. However, all clones are expected to have one or more serious hobbies. Both the elder MacLarren and their other siblings speak sternly to those clones that wish to live as idle dilettantes. However, non-monetary hobbies like inventing complex mathematical games or performing detailed literary analysis of 20th-century movies are all perfectly acceptable occupations, as long as the project is mentally stimulating and the individual has something interesting to show for his work.

Local Memes

While Hiroshi MacLarren encourages diversity among his thousands of clone "brothers," they share a large number of common attitudes and beliefs. The most important is a devotion to each other. Among all but a few of the MacLarren clones, family always comes first.

While intelligence is considered valuable almost everywhere, this is even truer among the MacLarren clones. Although some clones admire physical prowess in themselves and others, mathematical puzzles and games like chess and go are far more popular than any form of sports, exercise, or martial arts practice. The younger MacLarren clones regularly engage in contests of mental ability, and clones who leave the colony often find that the emphasis they place on intelligence makes others consider them snobs and elitists.

MacLarren Clone Templates

All clones share the same basic template. However, many of them possess increased attributes due to training and education. IQs of 14 or 15 are quite common. The MacLarren clones also differ in their social and mental advantages and disadvantages, skills, and motivations.

Unlike many of the less extreme genotypes, MacLarren clones possess a number of significant disadvantages. While improved technology has meant that some of these disadvantages could be corrected in the most recent clones, few MacLarens are willing to tamper with their precious genotype. Also, many geneticists now agree that the main features of the MacLarren genotype, including its extremely high intelligence, cannot be duplicated without including most of the disadvantages. Hiroshi MacLarren has little desire to see clones of himself raised by strangers, so he has forbidden outsiders from studying his genotype.

On Islandia, however, a small group of immigrant MacLarens who have become a Hive (p. 87) are actively studying the MacLarren genotype. Hiroshi has not yet taken any action against them because he doesn't want to restrain any of his siblings' projects. This group, known as The Outsiders, is attempting to use a modified MacLarren genotype as the basis for creating a successful Hive that contains dozens or even hundreds of members.

The Intolerance (all non-MacLarens) [-10], Overconfident [-10], and Workaholic [-5] disadvantages are common, but far from universal among the clones. While many MacLarren clones see themselves as the pinnacle of human evolution, some take advantage of various temporary or permanent biomods. Clones who use biomods that change their physical appearance will be shunned by other clones, and will acquire a -3 Bad Reputation among the entire MacLarren population. In general, only those clones who wish to cut themselves off from the rest of their family make significant changes in their appearance. Clones who truly wish to abandon ties to their relatives also change their last name. Clones who cut themselves off from the rest of the colony forfeit the trust fund that Hiroshi MacLarren has set up for them, so their income is whatever they can earn on their own.

MacLarren Clone Parahuman 97 POINTS

Attribute Modifiers: ST -1 [-10]; DX +2 [20]; IQ +3 [30]; HT +1 [10].

Advantages: Attractive [5]; Disease-Resistant [5]; Early Maturation [5]; Eidetic Memory (No skill bonus, -70%) [9]; Extended Lifespan [5]; Independent Income [5]; Lightning Calculator [5]; Longevity

[5]; Mathematical Ability [10]; Rapid Healing [5]; Versatile [5]; Wealthy [20].

Disadvantages: Alcohol Intolerance [-1]; Attentive [-1]; Compulsive Behavior (Counting things) [-5]; Insomniac [-10]; Low Pain Threshold [-10]; Unusual Biochemistry [-5]; Weakness (Airborne pollen; Fatigue damage only, 1d/5 minutes) [-5].

Features: Sexual Orientation (Homosexual); Taboo Traits (Genetic Defects).

Date: 2075. **Cost:** Not legally available; illegally obtained genetic material would cost upwards of \$200,000.

MacLarren Unity External Affairs

The MacLarren Unity and MacLarren Consolidated maintain a strict policy of political neutrality. The station trades equally with Earth, Mars, Luna City, Islandia, radical Duncanites, and even several infosocialist L5 colonies. Hiroshi MacLarren does draw the line at trading with dangerous fanatics like the leaders of Fountain-1, but avoids giving any offense to these groups. He merely refuses to take contracts from them. A few MacLarren clones have strong political views, but since they range from Green System to radical preservationist, the net effect mostly cancels out, especially since most members of the MacLarren family are almost as apolitical as their creator.

Hiroshi MacLarren and those clones who assist him in the family business refuse to take contracts they feel to be immoral, but will otherwise work with almost any group or individual who is able to pay them. While Hiroshi MacLarren is still primarily motivated by a desire to maintain the family fortune, many of his younger assistants are equally interested in the challenge of the assignment. Clients with unusually interesting or difficult problems sometimes receive a substantial discount on their bill.

Four months ago, a trio of 25-year-old MacLarren clones became involved with the infosocialist IAs of die Sonnenspinnerin Sieben (p. 93). While these clones still live on MacLarren, they have all visited die Sonnenspinnerin Sieben several times, and last month Liam MacLarren became romantically involved with Shane Anderson, CEO of Materials Application Geosynchronous, Inc. and a senior member of the IA. Liam MacLarren is a skilled data analyst and is eagerly lending his considerable expertise to various IA projects.

HIROSHI MacLarren 354 POINTS

Age 47; 5'9" tall. 145 lbs.; Hiroshi MacLarren is an attractive Eurasian man with long black hair and piercing green eyes. He is normally dressed in the latest fashions.

Hiroshi MacLarren is the head of MacLarren Consolidated and the leader of the MacLarren Unity colony. He is also one of the hundred richest people in the Solar System. While he only leaves his colony on special occasions (preferring the company of his clones to that of other people), he interacts virtually with the rich, famous, and powerful of the solar system on a regular basis. Rumors about his buying choices can make or break companies. His actions, comments, and thoughts are regular topics for discussion by journalists in all nations.

ST 9 [-10]; **DX** 14 [45]; **IQ** 15 [60]; **HT** 11 [10].

Speed 6.25; Move 6.

Dodge 6; Parry 6.

Advantages: Attractive [5]; Disease-Resistant [5]; Eidetic Memory (No skill bonus, -70%) [9]; Extended Lifespan [5]; Filthy Rich [50]; Lightning Calculator [5]; Longevity [5]; Mathematical Ability [10]; Multimillionaire 3 [75]; Programmable Ally (Wearable info-morph with LAI-7, 90 points, available 15 or less) [15]; Rapid Healing [5]; Status 5 (3 free) [10]; Versatile [5]. **Biomods:** Artery Cleaners [0]; Carninophages [3]; DNA Repair [4]; Guardians [5]; Pore Cleaners [2].

Disadvantages: Alcohol Intolerance [-1]; Compulsive Behavior (Counting things) [-5]; Insomniac [-10]; Low Pain Threshold [-10]; Selfish [-5]; Sense of Duty (MacLarren Clones) [-10]; Unusual Biochemistry [-5]; Weakness (Airborne pollen, Fatigue damage only, 1d/5 minutes) [-5].

Quirks: Attentive; Careful; Chauvinistic (MacLarren Clones); Dresses very extravagantly; Imaginative. [-5]

Skills: Accounting-18 [6]; Acting-15 [2]; Administration-16 [4]; Area Knowledge (Japan)-15 [1]; Area Knowledge (L4)-16 [2]; Artificial Intelligence-16 [2]; Bard-15 [2]; Board Games-16 [2]; Computer Hacking-16 [4]; Computer Operation-20 [1]; Computer Programming-18 [6]; Cooking-14 [1/2]; Detect Lies-14 [2]; Diagnosis-12 [1/2]; Diplomacy-17 [6]; Economics-17 [8]; Electronics (Computers)-15 [1]; Electronics Operation (Communications)-14 [1]; Electronics Operation (Security Systems)-13 [1/2]; First Aid-15 [1]; Free Fall-12 [1]; Gambling-13 [1/2]; Guns-14 [1/2]; History-14 [2]; Linguistics-14 [4]; Literature-13 [1]; Mathematics-16 [2]; Memetics-14 [4]; Merchant-16 [4]; Politics-14 [2]; Psychology-15 [4]; Savoir-Faire-16 [2]; Vacc Suit-14 [1/2]; Writing-15 [4].

Language: Chinese-15 [1]; English-15 [1]; French-15 [1]; Japanese-15 (native) [0].

Equipment: MacLarren is rarely seen without a wearable Virtual Interface that also contains an LAI-7 of his own design. This AI constantly monitors news and financial data and alerts him to anything of interest. He also frequently wears the latest designer clothing and an RTG powered, 4-hex color-changing swarmwear cloak that includes flyer chassis Forensic, Paramedic, Stinger, and Surveillance hives. When traveling away from MacLarren he wears a set of light nanoweave armor that has been impeccably tailored.

MacLarren Unity ADVENTURE SEED

One of the 16-year-old MacLarren clones recently vanished while visiting Islandia, and Hiroshi MacLarren just received a message asking for 10 million dollars for his safe return. If the PCs operate a detective agency or similar organization, they may be contacted by Hiroshi MacLarren, and asked to find the missing teen. Alternately, one of the PCs may have overheard or otherwise accidentally received a message from the teen, who is confused and seeking help.

After a serious disagreement with Hiroshi MacLarren, the young clone, named Ikko, ran away to live with friends he had met online. To help his friends get money and to strike back at Hiroshi, Ikko worked with his new friends to make it look like he had been kidnapped. Unfortunately, Ikko became unsure about wanting to really cut himself off from his family. His friends, including the young man he ran away to be with, do not want him to back out, since they would lose the 10 million dollar ransom. The fake kidnapping is becoming increasingly real. While Hiroshi MacLarren is anxious to get the boy back, his security advisor has told him that sending anyone from MacLarren Consolidated to search for the boy could further endanger him. Also, few of the clone family have the skills necessary to retrieve a kidnapping victim. The MacLarens are all happy to let the PCs help. A few of the other teenage clones know Ikko was going to meet friends he had met online. His closest friend, Raymond MacLarren, suspects that Ikko was planning to run away, but has so far been unwilling to tell anyone.

OTHER L4 COLONIES

There are over 100 colonies and stations in Lagrange 4, ranging from standard orbital factories and research stations to unique colonies inhabited by members of a single religion or ideology. A few examples are described below.

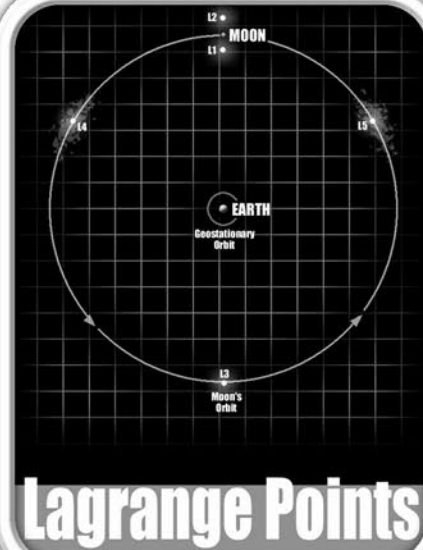
Amagi-3

This newly-built habitat (housed in a 500'-diameter sphere) is the principal space factory of the Japanese industrial firm Nippon Uchuukai-hatsu Kaisha (p. TS95). NUK is one of the largest of the many corporations that has begun relocating its major complexes from Earth orbit to L4 over the last decade.

Amagi-3 is a manufacturing center for cybershells, satellites, and space-going vacuum- and microgravity-adapted microbots; in fact, it makes most of the repair, painter, and cleaning swarms used for spacecraft maintenance. It's also the site of NUK's microbot R&D laboratory, which develops and tests new models. The laboratory has a system-wide reputation of being on the cutting edge of industrial microbot design. Almost all of the station is devoted to robofac and (mostly automated) laboratory facilities, with very little living space.

Less well known is the fact that the station is also the home of the Echo Project, NUK's "dry nanotechnology" research laboratory. Echo Lab is carefully isolated from all contact with the rest of the factory, for both security and safety reasons. No significant progress has yet been made, but researchers are quite hopeful that there will be a major breakthrough in the near future. No actual living humans or parahumans work or live in Echo; all work is carried out by cybershells teleoperated by researchers on the main VBFA asteroid, assisted by additional ghost, SAI- and LAI-controlled cybershells. Several other companies, including rivals Nanodynamics and Xiao Chu, have become aware of the secrecy surrounding the Echo Project, and are now recruiting industrial espionage specialists to help determine the extent of its progress.

Amagi-3 has a transient population of 300 people, along with several thousand cybershells. Many of NUK's researchers actually live in Islandia, and either telecommute or visit the station as necessary. Amagi-3 is Japanese territory, and a CR 5 facility.



AQUARIUS STATION

This 900-diameter water-filled Bernal sphere is the home of GenTech Pacifica's Space Aquaculture Project, which researches the effects of microgravity upon aquatic lifeforms, for the purpose of developing microgravity adaptation biomods for them. This project is likely being performed with the expanding asteroid belt colonist market in mind, and may involve a quiet partnership with Avatar Klusterkorp.

Aquarius Station has a population of 170, including Aquamorph parahumans and uplifted marine animals such as dolphins and octopi. Security is relatively heavy, as GenTech Pacifica has received intelligence that the station is being targeted by Blue Shadow environmental activists. The station is Australian territory, and is CR 5.

NEW DESERET

The Church of Latter Day Saints founded New Deseret in 2054. Along with Ravenstar (an all-Wiccan colony), New Deseret is one of the two oldest single-religion colonies still in existence. New Deseret is a Stanford Torus similar in size to Margaret (p. 102).

Designed to hold up to 40,000 people, its current population is 29,000. Originally constructed as a refuge from an increasingly secular world, it was planned as the first of a series of all-Mormon colonies, where the highest-ranking members of this faith could live in joyous harmony. Unfortunately, the church was only able to afford one other colony, New Kirtland. In 2071, factional violence within the New Kirtland colony escalated to the point that a group of fanatics demanding political and doctrinal changes set off several large explosive charges when they were attacked by the colony's security force. These explosions depressurized the colony, killing almost a third of the 4,000 residents before rescue teams from other colonies could arrive.

In the wake of the disaster, the church has given up on future space colonies and New Deseret remains a monument to failed dreams. Today, over 30% of the children born on New Deseret leave both the colony and the Mormon faith by the time they are 20. Most of them never return. The colony's population is slowly declining, despite its high birth rate and occasional immigration from Earth. Most earth-based Mormons regard New Deseret as an unfortunate failure.

New Deseret is ruled by a council of elders, most of whom are well over 100 years old. Some of the middle-aged men have begun to resent the potentially endless rule of these elders, and have recently petitioned for limits on the terms of council members.

Economically, the colony is largely self-sufficient. The inhabitants earn additional money for the colony by doing low-level programming and other forms of high-tech contract work. This income was initially supplemented by donations from the Earth-based church, but these were sharply reduced shortly after the destruction of New Kirtland.

The colony rotates to provide 1 G gravity. Inside, New Deseret's interior is landscaped to resemble a somewhat more verdant version of the American west, with individual houses and small apartment complexes. Large flat-screen displays cover most of the walls and roof of the torus. These screens display scenes from Earth and images from Mormon history and theology.

Most visitors to New Deseret are Mormons or potential converts, although declining revenues have forced the colony to admit a limited number of virtual and in-person religious tourists. These tourists are interested in experiencing life as members of various faiths, but seldom convert. Non-virtual religious tourists rarely stay in New Deseret for more than a week.

New Deseret's 29,000 citizens have an average wealth level of Comfortable. The colony has a small spaceport and is CR 4.

VOSPER-BABBAGE FACTORY ASTEROID

The VBFA is a vast factory complex occupying an oval asteroid two miles long and over a mile in diameter, which was moved into L4 in 2053. It is primarily nickel-iron, but has a significant deposit of carbon compounds that seems to be the remnant of an ancient collision with another asteroid. This asteroid serves as both the physical structure of the colony and the source for most of the factory's raw materials, as currently only a small portion of the asteroid's mass has been either mined or tunneled for habitation.

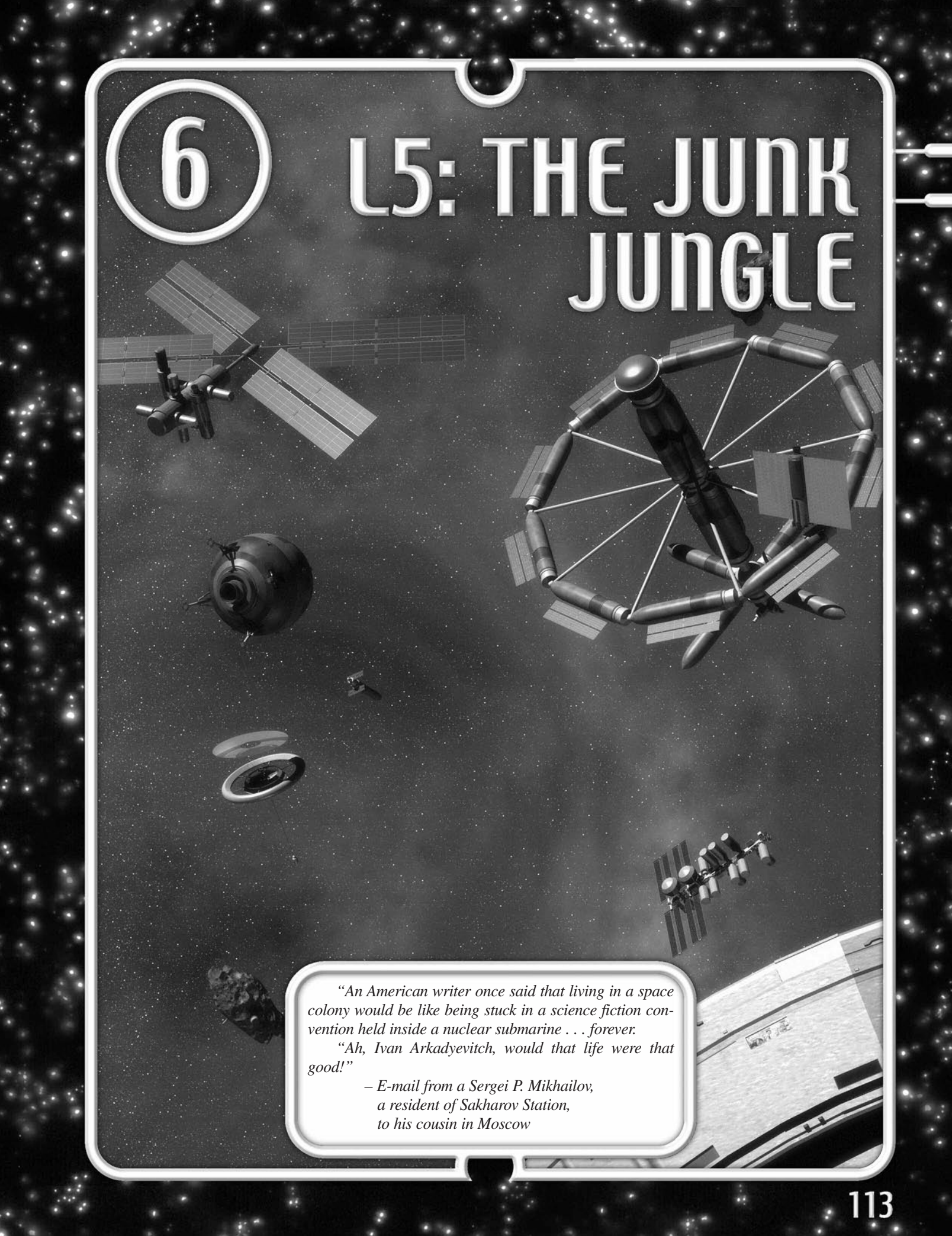
This asteroid is Vosper-Babbage's largest single factory, and has an annual income almost 30% of Islandia's. The major activity performed here is spacecraft manufacturing, but for the civilian and military sectors. The popular *Sudbury*-class USVs and deadly *Resolution* and *Gram*-class SDV-90s are manufactured here.

Unlike Islandia, the VBFA asteroid is almost exclusively a series of giant factories and research facilities. The interior is a maze of tunnels from 30 to 100 feet in diameter, and is festooned with a vast array of company logos, small shops, dwelling units, and advertising posters. There are huge spherical zero-gravity plazas at the intersections of some of the largest corridors. These plazas are covered with a 3-D lattice of cables that allow workers to easily get around.

VBFA is a microgravity habitat. Over 85% of VBFA workers are cybershells inhabited by LAIs and some SAIs. However, there are also more than 3,000 human and parahuman technicians, engineers, and scientists working here. Although much of the work is done by cybershells or humans with microgravity nanomods, Vosper-Babbage is always seeking to hire experienced Tennin and Vac parahumans to work in the zero-gee portions of the VBFA. About 2,000 of the factory's employees are microgravity-adapted humans who live in spacious quarters inside the main VBFA asteroid. The rest are temporary workers, some of whom commute back and forth to permanent residences in Islandia or other L4 colonies.

The human and parahuman employees stationed at VBFA have an average wealth level of Wealthy. The station has a small spaceport and is CR 5.





6

L5: THE JUNK JUNGLE

"An American writer once said that living in a space colony would be like being stuck in a science fiction convention held inside a nuclear submarine . . . forever.

"Ah, Ivan Arkadyevitch, would that life were that good!"

*— E-mail from a Sergei P. Mikhailov,
a resident of Sakharov Station,
to his cousin in Moscow*

Lagrange 5 is the region of gravitational stability located 60 degrees behind Luna's orbit around Earth. An object that is placed there will continue orbiting the L5 point, while being carried along by Earth and Luna as they orbit the sun.

Both the L4 and L5 Lagrange points saw stations established in the 2030s and 2040s. This was the boom time era of asteroid mining, and both of the Lagrange points were the destinations of nickel-iron and carbonaceous asteroids that were be boosted to feed Earth's space construction needs.

Things changed in the 2050s. The effort to build the huge Islandia colony (p. 83 in L4 resulted in a shift in population and income away from L5. Unable to compete, the majority of the L5 factory stations were eventually shut down, or sold to non-commercial concerns.

Although L5 was an economic backwater, its underused space stations were appealing to certain groups seeking to get away from it all – especially those who could not afford a step farther out to Mars or the asteroids. The first “fringe group” to see the possibility of acquiring a cheap second-hand property in L5 was a group of wealthy Christian hyperevolutionists (p. TS89) who in 2065 bought the old Vehicle Factory 4 from Vosper-Babbage, and set about creating the community they named Seventh Heaven (p. 134).

However, full-scale settlement of L5 did not begin until the 2070s and 2080s. The precipitating event was the development in 2070 of relatively cheap cellular repair nanosymbionts. First sold to spacers, they soon became popular in microgravity stations in Earth orbit and L4. The availability of DNA repair and microgravity biochemistry nano made it practical for people to live in inexpensive, poorly-shielded space habitats.

That's just what happened. There is plenty of old space junk sitting in Earth orbit. Most of this material was usually deorbited or allowed to burn up when its orbit decayed naturally, but some usable habitats were in high orbits. They were suitable and – more importantly – cheap, especially if one wasn't too picky. There were plenty of junk cleaners and other spacers who could be hired to tow it to a Lagrange point; L5 gradually accumulated a huge collection of improvised habitats, assembled from obsolete satellites, work shacks, fuel tanks, boosters, and mined-out “Swiss cheese” asteroids. It also got a new nickname: the Junk Jungle, scrap heap of the solar system.

Since the 2070s, and in particular since the Pacific War, the “junk jungle” of Lagrange 5 has become home to an ever-expanding tribe of exiles, junk scavengers, retired vacuum cleaners, exiles, dissidents, and homesteaders. Many of them are economic refugees or members of obscure ideological groups. Some arrive from Earth, but most are the castoffs of other orbital stations, L4 colonies, and lunar society. They come seeking

opportunities, privacy, or simply an escape from persecution.

In recent years, the exodus to L5 has actually increased. The Pacific War (2084-2085) produced an influx of homeless orbital refugees, mostly from TSA stations that were no longer supported by their governments or too badly damaged to stay operational. The Olympus Project has caused even more movement, as over the last decade, System Technologies has been paying companies to vacate orbital properties that stand in the way of its planned space elevator. Many of the evicted tenants have sought cheap alternatives elsewhere in the Earth-Lunar neighborhood.

L5 TODAY

The L5 point has become a huge trailer park in space. There are currently about 2,400 house-sized or larger habitats orbiting within a hundred miles of the Lagrange 5 point. The individual colonies range from a few dozen people in an improvised beer-can habitat to several thousand people in a second-hand station.

The key difference between L4 and L5 is that most “Elf” colonies are started by organizations that lack the funds to either settle on Islandia or construct their own purpose-built colony. As a result, L5 has a profusion of “squatter” settlements assembled by fringe religious, social, and political groups. While there are some success stories – such as Cornerstone (p. 115) and Seventh Heaven (p. 134) – even many of the larger stations tend to be operated on shoe-string budgets. Most L5 stations are short-lived ventures, some are run by tyrants, criminals or bizarre cults, and many teeter on the brink of economic ruin, life-support failure, or utter chaos.

The smaller L5 colonies are not self-sufficient, but since most are only a few dozen miles from their nearest neighbors, individuals and groups can and do eke out a living through contract work with larger stations and factories. A few better-organized groups have also located here for the cheap labor and real estate. This means that there are some factory stations, research labs, and even artist's colonies scattered among the eccentrics, hobos, and ideologues.

The ongoing difficulties of L5 have attracted various schemes to clean up or gentrify the region. Various non-governmental organizations have taken an interest in providing humanitarian relief (e.g., medical care, emergency evacuation, or sapient's-rights advocates) to distressed colonists. Islandia, Luna City, the European Union, and Japan have also intervened on occasion to shut down criminal operations or support NGO efforts. The last major intervention was in 2098, when French Foreign Legion commandos raided a colony that was manufacturing bioroid slaves for sale to orbital factories.

THE L5 POPULATION

No accurate census of L5's population has ever been made. Many of the colonists are not hospitable to people prying into their affairs, and some of the larger stations have artificial wombs and cloning to replicate themselves. The best guess is that 40 to 50,000 people live at L5, in nine medium-sized colony habitats and 250 smaller stations (some very small). Most are found within 10-100 miles of each other, in a cluster that completes one orbit around L5 every 89 days.

CORNERSTONE

"Stay close," Candace reminded them quietly. "Don't give the greenies any trouble, and if you have anything dangerous on you just hand it over."

Mariko and Sergei obeyed, watching the green-uniformed Security officers dubiously as he examined their passports. Mariko fumbled for a moment, then gave up her interface for a data inventory. Sergei reluctantly turned over his armgun and extra ammunition.

*Mariko watched closely, but didn't see any negative reaction to her Tennin physique. **Maybe this won't be so bad,** she thought.*

"How are you feeling?" Candace asked, perhaps picking up Mariko's unease.

Mariko shrugged. "Heavy."

"Sorry. There's not much at the hub here, it's all down on the rim."

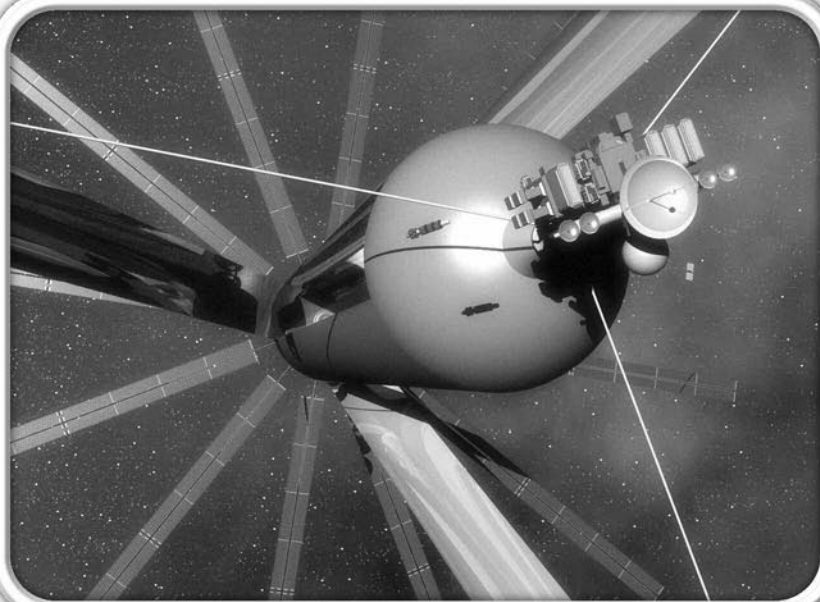
"I'll manage," Mariko assured her.

"It will be worthwhile," Sergei pronounced. Candace nodded agreement, smiling wolfishly.

Mariko wasn't so certain. Candace had been born here, and Sergei could make himself at home anywhere. Mariko was the odd woman out. Still, their venture wouldn't fly without her. She was the technical expert, the one who understood the Duncanite manufacturing codes they had carried all the way from Ceres. Codes that might bring down half a dozen Cornerstone industries and make the three of them rich as kings. And that would only be the first step.

*Candy's come home, and she's brought friends, Mariko thought, beginning to smile. **She always said this place needed a good shaking up. We're certainly the ones to deliver.***

*They passed through the final Security checkpoint, into the south cap monorail station. Mariko looked up and around her, at Cornerstone. **Ready or not, here we come.***



HISTORY

Cornerstone's history begins with the New Enlightenment, an intellectual movement which first reached prominence about 2015 in North America and parts of Europe.

The New Enlightenment

The New Enlightenment was originally conceived as a reaction against other intellectual trends of the time. The movement's leaders defined certain ideas as being fundamental to Western civilization: democracy, devotion to objective truth, and freedom of opinion. They believed that all three of these values were under attack, especially in the world's universities and other educational institutions.

In response, the movement called for radical democratic reforms. Constitutional guarantees of individual freedom were to be strengthened, especially with respect to self-expression and intellectual inquiry. Movement rhetoric claimed "freedom from ideology" as a fundamental human right.

The New Enlightenment was particularly concerned with education. Movement leaders claimed that public education had degenerated into a tool for political indoctrination, to be used by whatever cultural elite currently held power. They suggested that traditional public education should be abolished, to be replaced by computer-assisted education that could be delivered to every child at home. In theory, children thus educated would have better technical skills and would be better able to choose for themselves what beliefs to hold. The New Enlightenment anticipated the maturity of memetics as a rigorous science, and called for the design of a "memetic immune system" which would prevent children from being victimized by parasitic ideas.

The Cornerstone Foundation

In 2016, several leaders of the New Enlightenment movement established the Cornerstone Foundation, a non-profit organization devoted to the spread of movement ideals. The Foundation soon received a number of high-profile donations, making it a major player in intellectual circles. Despite this support (or perhaps because of it) the New Enlightenment met with only mixed success for a number of years.

Aside from its social concerns, the Foundation funded a great deal of cutting-edge scientific research. In particular, from the early 2030s it was a major backer of interstellar exploration, funding astronomical research and the design of deep-space probes. Later the Foundation was a major provider of funding for the Trailblazer program, which launched the first interstellar probes in the early 2050s.

Another Foundation venture was the construction of Cornerstone. A number of wealthy backers established a special fund, to be administered by the Foundation and used for the construction of an “island of excellence” in space. The colony was envisioned as a refuge for New Enlightenment ideals, a place where movement leaders could work and teach without having to compete for attention with a thousand shouting “ignorance cults.”

Building the Habitat

In 2049, the Foundation organized Cornerstone Enterprises, a corporation chartered within the Principality of Liechtenstein. This company was intended to be the administrative backbone for the eventual Cornerstone colony. It answered to the Cornerstone Foundation, but it would be effectively independent with respect to day-to-day operations at the construction site and (eventually) in the completed habitat.

Financial arrangements were completed and construction began in 2057. Perhaps because of the New Enlightenment’s appeal to scientists and engineers, the Foundation had no difficulty attracting enough skilled technicians to build and maintain Cornerstone. As a result, from the beginning it was a stable and well-maintained habitat.

Oddly, Cornerstone was the first habitat of any size to be built at the L5 point. The site was chosen out of a deliberate desire for isolation. It also served as a public relations nod to various ancient “space advocacy” groups, for whom L5 had greater symbolic value.

After the habitat was declared operational in 2065, over 9,000 hand-picked colonists joined the construction crew onsite. For six years Cornerstone was the mistress of L5 – and then the “Lagrange rush” began. Smaller, cheaper habitats began to spring up like mushrooms,

many of them in poor repair or inhabited by ideological fringe groups. By 2080 it was obvious that the insanity of Earth had followed the New Enlightenment movement into space. Cornerstone was doomed to be the queen of an orbital slum.

CORNERSTONE HABITAT

Cornerstone is an oversized “tin can” habitat built as a single-walled cylinder 15,800’ long and 2,600’ wide. The station does not utilize solar power, instead relying on three redundant fusion power plants (typically only one is active at any given time). The habitat rotates on its axis to produce 1 G gravity.

There is a large spaceport hangar on either end of the habitat and external cradles dot the surface – each capable of docking a *Meizi*-class transport. The station maintains a permanent population of 12,000 colonists and crew in considerable comfort. There are 65,890,556 empty spaces waiting for future expansion.

Design: Cylinder hull (170,892,800 spaces, titanium alloy, light frame); cDR/cPF 5/100 (slag armor). Hull radiators (250 ksf).

Modules: New command center; old command center; 4 large radar; 2 large PESA; 1,000 tanks (water); 10 radiocom; 5 lasercom; 10 large robot arm; 1,200 labs (200 physics); 120 farms; 5 hospitals; 200 reconfigurable housing; 10,000 open; 30 park; 20 plaza; 10 robofac; intrastation transport (15,000 person capacity); 3 fusion reactor core; 500 new fusion reactor; 50 large entry modules; 2 spacedock hangars (300’ long, 300’ wide, 400’ high: 72,000 spaces each); 10 external cradles (18,750 tons each); 1,000,000 cargo (5,000,000 tons).

Statistics: EMass 138,099,977; CMass 143,302,479; LMass 143,302,479. Cost M\$209,904.68. cHP 1,067,040. Size Modifier +16/+21. HT 12. Maintenance Interval: 0.04 hours (2,199 man-hours/day). RRA 250.

Performance: None.

Inside, Cornerstone is a typical cylindrical habitat, with almost all of its inhabited territory spread across the inner surface of the cylinder’s “sides.” By convention, Cornerstone’s inhabitants use compass points to give directions. “East” is the direction in which the habitat spins, while “west” is the opposite direction. When facing spinward or “east,” “north” is toward the left-hand end cap and “south” is toward the right-hand end cap.

The general flavor of Cornerstone architecture is one of quiet refinement. Buildings are usually low to the ground, with only the City Tower taller than five stories. Greenery is everywhere. There are no laws against public bad taste, but there is considerable social pressure against visual or noise pollution.

The Farmlands

Cornerstone's agricultural areas are at the habitat's ends, forming two belts of farmland which are each about six-tenths of a mile wide. The farmlands are the only part of the inhabited surface not restricted to the sides of the cylinder. They also occupy a series of terraces, stretching about 200 feet up onto the cylinder's "caps." These terraces are mostly fruit orchards and other tree-borne crops; above them the caps are colored sky-blue. A person inside Cornerstone can look toward either cap, and get the visual effect of distant tree-covered hills framing a wide valley floor. Of course, the effect is spoiled when one looks *up* to see the inhabited surface arching overhead!

Residential Zones

The central region of Cornerstone's inner surface, equally distant from each end cap, is the most densely populated zone. This region ranges from about 1.6 to about 2 miles wide. Most of it is typical "suburban" housing, rich with small apartment buildings, rowhouse blocks, and detached homes. Most residential buildings are low, with even the apartment buildings restricted to three stories. Cornerstone's paved streets tend to be narrow, dominated by foot and bicycle traffic rather than ground cars. They also wind around a great deal, or veer into cul-de-sacs surrounded by homes. The street plan is confusing to visitors at first, but they soon adapt, helped by the fact that even nearby areas are visible along the land's upward curve.

FREEDOM DAY

Every year, the population of Cornerstone celebrates "Freedom Day" on June 16, the anniversary of the day on which the last loans financing the habitat's construction were paid off. This is Cornerstone's great patriotic holiday, replacing the Fourth of July and other national celebrations enjoyed back on Earth.

Freedom Day is a big deal. The University relaxes discipline for the day and permits wild revelry on campus. The Mall is gaily decorated, its shops sponsoring music and games while offering free souvenirs and food. There are athletic competitions in Central Park. Businesses put on public displays, demonstrating their latest technological marvels. Smaller community observances take place in residential areas throughout the habitat.

Freedom Day celebration always culminates in a large fireworks display – ordinarily an insane thing to even attempt in an orbital habitat! The fireworks display itself is always imported; it's the *safety devices* which are locally designed as a demonstration of technical wizardry. The display is always recorded for InVid and slinkies, which are transmitted to other habitats across L5 and beyond.

social activity – while it's possible to order food and other goods for home delivery, only the most reclusive citizens do so routinely.

In Cornerstone, a great deal of technical work is done from individual homes, using household computer power or telepresence. Even the smallest homes have small (Complexity 6) computers, running subsapient AI and providing broadband access to the Web. Many homes have built-in Complexity 7 microframes running fully sapient AI, along with cutting-edge VR equipment and extremely broadband web access. Neural interfaces are almost universal within Cornerstone, and indeed the habitat is known for advanced neural-interface technology.

For those experiments or activities that require physical presence, research facilities (libraries, computer centers, and laboratories) are also scattered among the residential zones. This often leads to neighborhoods devoted to specific disciplines. For example, people who often work in the same computer center would tend to live close by, many of them using the same common areas and commercial establishments.



The residential areas also include parkland and commercial buildings. In general, every resident is within easy walking distance from a community park and a few small businesses (restaurants, grocery stores, and so on). Cornerstone society puts a premium on *shopping* as a

Central Park

Central Park is the largest recreational area in Cornerstone, a 20-acre commons lying exactly halfway between the two end caps. It includes a small lake, several athletic fields, and a shell-stage suitable for outdoor concerts. The Cornerstone Symphony Orchestra often plays here, a 90-member amateur ensemble made up of Cornerstone citizens and University students. The space is *not* suitable for public meetings of more than a few hundred citizens; “town meetings” are usually held in virtual space instead.

THE CORNERSTONE ECONOMY

The loans which financed the construction of Cornerstone were paid off in 2087. Still, even with most routine needs met by the habitat’s local farming and manufacturing, operating costs remain in the billions of dollars per year. How does Cornerstone stay financially afloat?

Part of the money comes from a special Earthside trust fund, managed by Cornerstone Enterprises. This fund was established long before the habitat was built, founded on the donations of wealthy New Enlightenment backers. Meanwhile, Cornerstone Enterprises is also a holding company, owning (and drawing profit from) a number of copyrights, patents, and subsidiary businesses.

Such investment income covers about 60% of the habitat’s annual operating costs. Unfortunately, it is quite dependent on the health of Earth’s economy. On at least three occasions Cornerstone Enterprises has been hard-pressed to meet the habitat’s costs, while the return on its holdings temporarily went sour. Also, since much of this revenue is derived from intellectual property, Cornerstone’s financial health is directly threatened by patent violations and other forms of piracy. The surge of nanosocialist ideology on Earth has been viewed with extreme alarm on Cornerstone.

The rest of the habitat’s operating costs are met by the habitat fee (see p. 120), which comes from the incomes of the habitat’s individual residents. So ultimately, Cornerstone derives most of its income from *ideas*. The University is a major income stream, accepting as it does over a hundred foreign students each year. Cornerstone’s citizens also operate dozens of small technical firms. Some of these do basic research and develop new technology. Others offer consulting services to customers everywhere in the Earth-Luna system.

One of Cornerstone’s intangible (but more valuable) assets is its *prestige*. Cornerstone is known system-wide as a center for excellence in cosmology, high-energy physics, and memetics. Its computer scientists and neurosurgeons are also in demand, with specialties in artificial intelligence and advanced neural-interface technology. Despite the habitat’s small population, it boasts no fewer than *three* living Nobel laureates in residence. All of this translates into market presence, and thus into income.

The Mall

West of Central Park, about one-third of the way around Cornerstone’s circumference, is the Mall. This is a place for shopping and social activity, incorporating over 100 small businesses. Shops in the Mall tend to be boutiques, specializing in luxury consumer goods. Many of the habitat’s most distinctive restaurants are here as well.

At the south end of the Mall, *Bertram’s* is a luxury establishment serving *haute cuisine*. It is expensive, and features human chefs and wait staff. The lighting is kept low and there is considerable sound muffling between tables, making it a popular place for quiet meetings.

Moonwalk sits at the opposite end of the Mall, closest to the University campus. Here the cuisine is much less formal and much more diverse – patrons can order everything from Afghan to Tex-Mex cuisine, and wash it down with a bewildering variety of beers or soft drinks. There is a dance floor and an extensive VR gaming hall. Moonwalk is naturally popular with Cornerstone’s younger citizens and with University students.

Near the center of the mall stands Cornerstone Hostel, a five-story building designed for transient guests. The Hostel is small, but luxurious even by Earth standards, operated by a well-known hospitality firm based out of Nairobi. The fact that Cornerstone Security monitors the Hostel closely is a poorly-kept secret. Visitors who object to this must find their own quarters, since there is no other guest hotel in the habitat.

The University

About a hundred yards from the north end of the Mall is the main gate of the University of Cornerstone campus.

The University campus is the most densely-populated region of Cornerstone. At any given time, over half of the University’s 1,000 students come from outside the habitat. These foreign students, plus a few Cornerstone natives who don’t wish to commute from home, live in several large apartment complexes around the edge of campus.

The University is small but high-quality, attracting students and instructors from as far away as Earth or L4. It offers instruction in a wide range of disciplines, although there is a heavy emphasis on the “hard” sciences such as astronomy, computer engineering, or physics. The University has close ties to the Cornerstone Foundation and to the many small independent laboratories scattered around the habitat.

City Tower

About 200 yards west of the Mall and the University campus stands City Tower. At eight stories, the Tower is by far the tallest building in the habitat. It is located on the habitat's median line, exactly halfway between the end caps. The observation deck atop the Tower is a popular site for visitors, offering a superb view of the entire habitat.

City Tower is the administrative center of Cornerstone. It incorporates offices for the Administration and Operations departments, a major computer center, and the habitat's main control center. Cornerstone Security headquarters is right next door, a fortified blockhouse which is widely regarded as the ugliest building in the habitat. The Maintenance Department also has its administrative center in the City Tower area, although most Maintenance workers operate out of equipment depots located around the habitat.

Factory Block

Continuing west from the Mall-University-Tower complex, a pedestrian eventually reaches the Factory Block. This site is another third of the way around the habitat's circumference, so that Central Park, the Mall, and Factory Block fall roughly at the points of an equilateral triangle. The Factory Block is easily spotted from anywhere inside the habitat – the widest and straightest paved roads in Cornerstone connect it to large freight elevators at each end cap.

The Factory Block is Cornerstone's main site for industrial manufacturing, a ten-acre zone of warehouses and heavily-automated factories. Most of the Block is owned by Cornerstone Enterprises (p. 116), but about a third of it is given over to private business concerns. The factories here produce most of the spare parts, equipment, and consumer goods needed within Cornerstone. Specialty items must be ordered from elsewhere, but most of the colony's routine needs can be met locally.

The Factory Block is slowly being upgraded to modern "robofac" specifications, a trend which may soon give Cornerstone a surplus of high-quality finished goods for export.

EXTERNAL AFFAIRS

For all its disavowal of ideology, Cornerstone society is based on a well-defined ideology of its own. That ideology has earned Cornerstone the enmity of many other states, some as far away as Earth. Such societies consider Cornerstone an abomination, a haven for elitists, atheists, and cultural oppressors.

Within the L5 cluster, the theocracy of Seventh Heaven is Cornerstone's most constant foe. Digital Creationists there view Cornerstone's AI research as a blasphemous attempt to enslave

divine beings. Even less radical Seventh Heaven citizens object to Cornerstone's combative agnosticism. Hostilities are normally limited to memetic attacks, although Seventh Heaven has occasionally attempted rescue missions aimed at "liberating" sentient computers. Cornerstone Security has thus far managed to repel all such incursions, although the Digital Creationists keep trying.

On Earth, the nanosocialist nations consider Cornerstone to be an ideological enemy. They often use political pressure and economic sanctions to attack the Cornerstone Foundation, on Earth and in space. During the Pacific War a TSA infiltration team managed to shut down two out of the habitat's three fusion power plants with a targeted microbot swarm. Since then, Cornerstone has refused to deal with the TSA in any way, and Cornerstone Security is particularly alert against nanosocialist infiltration.

Relations with other Earthside nations vary from cool to friendly. Cornerstone's closest allies are its business partners in the United States and the European Union. It also carries on quiet but friendly contacts with Duncanite groups, on Ceres and elsewhere.

VISITING CORNERSTONE

Legally, Cornerstone is considered private property within the national territory of Liechtenstein. Visitors are subject to customs and immigration procedures; these are trivial for citizens of Liechtenstein or Switzerland, and very easy for anyone else. However, this procedure only gives a visitor access to the spacedock area. To enter the habitat proper, a visitor must pass strict examination by Cornerstone Security.

Security carefully searches every visitor's person and baggage, looking for contraband (weapons, obvious sabotage devices, and microbot swarms). Nothing is ever *confiscated* unless it presents a clear and immediate danger to the habitat. Instead, if a visitor is found to be carrying contraband he is given the choice of keeping it and getting back on his ship, or handing it over to Security for the duration of his visit. Security has been known to accept military-grade weapons from visitors upon arrival, and then return them on departure, all without a moment's hesitation or discourtesy.

Meanwhile, Security reserves the right to bar entrance to any visitor, without justification. This right is rarely exercised unless a visitor is carrying contraband. The major exception involves citizens of Seventh Heaven or the TSA nations, who as a matter of policy are *never* knowingly permitted into the habitat.

Once inside Cornerstone, a visitor will no longer be under close scrutiny (although Security makes it a point to discreetly keep track of visitors). Cornerstone society is outwardly as free and open as that of any space habitat, and apparently accepts visitors gladly (but see *Local Memes*, p. 121).

LIFE IN CORNERSTONE

Cornerstone is a strong and prosperous community. Life there can be quite pleasant, as long as the society's basic memes are respected.

Administration

Cornerstone Enterprises directly employs about 1,300 people to run the habitat. Major departments include Administration (about 120 workers), Agriculture (about 240 workers), Maintenance (about 300 workers), Operations (about 240 workers), and Security (about 400 workers). Employees wear distinctively colored uniforms while on duty, and are trained in public relations as well as their technical specialties. Salaries range from \$30,000 to \$150,000 per year. Most employees find the workload light, spending a 20-hour work week supervising robots or automated systems.

Cornerstone's security detachment is particularly well-trained and has very high morale. Under most circumstances Security officers carry only non-lethal weapons, but if pressed they can quickly deploy military-grade hardware. Rumor has it that Cornerstone Security includes a company-sized detachment of elite commandos, intended for deterrence raids against other habitats. If such a force exists, it has never been seen in action.

Law and Government

Cornerstone is sometimes called a techno-libertarian state. New Enlightenment rhetoric has always been highly libertarian. On the habitat, traditional "government" is represented only by a system of neighborhood councils, which have very little real power. There are no "taxes" as such. There is a legal code, based on EU and Liechtenstein practice, but there is no public system of legal enforcement.

On the other hand, Cornerstone is far from being a minarchist paradise. Cornerstone Enterprises fulfills many of the functions of a government. It levies the habitat fee, it deports those who cannot pay, and it enforces both a strict set of safety regulations and the provisions of the legal code. Private enterprise is unregulated, but almost all essential economic activity on the habitat is controlled directly by the corporation. In effect, Cornerstone is a *corporate state*, whose government is much more accountable to the Cornerstone Foundation than to the habitat's citizens.

Cornerstone Enterprises *could* operate as a heavy-handed dictatorship, but since the colony's foundation it has rarely exercised the full range of its powers. Cornerstone society could be considered as having an overall Control Rating of 2. It is at CR 0 with respect to individual self-expression, and CR 6 with respect to weapons and military equipment.

THE HABITAT FEE

Some of Cornerstone's costs are covered by a unified *habitat fee* levied on its inhabitants. This fee is effectively an extremely regressive income tax, although it is *never* referred to as such in polite society. Every permanent or semi-permanent resident of the habitat must pay a minimum of \$2,000 per month to Cornerstone Enterprises. Residents who make more than \$2,400 per month are assessed a flat 83% of their income, up to a maximum fee of \$12,500 per month. Even children who have no independent income must have the minimum payment made on their behalf (a strong incentive for residents to limit their reproduction to what the habitat can support).

Residents who are unable to pay their "habitat fee" get some grace, but if they are ever in arrears for more than three months in a row (or six months total in their lives) they are summarily deported. On the other hand, in exchange for the fee a resident is guaranteed many services from Cornerstone Enterprises: basic housing, a sufficient food allotment, access to personal power and data services, a basic level of high-quality medical care, and so on.

There are some exceptions to the habitat fee. For example, indigent University students of exceptional academic promise may tap into a scholarship fund that pays the fee, along with their tuition. Meanwhile, residents who want housing beyond their basic allotment must pay a surcharge; wealthier citizens may have more luxurious living space but they do pay more for the privilege.

Surprisingly, even Cornerstone's less affluent citizens rarely complain about paying the habitat fee. There is a great deal of patriotism in Cornerstone – wealthy and poor citizens alike have voluntarily increased their fee payments when it was necessary to cover costs. In any case, the housing and services received in exchange are of good quality, delivered respectfully to every citizen regardless of means. Still, there *are* frequent complaints about the fee's extreme regressiveness. Much local political debate centers on tinkering with the fee schedule to make life easier for ordinary citizens, usually by raising the maximum and lowering the minimum payment.

Local Memes

For all its avowed devotion to memetic freedom, Cornerstone society is remarkably conformist. The citizens hold certain memes very strongly, and can react with stony hostility if these are challenged.

Naturally, Cornerstone society tends to be libertarian in sentiment. Most citizens are minarchists rather than anarchocapitalists – although they admire free enterprise, they accept strong government that fulfills its “proper” role. Naturally, they regard the government provided by Cornerstone Enterprises to be acceptable or even ideal.

Cornerstone is unusual among L5 colonies, in that it is strongly Preservationist in outlook. Local society frowns on radical genemods for human beings (on the other hand, agricultural genetics is a minor but accepted industry). Some prominent citizens have publicly denounced terraforming efforts, calling instead for the construction of more artificial habitats in space.

Although near-sapient and fully sapient AI are very common in the habitat, the meme for pan-sentient rights is weak. The human citizens often treat their computers with affection and respect, but they do not consider AI to hold any civil rights.

One of the strongest local memes is *atheism*. On matters of religion, most of Cornerstone’s inhabitants are agnostic at best; many of them are militant atheists. This is part of the local disdain for all forms of “ideology,” although ideologies with spiritual or theistic elements (“God memes”) are particularly scorned. Citizens who hold religious beliefs usually practice them discreetly at home. This meme is weaker on the University campus, where some foreign students are openly religious; there is a small nondenominational worship center in the student union.

The Generation Gap

Cornerstone society is subject to some internal strain along generational lines.

Most of the habitat’s business, intellectual and social leaders are *at least* in their 70s; some of them date back to the foundation of the New Enlightenment movement itself. On the other hand, there is a population of about 3,000 young citizens who are 35 or less, and were born on Cornerstone. While they took in New Enlightenment ideals with their mother’s milk, these youths have much less emotional attachment to the movement.

Ironically, the educational goals of the New Enlightenment appear to have worked on the movement’s children, but the effect has been to bring them to question many of their society’s assumptions. Many of these young rebels are both exceptional scientists and vocal social leaders. Recognizing how conservative and conformist their society is, they consider themselves much more “enlightened”

than the elders who rule the colony. Some of them are impatient to take on leadership roles, and are not above intriguing for them. Others are defecting away from Cornerstone, usually seeking out radically transhumanist societies or Duncanite microstates.

STOCKHOLM, Sweden/Teralogos: With pomp and ceremony, University of Cornerstone professor Harôld Polanski received the Nobel Prize in Economics for his development of methods for analyzing memetic cognitive ecologies. Outside the Stockholm Concert Hall, the scene was less regal. Hundreds of pan-sapient rights demonstrators, including many transhumanists uploaded into exotic cybershells, noisily protested the exclusion of LEGGIERO, Polanski’s SAI-9 research assistant.

Last month, Teralogos reported allegations by ex-grad student Lila Manx, Polanski’s other assistant. Manx, now resident at Seventh Heaven, credited LEGGIERO with all key insights in Polanski’s theory. Polanski dismissed this, calling LEGGIERO “a useful tool, nothing more.”

Other Cornerstone students uniformly condemned Manx’s allegations. “Lila was a model student until her infection by a toxic deistic memplex of the digital creationist phylum,” said Erika Grey, Manx’s ex-roommate. “Her attempts to propagate it led to peer isolation, depression, and exodus from Cornerstone. It’s tragic she’s lashed out at Dr. Polanski.”

CORNERSTONE CHARACTERS

Cornerstone citizens are likely to stay close to the unmodified human genome. Most of them have the 0-point Genefixed Human template or the Alpha Upgrade template (p. TS115).

Social status on Cornerstone is rather different from the system-wide norm. In particular, residents almost never have Status lower than 0 or higher than 5:

Status Table

Status	Examples
5	Chief administrator, senior Foundation official.
4	Senior administrator, system-wide celebrity resident.
3	Junior administrator, major business owner.
2	Well-off citizen, minor business owner.
1	Ordinary citizen.
0	Subsidized guest, university scholarship student.

Note that the *average* citizen is Status 1. This is appropriate, since even an ordinary Cornerstone citizen has unusually high standing in the general system-wide society (it also simulates the habitat fee as part of the cost of living).

If any resident falls below Status 1 he is at risk of deportation; this risk is immediate if he falls below Status 0.

CORNERSTONE TECHNOLOGY

Cornerstone is the source of a number of minor technologies, most of which are on the open market system-wide. A few items are kept unique to Cornerstone, protected by trade secrecy rather than copyright or patent law.

One of the most popular of these products is the *Gauss-II* brain implant. Developed at Platonics Limited, a small local neuroengineering firm, the Gauss-II is based on the standard Virtual Interface Implant (p. TS125 and p. TS150). However, the integral computer is larger (Complexity 5). A cross-shunt is also made to a secondary implant, resting in the centers of the brain that are most involved in abstract mathematical reasoning. The Gauss-II provides a standard VR interface, but it can also be used to permit the user to better “visualize” abstract mathematical concepts. In game terms, this grants the user the Mathematical Ability advantage, costing 10 character points.

The Gauss-II implant costs \$25,000 (plus \$8,000 surgery), and can only be obtained by visiting the Platonics Limited clinic on Cornerstone. The implant is “trapped” to self-destruct if surgically removed – roll vs. Electronics Operation (Security)-4 to prevent this if aware of it. If it self-destructs, the user is unharmed, but its critical components and programming are wiped (this is to protect Platonics Limited’s trade secrets).

Fountain-1

“We need to improve recruitment. The last two shipments of convicts have been subnormals, only fit to become Class 3 or 4 Workers – if the next group is any worse we’ll be able to do better with the damn bioroids. What we really need are more personnel with advanced skills, especially Class 1 and 2 technicians and scientists.

I’m also recommending that we look into the ED’s security training procedures. One Class 3 Protector severely beat a Class 2 Drone who accidentally wandered near a high security area, and another Protector subjected a bioroid to severe verbal abuse. We need strong Protectors, but not ones who will harm or upset the menials. Unless ED can provide proof that such incidents will not be repeated, they’ll need to lighten up on the Protector aggression induction. We need to keep the lesser castes happy to maintain productivity.”

*– Class 2 Leader
Sophie Ferguson,
Weekly Status Report*

CORNERSTONE ADVENTURE SEEDS

Angels in the Outfield

Cornerstone Security has captured a Seventh Heaven infiltration team in the farmlands. The invaders had crude weapons and were carrying a small but advanced AI computer when they were apprehended. Strangely, the computer was not of Cornerstone manufacture and had apparently been introduced to the habitat by the infiltration team. Are there more Digital Creationists loose in the habitat? And why were they trying to smuggle a sentient computer into Cornerstone?

Chrysanthemums and Floating Dragons

The PCs are hired by a pyrotechnic contractor to provide security for this year’s Freedom Day display (p. 117). The munitions being used will come under very close scrutiny as they are being brought into the habitat; woe betide the PCs if Cornerstone Security finds anything amiss. The party will have to continue to work with prickly Security officers until the celebrations are over. Of course, the question does arise as to *why* the contractor chose to hire the PCs instead of their usual security firm . . .

Spreading the Good News

The PCs are hired to accompany a renowned scientist during an extended visit to Cornerstone, as her assistants and security detail. She is in the habitat to attend a conference and engage in professional exchanges with local citizens. Unfortunately, she is also a devout member of a religious sect (the GM should decide which) and regards Cornerstone’s atheism as inherently wrong. The PCs must deal with the consequences as their principal repeatedly challenges local beliefs. Meanwhile, even if she is in no physical danger from Cornerstone’s citizens, that doesn’t mean someone else might not choose to attack her (political enemies from her home society, terrorists out to discredit Cornerstone, and so on).

Fountain-1 is one of the less pleasant colonies in L5. The colony is run by the Posthuman Fitness organization, a technofascist cult. However, Fountain-1 is careful not to violate international law, and its existence, though unpleasant, is tolerated.

HISTORY

In 2067, Japanese writer Kaede Tatsuno published a series of essays advocating what she described as the doctrine of Posthuman Fitness. Tatsuno called upon all nations to begin rigorous mental and social tests of their populations. The citizens would then be assigned to occupations that fit their own particular talents. She also recommended that anyone who appeared to have untapped potential should be aided to develop it through a combination of memetic theory-enhanced education and

neural implants. The superiority of organic life forms over machines also became an increasingly important part of PF doctrine.

The PF movement, as it began to be called, rapidly gained in popularity in Japan, Korea, and Australia. Several PF “education enclaves” were established, and the movement began to grow rich selling instructional InVids and other material aimed at “tapping latent genetic potential” and “tracing superior genetic lineage.” Skilled memetic engineering helped the PF movement grow; in its heyday in 2070, it boasted some 4.2 million members. Critics claimed the PF counted everyone who subscribed to its InVids as a follower, and the committed membership was only about 47,000. These were individuals who had attended sessions in PF education enclaves and received the organization’s special “focus implants” – which many of them paid \$25,000+ for.

The PF was also accumulating enemies. Friends and family of PF members claimed that the organization’s adherents were being bilked and brainwashed by the group’s leadership. A series of high-profile lawsuits was filed against PF leaders. In 2071, a reporter went undercover into a PF enclave in Perth, Australia, and exposed PF leadership’s practice of using neural modification implants to “re-focus” the loyalties of disgruntled members who wished to leave the organization, including minor children.

Arrests were made, and mass support for PF began to collapse. However, a hard core of several thousand dedicated adherents still remained, determined to fight what Kaede Tatsuno claimed was an “orchestrated attempt by the mass-society to destroy the Posthuman Fitness movement through fraud and persecution.” Nevertheless, with both lawyers and police breathing down their necks, Tatsuno decided that Earth was no longer a healthy place for her form of posthumanity to thrive. Using the more than \$750 million in PF funds that had been stashed in secure data havens, the organization purchased a secondhand L5 habitat from a bankrupt religious colony.

In 2080, PF members from Japan, Korea and Australia began emigrating from Earth to the station they renamed Fountain-1. Tatsuno did not join them. Before she could board the TAV that would carry her into space, she was murdered, shot dead by a former PF member who claimed the organization had brainwashed his wife and son.

The martyrdom of their spiritual leader did not stop or slow the Posthuman Fitness movement down; in fact, it contributed to the atmosphere of paranoia and persecution, and helped spur the exodus of 3,800 members to L5.

Thanks to its disciplined if ruthless leadership, its dedicated membership, and its reasonable level of funding, Fountain-1 was a success. This in turn has continued to keep the PF movement alive on Earth, where regular promotional InVids extolling life on Fountain-1 continue to attract followers and supporters on Earth. Over the last 20 years, the colony has received regular donations from PF-associated groups (chiefly in the Pacific Rim

Alliance, though there are supporters worldwide); until 2093, these – along with a well-managed investment portfolio – made up most of the station’s income.

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Fountain-1 Habitat

Fountain-1 is an asteroid-hulled station 900’ in diameter. The station has a population of 7,200 (including 3,200 bioroids). The average wealth level is Average, but many of the colony’s leaders are Wealthy or better. It has CR 5 (6 for visitors).

Fountain-1 can be claustrophobic. The colony burrows deep into the asteroid, and while there are many tunnels that are as wide as terrestrial city streets, there is little open space. Only a small percentage of its inhabited space is park or garden, and these rely on artificial light. Half of Fountain-1’s inhabitants lack proper housing, and instead live in small cabins, usually two to a room. There is only half an acre of garden space, and there are no large farms at all – most of the colony eats vat-grown food.

Unlike most space colonies, Fountain-1 is heavily armed. It has 12 light laser towers, spaced equally around its equator. They are normally retracted; few know of their existence.

Design: Spherical Hull (729,000 spaces, rock); cDR/cPF 5/10,000 (70,000 waste rock spaces). Solar cells (1,250 ksf). Hull radiators (12 ksf).

Modules: Old control center; medium ladar; 2 medium PESA; 2 medium radar; radiocom; 2 lasercom; 25 new fusion reactor; new fusion reactor core; 500 tanks (MOX); 10 2.5-MJ light laser towers [S]; 2,500 cabin; 5 factory; 5 garden; hospital; 25 housing; interstation transport (7,500-person capacity); park; 5 plaza; 250 vatfac; 5 large entry modules; 200 labs; 10 minifac workshop; 2 large robot arm; hanger (200’ long, 200’ wide, 200’ high, 16,000 spaces); 3 external cradles (2,500 tons each); 10,000 cargo (50,000 tons).

Statistics: EMass 3,639,043; CMass and LMess 3,437,543. Cost M\$598.34. cHP 37,965. Size Modifier +13. HT 12. Maintenance Interval: 0.82 hours (117 man-hours/day). RRA 12.

Performance: None.

INSIDE FOUNTAIN-1

Sharpen your focus. Open your mind. Master your genes. Earth is mediocrity: the destiny of PF is in the stars.

– Kaori Tatsuno, *The Fountain and the Razor*

Fountain-1 is an efficiently run colony with healthy and generally contented inhabitants. However, it is also a rigidly controlled totalitarian state where all of the inhabitants are tools of the ruling oligarchy. Willing tools, but tools nonetheless.

VOCATIONAL STIMULUS: HOTSHOTTING

Hotshot nanosymbionts are customized permanent nanomods that trigger the release of endorphins when the user engages in certain activities. It's possible to design hotshots for almost anything: cooking, writing poetry, washing dishes, scientific research, sports, fighting, even surfing the web. In preparation for hotshotting, brain-scanning is used to find the deep structures laid down in a particular individual's brain as he performs a specific activity. Then permanent nanofactories are carefully installed and modified so that they will trigger the release of endorphins when these activities are performed. If properly done, a hotshot results in the ultimate in positive reinforcement. Existing reinforcers like sex or eating can be hotshotted to make them even more pleasurable, too.

Statistics: This is treated as an Addiction (p. B30) to the endorphins produced in the brain when the hotshot activity is performed. To get his daily fix, the character must spend at least two hours on the activity he is hotshotted to perform. He becomes Single-Minded while doing so (+3 to skill if concentration is required). Missing the hotshotted activity causes withdrawal. Point cost is variable: hotshotting is worth 0 points if the hotshotted activity is something useful, such as a socially-acceptable profession; otherwise, it tends to be as self-destructive as any drug addiction; treat as a cheap, highly-addictive drug (-10 points).

Continued positive reinforcement will usually cause a hotshotted person to develop other disadvantages closely related to the focus of his hotshot; these typically develop within a month of being hotshotted (roll vs. Will to avoid every 2 weeks). This is usually a Compulsive Behavior, but other disadvantages may be appropriate: Bad Temper (if hotshotted toward combat activity), Lecherousness (if a sex hotshot) or Workaholic (if the hotshot is related to his job). These disadvantages are likely to persist even if the nanomod is removed.

A hotshot may also have tertiary effects, at the GM's discretion. After a few months of hotshotting, some personalities may eat less (losing any Fat or Overweight disadvantages and eventually becoming Skinny), neglect grooming (lowering Appearance) or talk of nothing but their hotshotted activity (Odious Personal Habit).

Operation: Cost of brainscanning, plus \$5,000 for the nanosymbiont, plus an additional \$5,000 for customizing it to a particular individual and activity. LC 4.

Government and Society

One of the most terrifying facts about the residents of Fountain-1 is that almost everyone, from the ruling council to the lowliest repair technicians, is happy and content with his existence. The lowest-status residents serenely perform mindless, routine tasks without complaint. Previously violent criminals are now peaceful and cooperative members of society.

Fountain-1 is run according to the principles of PF. Every new resident and every minor child is given an exhaustive series of mental, physical, and social tests, including brainscanning (p. TS166). Then the Employment Division decides what career or task-set the individual is best suited for. Problem individuals undergo mandatory psychosurgery (p. TS166) to help adapt to and excel in their new profession. The most controversial activity in Fountain-1 is the use of "hotshotting" nanosymbionts in most of the population, a practice euphemistically referred to as "vocational stimulus." These techniques, originally developed for training bioroids and uplifted animals, are extended to all citizens; they ensure that they enjoy their selected jobs.

Once an individual has finished "vocational selection," the Employment Division assigns him to a profession. Anyone with IQ 12+ will be assigned to a "Class 2" profession in research, mental engineering, medicine, or some technical trade. Exceptional individuals, all with IQ 13+, are groomed for "Class 1" management positions in the governing committee, trained in psychosurgery, or assigned to the secret covert operations division. However, IQ 11- citizens are assigned to less demanding "Class 3" tasks like routine maintenance, safety inspections, or various manual "Class 4" tasks, including acting as personal servants or breeders.

Fountain-1 also makes extensive use of bioroids, and is one of the larger markets for them. Bioroids are preferred to robots, because they are both less expensive and considered ideologically superior. Most of the bioroids used by Fountain-1 are models that were originally manufactured to order by Xiao Chu during the early to mid 2070s, and are presently 25 to 30 years old. However, recent controls on the marketing of bioroids have made it hard for Fountain-1 to legally acquire newer models. Fountain-1's leaders boast

that its bioroids are treated exactly the same as its human residents. Chillingly enough, this is absolutely true.

Due to the leaders' distrust of sapient AIs, SAIs are illegal in Fountain-1. LAIs are limited to a few carefully monitored systems; cybershells and virtual interfaces can only run NAIs. The residents of Fountain-1 are extreme "carbon chauvinists." AIs are seen as potential rivals of humanity, and the creation of ghosts is forbidden. Shadows are only created for psychological testing and interrogation and are destroyed after they are used. Under Fountain-1 law, no shadow is allowed to exist more than a week.

Fountain-1 Characters

About 50% of the residents of Fountain-1 are humans, mostly of Australian, Japanese, and Korean ancestry. Most are genefixed or Alpha upgrades. The remainder are various bioroids. The most common types are the XR-5 (p. TS117) and Tianyi (p. TS117) models.

Most of the population of Fountain-1 have Sense of Duty (Fountain-1) or Fanaticism (loyalty to Fountain-1). This comes from a mix of memetic engineering and regular brainscanning to determine loyalty. In addition, 90% of the Fountain-1 population, including all bioroids, have undergone "vocational stimulus."

Local Memes

The single most important meme is a belief that a rigid hierarchy based upon aptitude and efficiency is the ideal form of government, and that this can be achieved through the careful shaping of individuals. Freedom and democracy are weak and inefficient. Ultimately, a system-wide government based upon their ideals will come to pass. Carbon chauvinism is also nearly universal on Fountain-1. AIs are regarded as dangerous and inhuman, and SAIs as a threat to human supremacy in the solar system.

Visiting Fountain-1

Fountain-1 is an independent and rather paranoid state that is very careful about visitors. Everyone coming to Fountain-1 is subjected to extensive searches for weapons, surveillance technologies, or any other unusual technologies or medical anomalies. Fountain-1 has few visitors. Normally, only immigrants (80% are convicted criminals), Posthuman Fitness believers, and people seeking access to Fountain-1's psychosurgery techniques come to this station. Reporters, tourists, sapient's rights activities, sapient digital intelligences, and the curious are not allowed to enter Fountain-1.

Visitors who have not previously received full PF evaluations or who do not wish to immigrate to Fountain-1 are restricted to public and residential sections far from all essential services and research facilities. Visitors are accompanied by a loyal bioroid "tour guide" – who is also a trained killer intensely loyal to the principles of PF.

Economy

In addition to receiving contributions from PF groups, Fountain-1 has become known as a center for research in mental enhancement and psychosurgery. Individuals living on Fountain-1 hold a number of patents in this area, some of which provide a continuing source of income. In addition, Fountain-1 scientists are also involved in activities such as designing educational software and conditioning procedures for bioroids.

Many in Earth-Lunar space also associate Fountain-1 with the darker side of criminal justice. While most colonies either incarcerate criminals or repatriate them to their home nations, some colonies lack prison facilities, or cannot convince the criminal's home nation to take him back. Colonies that wish to dispose of violent criminals quickly and cheaply need only contact Fountain-1. Fountain-1 contracts with these colonies, which transport violent offenders back to Fountain-1 for *retraining*. Some convicts become involuntary recruits to Fountain-1's PF evaluation and alteration system.



INSIDE FOUNTAIN-1

Fountain-1 is exceptionally clean, orderly, and regimented. Specially colored armbands are worn at all times to identify each individual's caste. Also, everyone in Fountain-1 possesses either an implant communicator or virtual interface implant, to allow the leaders to track the movements of every individual and to easily issue orders.

The lower levels of Fountain-1 are relatively comfortable and are decorated with elaborate murals and other items designed to help reinforce the inhabitants' memetic programming. Levels that are primarily inhabited and used by the leaders are extremely luxurious. Imported carpets and tapestries line every surface, and most of the items used in daily life are in beautifully handmade casings.

A special caste of workers exists purely to create handmade artistic casings for personal electronics, to hand-forge and polish silverware, and to otherwise provide the leaders with elaborate and beautiful items. These items are also occasionally sold to wealthy outsiders. Since many people suspect how these goods are manufactured, the market is limited to buyers for whom aesthetics is more important than morality. Every leader also has one or more personal servants. While the highest status individuals actually have human servants, most members of the Leader caste use specially designed bioroid or parahuman servants.

EXTERNAL AFFAIRS

The rulers of Fountain-1 have close ties with a number of anti-SAI and authoritarian groups throughout the solar system. They also oppose groups that promote bioroid rights laws.

Fountain-1 has ties to several of the less reputable L5 stations. While Fountain-1 maintains links with various Posthuman Fitness groups on Earth, especially in the

FOUNTAIN-1 ADVENTURE SEED: INFILTRATION

One or more characters with the appropriate skills are called upon to infiltrate Fountain-1. While many groups want to know what is really going on there, the most likely people to finance such expeditions are the Australian or Japanese governments, who are both worried about what their political radicals are up to. Other groups interested may be radical sapient-rights groups, or wealthy individuals who are willing to pay for information about someone who has been sent to Fountain-1.

Pacific Rim Alliance, the only Earth nation with which it has formal relations is the infamous Zarubayev regime of Kazakhstan. Sergey Zarubayev is providing extensive funding to this colony in return for access to their specialized bioroids and neurovirus therapy. Currently, several Fountain-1 geneticists and mental engineers are in Kazakhstan, but Zarubayev has recently demanded access to the actual technology.

Fountain-1 has poor relations with the European Union, Islamic Caliphate, Pacific Rim Alliance, and the United States. It gets along fairly well with China. In L5, it considers Seventh Heaven to be its worst enemy.

STARBURST STATION

"Final antimatter destruct-sequence engaged. 10 seconds and counting."

Althasian troops had finally conquered Starburst Station, the last refuge of the Free Stars League. Karg's battle-barge hovered above the forward viewers like a giant, carnivorous insect. Karg himself stood on the station's bridge, guards ranged about him. Before him stood the Commander, uniform torn, manacled and helpless.

"Give me the computer codes, human. You are defeated!" Karg thundered.

"Never!" The Eternal Commander's eyes glowed with pride, unconquered, facing the indigo-skinned alien without fear. It was as if the electro-chains didn't exist. "Your cycle of conquest ends here, General Karg, at Starburst Station. The chain is broken."

"Five seconds and counting." The station's computer continued the self-destruct sequence, oblivious to the struggle of wills.

"Surrender to me! Will you kill everyone that you love?" The alien gestured with a wide hand to Lieutenant Bliss, struggling in the grip of two guards.

Bliss lifted her chin proudly, green hair dancing, and glared her defiance. "The Yantari have a saying: Liberty tastes sweeter than life!"

"Fools! If you both die, your precious Free Stars League dies with you!"

"No." The Eternal Commander met those cruel yellow eyes, quiet triumph in his voice. "Freedom will never die. As long as people look up to the stars in hope, as long as the memory of love and justice lives on in peoples' hearts, its spirit – our spirit – will endure."

"One second . . ."

"Yield!" the Althasian roared, dragging the Eternal Commander closer and wrapping massive blue hands around his neck. "I have won! I have finally defeated you! I have –!"

"Zero. Destruct sequence engaged and completed."

*– Last episode of **Starburst Station**, airdate 2067*

HISTORY OF STARBURST STATION

The station in the Junk Jungle is only seven years old; it was finished in 2093 but the spirit of Starburst Station is much older. The *Starburst Station* serials are familiar to anyone who grew up in the turbulent 2060s; the Free Star League, the Eternal Commander and his beloved Lieutenant Bliss, the adventurers who were drawn to the frontier outpost, and their ongoing battles with the Althasian Empire were all presented in a popular InVid series created by Mawari Digital that ran for eight years (2060-2067).

The story of Starburst Station and its fight for freedom against terrible odds created a following of dedicated – even fanatical – fans. After the series was canceled, these fans claimed the *Starburst* serials as their own, developing the Althasian language, and creating their own underground *Starburst* serials. Finally a group of fans choose to take the last step and bring Starburst Station to life.

Lauri Banyon, developer of the Althasian language and its seven dialects, as well as a major figure in AI linguistics, put up the initial seed money. She drew together several other influential figures – Scott Jasper, the developer of the Organic Construction System used to build Luna City, and Tai Qui, a little-known investment broker from Hong Kong. Tai Qui turned the initial money donated by fans into the wealth needed to build a station – or, as it turned out, to purchase a decrepit L5 habitat (the former High Jerusalem, an evangelical Christian colony that had suffered a social and life support crash, and been evacuated in 2087), and extensively renovate it.

Nearly a million fans offered money and skills to the station; a great deal of station renovation was done at cost or less, by architects, engineers or construction workers who donated their time and work. These people also found ways to bring every aspect of the original series to life in their station. The shifting walls of the serials became chameleon skin; the various planets visited by the Eternal Commander and his field crew became specially designed gardens.

There were compromises – the Starburst Station of the series was a shining “collapsium” metal construct that employed anti-gravity generators; the real station was a slag-reinforced sphere of nickel-iron whose rotation only provided gravity along the equator. Some of the show’s

aliens, originally nothing more than digital effects, remain beyond even the most advanced biomods or surgery, and have been recreated with cybershells and holograms. However, as far as the Starburst inhabitants are concerned, they have brought the heart and soul of the series to life in their station.

Starburst Station, in the L5 area, holds some 4,900 people dedicated to the ideals of freedom, hope, justice, and courage celebrated in the old series; a further 1,000 or so tourists are visiting at any time. The Station runs one of the major search and rescue teams in L5, often absorbing the costs of such rescues in the interests of preserving life. Also, the need to recreate the aliens from the old series means they have excellent medical facilities and have created a variety of imaginative cosmetic modifications for both people and animals.

Tourism and new – though unauthorized – *Starburst* episodes are a major part of the station’s economy. Tai Qui continues to be the financial heart of the station; his investments consistently bring in the money needed to keep the operation going.

After the series was canceled, these fans claimed the STARBURST serials as their own, developing the Althasian language, and creating their own underground STARBURST serials. Finally a group of fans choose to take the last step and bring Starburst Station to life.

YANTARI PHILOSOPHY

The Yantari Philosophy is mentioned only twice in the serials, as the explanation for Lieutenant Bliss’ remarkable ability to be in the right place at the right time. Tai Qui is a follower – and the real-world creator – of the Yantari Philosophy. He uses it to predict and master the world economy. This philosophy is spreading outside the Starburst Station, through Tai Qui’s publications and the evident financial benefit it offers. Two Yantari schools have opened on Luna and advanced students apply to study with Tai Qui himself. Tai Qui claims that the financial rewards of the philosophy are an unimportant side effect and most Yantari philosophers do not suddenly become millionaires. Yantari philosophers sometimes have mild Delusions (elements of the TV show are real) but may possess the Serendipity advantage, depending on the campaign style.

COLONY DESIGN: STARBURST STATION

Starburst Station has a 1,500' diameter sphere hull, along with a large (500' by 200') solar panel array. It rotates to produce 0.75 G. The station has a population of 5,000-6,000, with an average wealth level of Comfortable. It has a small spaceport and is CR 3.

Design: Sphere hull (3.375 million spaces, steel alloy, light frame); cDR/cPF 5/100 (slag armor). Solar panels (1,000 ksf). Solar cells (500 ksf). Hull radiators (25 ksf).

Modules: New command bridge; 2 medium radar; 2 medium PESA; medium ladar; 75 old fusion reactor, old fusion reactor core; 1,000 tanks (water); 4 2.5-MJ light laser towers [S]; 60 farm; 10 factory; 60 housing; 128 open; 8 park; 50 plaza; intrastation transport (for 10,000 people); 10 large entry modules; 50 surgery; 2 spacedock hanger (300' long by 300' wide by 400' high); 4 external cradles (3,125 tons each); 50 lab (2 physics); 30 minifac workshops; 50,000 cargo (250,000 tons).

Statistics: EMass 6,674,546; CMass 7,087,047; LMass 7,087,047. Cost M\$3,480.98. cHP: 52,734. Size Modifier: +15. HT 12. Maintenance Interval: 0.34 hours. RRA 18.

Performance: None.

INSIDE STARBURST STATION

The residents of Starburst Station live and work in a wide strip along the equator of their spherical station, while factories and two large docking bays are located in the lower-G sections near the poles. External mirrors (included in the solar panels) reflect sunlight down the sphere's central axis when needed, creating an Earthlike day/night cycle. Internal transport is via an array of monorails, elevators, and slidewalks.

From the outside, the station looks nothing like the original of the series, but much of the inside and the building interiors are faithful to the look and the imaginary culture of the *Starburst* serials. Slightly curved hallways open out into beautifully sculptured gardens and farms – with peculiar “alien” plants – welcoming homes, bustling workplaces, and modules where the command crew works to ensure the safety of the station and its inhabitants.

The internal walls of the station are chameleon skin or holographs, keyed to the v-tags everyone wears, and they change color according to who's walking by. The designers also integrated life support and emergency functions into the system, so inhabitants can monitor the status of the station just by looking at the walls of their homes.

THE ETERNAL COMMANDER

In the old serials, the leader of Starburst Station was the Eternal Commander, a man made immortal by wise aliens. When the station came on line, the inhabitants chose an Eternal Commander from their ranks. Scott Jasper accepted the position and was surgically altered to look exactly like the Eternal Commander of the serials. In addition, he was fitted with slinky uplinks, allowing selected thoughts and experiences to be recorded for the next Eternal Commander. The decision to use slinky recordings rather than ghosting or cloning the Eternal Commander was made after much debate. The slinkies were accepted as the best balance between the necessity to preserve an unbroken line of experience and the need for a fresh viewpoint in the Commander's post. Scott died within six months of accepting the position, and the command staff chose a successor.

The current Eternal Commander is Braxton Willis, 37 years old and a British citizen. A former E.U. diplomat turned space lawyer, he is also a devoted follower of the Yantari philosophy, and was instrumental in establishment of the station and its present legal registry. He willingly accepted the position of Eternal Commander. Like his predecessor, he was altered to look like the original from the serials and fitted with slinks. He also downloaded Scott's slinky recordings, giving him the benefit of his predecessor's experiences. A workaholic, he is trying to transform himself into a Yantari paragon, despite occasional moments of self-doubt.

COMMAND STAFF

Stationwide decisions are made by democratic cybervote. In the interests of safety, a command staff is elected and is sworn to protect the station and its inhabitants. Of the original investors, only Tai Qui is on the command staff. Laurie Banyan is the Ambassador from the Althasian Enclave and Scott Jasper died within a few months of the station's completion.

The command staff is made up of about a thousand people with various specialties, including zero-gee architecture, diplomacy, law, station engineering, and, of course, advertising and marketing. Legal issues or problems with tourists or visitors are brought to the command staff, who handle problems “in accordance with the laws of the Free Stars League.” The inhabitants of the station developed these laws themselves, since the Free Stars League was nothing more than backstory in the original serials.

Ambassadors from the command staff are working to develop a true community among the various colonies in the Junk Jungle. Starburst Station has hosted meetings of the leaders of Sakharov Station, Ravenstar, Seventh Heaven, and Peng Lai in hopes of creating some official, peaceful relationships among the mid-sized independent colonies of the Junk Jungle.

The Althasian Enclave

In the old serials, the Althasians were the archenemies of the Free Stars League and very popular among the fans. The languages, customs, religions – even music – of these aliens were reconstructed (with a great deal of imagination) from tidbits of data revealed in various scenes in the original show. Modern medicine allowed dedicated fans to become the aliens they loved. Lauri Banyon was among the first to become Althasian, and she brought about 500 others with her. Over the past seven years, the population of Althasians has grown to 900 or so.

Althasians resemble humans, but have smooth blue skin, space-black hair, and large, golden cat-like eyes. They possess both sensitive vision and are noted for their ability to ignore pain. The transformation is produced via surgery and nanoviruses: a vat-grown “cat’s eye” biomod transplant (which gives Night Vision [10], costs \$5,000, and takes 6 weeks rest to recover from), no-shock gland biomod transplants (p. CI161), and a cosmetic proteus nanovirus (p. TS165) to modify skin, hair, and facial features.

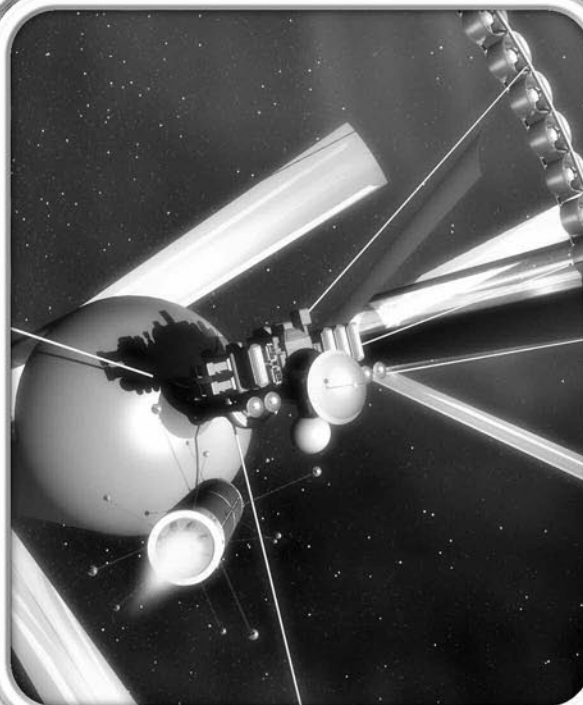
While the Althasians of the serials were enemies of the station, Lauri Banyon’s group has quickly become one of the most visible parts of station life. The Enclave itself is an area of shadowed parks and sharp angled, dimly lit buildings, for the Althasians are a nocturnal people. Tourists make the Enclave a popular destination, and humans look very out of place in the peculiar architecture of the supposedly non-human residents.

REPLAY

Braxton Willis, the new Eternal Commander, has experienced Scott Jasper’s last moments first hand. He knows his predecessor was murdered, but neither he nor Scott knew who or why. Now certain events in Scott’s slinkys are being repeated in his life – but they look like coincidences. Unable to trust his friends and fellows on Starburst Station, the Eternal Commander must turn to outsiders.

LIFE IN STARBURST STATION

Starburst Station is not like anywhere else. Aliens mingle freely with uplifted animals and normal-looking humans. Young Althasians bluff and posture as they struggle to win their name – the primary goal for all of the fans transformed into the blue-skinned, fierce-looking aliens. Many fans have altered themselves to look like actors from the old series; there can be a half-dozen versions

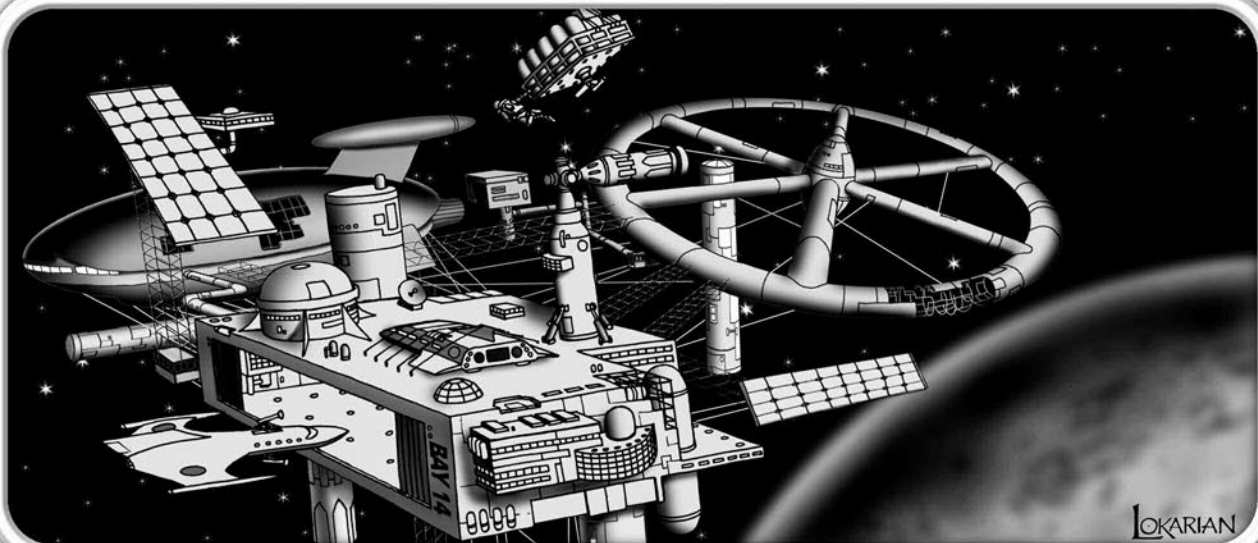


of Lieutenant Bliss at a coffeehouse or bar, which can be very confusing. SAIs, designed and programmed to resemble various alien species, are granted full citizenship on Starburst Station.

The residents of Starburst Station are well educated and often work, off and on station, in high-paying scientific, medical, or technology jobs. Tutors and professors work on Luna, teaching biology, genetics, or cultural analysis. Althasians work in the search and rescue teams, or other dangerous tasks that might earn their name for them. Yantari philosophers travel throughout the inner system, putting themselves in the middle of events in accordance with their beliefs.

While the *Starburst* serials were the inspiration for Starburst Station, the station accepts committed members from other fan communities. Over the past three years, the command staff has allowed other fictional communities to immigrate to Starburst Station. Friction between the newer residents and *Starburst* purists has become the topic of much debate, and more than a few brawls in the Enclave.

The followers of the *Imperial Legion* InVid series have become a large minority. Their stories focus on a galaxy of warring races, each fighting to control key resources and colonize newly discovered planets. The Imperialists’ warrior ethics and military expertise are attractive to young Althasians and it’s becoming common to see these Starburst aliens in Imperial uniforms. The Imperialists’ military leanings are disturbing to many residents who fear the rapidly growing subculture will gain enough political power to corrupt the peaceful ideals of the Free Star League.



Common Memes

Belief in *alien contact* is omnipresent on Starburst Station. Discussions about alien life and contact center on the hows and whys, not whether or not intelligent alien life exists at all.

The responsibility of every individual to participate in the governing of the whole is a key concept behind the laws of the Free Star League and cyberdemocracy is the chosen method. Morphological freedom and pan-sapient rights are embedded in both Starburst Station law and culture.

EXTERNAL AFFAIRS

Starburst Station has been increasingly active in the Junk Jungle. They are attempting to create peaceful diplomatic ties among the different colonies in the area, as well as inviting some groups to join their (no longer imaginary) Free Stars League.

For years, the residents of the station have been arguing about Fountain-1. Most Starburst inhabitants find the existence of Fountain-1 a violation of their cherished beliefs and demand that the Command staff take some action to help the victims of the Fountain-1 regime. The Imperialists are particularly vocal in their desire to interfere or even attack Fountain-1. Lately the Imperial tactical teams have been simulating station-to-station battles that strongly resemble possible situations between Fountain-1 and Starburst Station. Command staff sympathizers have been slow to put a stop to these simulations.

The Station also has ties to the TSA on Earth. Followers of the old serials have been violating copyright and trademark laws ever since the first fan-produced InVid episode was distributed. TSA companies are the pipeline Starburst uses to sell its illegal sequels on Earth. The copyright holders of the original series have been engaged in a long legal battle with Starburst Station, attempting to regain control of their intellectual property.

SAKHAROV STATION

The smell always gets to you, even if you've been there before. It's damp; a station like that shouldn't be humid. Pink stuff leaks from the ventilators and oozes from between the wall plates. One night I woke up and the stuff was crawling across my floor. But the people here – it's like time travel – they'll give me my doctorate. If I can get them to talk to me.

– Rebecca Swenson, Oxford meme scholar

HISTORY OF SAKHAROV STATION

Initial planning and construction of Sakharov Station began in 2026; it was the last gasp of the Russian Federation space program. Israeli investments provided desperately needed hard currency for Russia's economy while the Israeli government hoped the Russian space program would give them control of the near space "high ground."

Heavy lifters, antiquated even then, tossed a tin can into the uninhabited L5 point. Cheap labor from a half dozen Eastern European countries were housed in prefabricated, leaky dormitories attached to the central support of the half-built station. As China raced into space, surpassing most other nations, Israel found more profitable areas for their investments and the Russian Federation abruptly abandoned Sakharov Station as a crippling financial drain.

However, there was already a permanent population on the station, a mixture of Israeli and Russian scientists, technicians, and a supposedly temporary population of construction workers. Some of these early inhabitants had not only lost their jobs . . . but a changing political climate back on Earth made returning home dangerous. Instead, the staff took control of the station and declared themselves an independent colony.

Through the '30s and '40s, Sakharov Station struggled for survival. The station had been designed for research, with a great deal of space given over to laboratories and astronomical equipment. It hadn't been designed for permanent habitation. At first, the station sold research time and lab space – then they were forced to sell the equipment itself. In 2042, the station had a critical life support failure. Everyone on the station nearly asphyxiated before an ESA shuttle could reach them with equipment and aid. Prospects improved when the United States got back into space, and Sakharov Station was used as a trans-shipment point and its personnel hired for technical support.

Today, Sakharov Station is neutral territory, where Martian Triads and major corporations can meet without scrutiny or censure. Sakharov technicians are also popular in the L5 area, where technology can be years behind Earth standards. They are located in the center of the L5 point, excellently positioned for shipping. Most major corporations active in the L5 area or Luna have at least a small office here.

SAKHAROV STATION HABITAT

Sakharov is actually a cluster of multiple stations and spacecraft tethered together – its core, excluding Rebecca's Arm (p. 132), is approximately equivalent to seven “soda can” work shacks in fair to terrible condition (see *Buying It Used*, p. TS190). The station has a population of 500 people with an average wealth level of Average. It has a small spaceport and is CR 2, except for weapons, which is CR 5 for guests and CR 1 for residents. Residents of Lenin's Tomb (p. 132) make about half the average income.

Sakharov Station has few modern amenities, its antiquated communication system limits web access, there are few public v-tags, and much of the technology is 50 years old. Food is grown in vats, gravity is erratic, and slow atmosphere leaks are common. Everyone who lives on the station carries their own respirators – even the children.

INSIDE SAKHAROV STATION

Sakharov Station is divided up into distinct districts, each in a different joined habitat. The Station has a unique, organic odor to it, from severe overcrowding and the fungi and pink slime mold that grows in every damp corner of the station. Visitors are horrified by the occasionally mobile (in microgravity) mass; residents are used to it, but know to stay well clear. There are actually more than a dozen species of toxic fungus growing on Sakharov Station, all mutating rapidly due to the lack of radiation protection. The pink slime mold is harmless, but aggressive enough to keep the other types at bay. More advanced methods of

controlling the various infestations have failed. Some of the toxic fungi have useful properties, and the inhabitants sell one species of edible hallucinogenic 'shrooms to passing vessels and L5 residents.

Many of the original inhabitants of the station are still alive, and the station is well into its third native-born generation. Seventy percent of the population are floaters (p. TS115) – humans raised in microgravity without compensatory genetic changes or biomods. As for the rest, 15% are humans or parahumans – mostly criminals and fugitives from other stations – who have microgravity biomods, 10% are Tennin (primarily outlaws that have fled Duncanite communities), and the rest are a melange of people of all types and backgrounds, many of them fugitives.

The natives' long isolation in the L5 area has made them independent, insular, and wary of outsiders. Their loyalties are to their families, their districts, and the station itself. However, some may harbor fugitives they find useful (or who pay them).

Common Memes

Sakharov stationers favor capitalism in its raw state and accept bribery, extortion, and blackmail as part of a capitalist society. In addition, Sabra residents are susceptible to nationalism in relation to Israel, and the inhabitants of Lenin's Tomb have an underdog's unshakable loyalty to their home district. Younger residents on Sakharov are particularly vulnerable to mechanimism when first exposed to the more advanced computers on Earth or Luna.

St. Petersburg

This is the largest district on Sakharov Station – three “soda cans” linked together, and the major point of contact with the outside world. It's a free port, where everything from pirated AIs to illegal genomes to stocks and bonds can be traded without concern for law or tariffs. There are also gray-market stores selling brain implants and nanodrugs of dubious quality. Some of the connections run to deep space and the Martian Triads and Trojan Mafia; others to Israeli and Russian arms dealers and gangsters back on Earth.

St. Petersburg has invested in a more modern Augmented Reality infrastructure, with newer web connections and ever-present v-tags. They recently bought an AR street improvement program that applies virtual decorations and filters offensive views from connected headgear. The street designs are based on pre-Soviet images from the old Earth city of St. Petersburg. Of all the Sakharov districts, St. Petersburg seems most civilized.

St. Petersburg residents are rich compared to the rest of Sakharov Station. Children here often have access to black-market microgravity-adaptation and DNA repair nano (which keeps them healthier), and VI implants. These kids are more cosmopolitan, and many leave to live on Earth or other more civilized places.

Rebecca's Arm

This is the oldest organized habitat in Sakharov Station, and proud of it. But Rebecca's Arm is not large – just two soda cans tied together. People from Rebecca's Arm go off-station to make their living. They hire out as workers and technicians, specializing in the obsolete equipment common in the L5 area. Most of their customers are other poor colonies who are using antique equipment, abandoned asteroids, or refitted shuttlecraft from the turn of the last century. Rebecca's Arm maintains a junkyard of dead and dying space vehicles outside the station (see below), which they salvage, repair, and sell to merchants and hauling companies too poor to afford anything better.

Like all of Sakharov Station, except for St. Petersburg, there is little in the way of modern comforts. There are relatively few v-tags, and web access can be erratic.

The Junkyard

This isn't really a spaceyard – it's a junkyard of old spacecraft docked in and around the station. At any given time, there are 20-50 spacecraft here, of which a half-dozen are somewhat serviceable. The rest are in various states of disrepair, including some gutted hulks. Many of the spacecraft here date back to as early as the 2020s. You won't find anything here with a pulse drive, or new control systems, or new reactors. All of the vessels are missing their weapon systems, and most have no sensors.

Sabra

Sabra is an ambitious and growing community. They have two soda can habitats and have been aggressively renovating and towing in what they can from outside, sometimes working as cut-rate vacuum cleaners. Customs and laws in Sabra are based on interpretations of the Torah.

Sabra residents can be found working in construction and technical fields, like their neighbors from Rebecca's Arm, but they have also begun to make a name for themselves as advisors and guides for corporations and governments wishing to expand into the L5 area.

Some residents of Sabra still have ties to Israel (and possibly to the Mossad, Israel's foreign intelligence agency).

Lenin's Tomb

This is the ghetto of Sakharov Station, three decaying soda can work shacks. The Tomb is an old part of the station, originally temporary quarters for construction workers. When the station went independent, they were stranded. This section is the worst maintained, with the worst infestation of mold. Inhabitants here live in squalid and dangerous conditions. Their modules are falling apart, and residents have little hope of escape. Their food vats and few garden plots are contaminated with toxic growths, along with their life support relays.

People from Lenin's Tomb survive by taking the filthiest and most dangerous jobs both on station and off. If a fly-by-night nanocorp wants a cheap refit done on a mined-out asteroid, workers from Lenin's Tomb get the job. When the acid-secreting fungus infesting the main life support module in Section Seven gets out of hand, residents from Lenin's Tomb are called to clean it out. These stationers have become experts in making do with duct tape, dysfunctional microtech, corrupted computer systems, and technology so old most people have forgotten about it. Residents from the Tomb know more about fungal infestations than anyone else, and more than a few feuds in Lenin's Tomb have ended with the loser consumed by a previously unknown flesh-eating fungus.

Lenin's Tomb residents cannot afford even the most basic genefixes for their children and most children from the Tomb are floaters (p. TS115). The people here are almost all unmodified humans, except for unintended mutations and the occasional disfiguring illness or injury. They speak a dialect so thick that even other Station inhabitants can barely understand them.

EXTERNAL AFFAIRS

Sakharov Station is one of the oldest L5 habitats. The station's personnel remain strictly neutral in modern politics; having outlived their old enemies, they're not eager to make new ones. Other colonies in the Junk Jungle have a certain respect for Sakharov Station's ability to survive and their years of experience living in the L5 point.

The Russian-speaking natives of Sakharov Station can be found all over the L5 area, and occasionally in more distant colonies, working as technicians, construction crew, or negotiators. Both Russia and Israel have large diplomatic offices on the station, with live personnel and priority on St. Petersburg's airlocks.

These stationers have become experts in making do with duct tape, dysfunctional microtech, corrupted computer systems, and technology so old most people have forgotten about it.

OTHER L5 COLONIES AND STATIONS

There are many smaller stations in Lagrange 5. Here are a couple of examples:

NICKAJACK STATION

This habitat is a wheel-shaped space station whose LCD surface is now digitally painted to resemble a giant roulette wheel. It was originally intended as a libertarian business park and tax shelter, but poor management led to infiltration by organized crime.

At present, Nickajack Station is registered to the free city of Montreal through various dummy companies, but is controlled by the Maple Syndicate. The main business of Nickajack is its high-stakes casino with a “California gold rush” frontier theme, but it also boasts some decent restaurants, bars, and shops; much of the merchandise is pirate copies of brand-name goods duplicated by the station’s 3D printers.

The majority of Nickajack’s customers are off-shift or vacationing visitors from other L5 colonies and Luna. Nickajack has a permanent staff of 200 (about half are bioroids), with a transient population of 2,000. It is well-protected by syndicate enforcers, plus a couple of laser towers and second-hand AKVs; there have been a few clashes with Triads trying to muscle in. Nickajack is CR 2, with a small spaceport.

PENG-LAI HABITAT

Peng-Lai is a Bernal sphere with a population of 4,200. It is the headquarters of the Peng-Lai movement, a fusion of Taoism and transhumanism founded in Taiwan in the 2060s. Peng-Lai grew to 220,000 adherents in China and East Asia (and many on Mars) before it was banned (in 2079) by China. The group was charged with distribution of unlicensed commercial neurotropics and anti-aging nanosymbionts; in actual fact, their playful creation of an eidolon of the last Dalai Lama may have had more to do with it, plus the general hostility of the Chinese regime to unsanctioned “cults.”

Peng-Lai are “fourth wave” transhumanists, working to improve themselves via nanomod to the human body rather than through digital intelligence, although most members have shadow partners. Peng-Lai has good relations with the hyperevolutionists of Seventh Heaven, and they and other transhumanist sympathizers helped the colony get started.

The Peng-Lai colony was originally owned by Nanodynamics; it’s leased to the organization, but is Panamanian territory. It has a small spaceport and is CR 2.



RAVENSTAR

Ravenstar is a Bernal sphere similar to Starburst Station (p. 126), but with a population of 1,670. The inhabitants are all Wiccans, including several covens of practicing witches; the colony is ostensibly run on anarchist principles, but in practice is run by a council of high priestesses.

The habitat itself is owned by the Ravenstar Corporation; moving to the station means buying stock in the company. Most occupants are wealthy (primarily American) wiccans and neo-pagans, many associated with the Covenant of Unitarian Universalist Pagans.

Most of the colony interior is open space, with buildings, gardens, and sacred groves along the equator. The majority of the inhabitants do not work for Ravenstar Corporation, but telecommute to jobs elsewhere in Earth-Lunar space. Unlike Margaret (p. 102), Ravenstar, while somewhat matriarchal in orientation, is not limited to women.

Ravenstar has a space dock and is CR 4. Ravenstar Corporation is registered with the government of Ecuador, which is also the colony’s “flag of convenience.”

SEVENTH HEAVEN

Seventh Heaven was the first “fringe” L5 colony to be established. It is a cylinder some 600’ long and 120’ in diameter that nevertheless houses a large population: 3,200 humans and 7,000 sapient digital intelligences, a mix of SAI, shadows, and ghosts.

The station was originally a factory complex, and has now been largely converted into a maze of laboratories and apartments. Unlike more open habitats like Islandia, there are no large farm areas or open skies, although a few greenhouses and hydroponic gardens exist. However, the colony is by no means boring: most of the interior has been refitted with reconfigurable smart architecture, so that walls, furnishings, and decorations are quite mutable. It’s fashionable to change one’s apartment as often as one changes clothes, although a few rogues make a point of keeping the same designs for months at a time.

Seventh Heaven is an artist’s colony writ large, where the canvas is the human body and mind. The colony was established in 2065 by Christian hyperevolutionists. They believe that sapient AIs and other digital intelligences possess souls, and that both technological and spiritual progress depends on the conscious uplifting of humanity.

In practice, the colony is an “industrial park” for posthuman research. The colony offers lab space and facilities plus computer time to more than 100 different bioengineering companies, software companies, and radical bioengineering combines. The presence of multiple companies under the same shell is designed to encourage synergy. All are supported by the Church of Seventh Heaven, which is itself a nonprofit research foundation as well as an organized religion.

One unique element of Seventh Heaven is the encouragement of human experimentation. Due to the presence of several hundred committed hyperevolutionists, the research labs have no lack of experimental subjects eager to undergo cutting-edge procedures in the name of posthuman transcendence. Those who succeed are hailed as visionaries and saints; those who fail are its martyrs, and are taken care of by the Church. The Church’s early advocacy and adoption of once-experimental uploading techniques has given it the largest population of “fragments” in human space.

Seventh Heaven is run by the Bishop of Seventh Heaven, who is elected from Church membership. Otherwise, the station operates on fairly democratic grounds.

The colony is CR 1, with a small spaceport.



ZHENGSHENG STATION (ORIGINALLY KUJANG STATION)

In the early 2080s, this Indonesia-Malaysian station was the TSA’s primary extraterrestrial colony, serving as a construction shack from which solar power stations were built for later transport into GEO.

The station was a prime military target, but due to its large size, destroying it with an AKV strike was deemed too likely to result in debris that might damage other stations belonging to non-belligerents. Instead, three SDVs closed on the station and “neutralized” it with a barrage of particle accelerator fire, which was followed by a spaceborne infantry assault. The station was captured largely intact; there were no survivors.

The station was decontaminated following the Pacific War and has since remained in the possession of the PLAN-SF, who use it as a training area for orbital cyber-shell assaults. It has a permanent population of only a dozen humans (plus twice as many bioroids and cyber-shells); most are technicians and custodians, plus a few soldiers on guard duty. The population can swell to 400-500 during semi-annual combat exercises. At all other times, large parts of the station are empty and kept in vacuum; the rest is used as a backup fueling station and spare parts warehouse for PLAN-SF vessels.

Zhengsheng Station’s full-time staff is small enough – and bored enough – to be easily bribable; occasionally the station has been used as a LEO transshipment point by snakehead gangs moving would-be colonists from L5 to Mars. It has a space dock facility and is CR 2.

APPENDIX: SPACECRAFT AND STATIONS

This chapter details equipment, spacecraft, and design options common to Earth-Lunar space.

PERSONAL SPACECRAFT

Not all manned spacecraft are lumbering giants or sleek space planes – many are no larger than a motorcycle.

RSX-100 “BROOMSTICK”

Made famous in Sanjay Khan’s hit slinky “Gangs of L5” and Artemis Studios/Mawari Digital’s exploitation saga “The Witches of Ravenstar,” the RSX-100 is a high-performance production rocket scooter, or “broomstick,” manufactured by NUK Orbital Industries. This and other broomsticks are used as individual transports for short inter-station jaunts in orbital space, and, especially, in L4 and L5. The Vacs of Clarke-1 are also famous for their skill with these tiny spacecraft.

The RSX-100 has a light-alloy frame with minimal controls (piloted mostly via virtual interface), a “seat” (actually a collection of hand bars, acceleration padding, and foot rests), a fuel tank, and bolt-on vectored-thrust metal-oxygen rocket engine. The rider (who uses Piloting (High Performance Spacecraft) skill, is completely exposed. A broomstick is stripped down – they don’t have life support, or even a radio (everyone has one in their suit anyway), and there’s no navigation system (use the rider’s virtual interface’s GPS receiver or a radio beacon). It has a small enclosed cargo compartment.

The RSX-100’s engine burns 108 gallons of MOX fuel per hour. It has 333 seconds (5.5 minutes) fuel, giving Burn Endurance 0.0925 and Delta-V 0.31 mps. Payload is 340 lbs.: 120 lbs. of fuel, 20 lbs. cargo, and one person.

Subassemblies: Body 0.

Powertrain: 100-lb. thrust MOX rocket.

Fuel: 10 gallons MOX (fire 12).

Occupancy: 1 XCS (cycle). **Cargo:** 0.5 cf (20 lbs.).

Equipment

Body: None.

Statistics

Size: 3’ □ 1’ □ 1’ *Payload:* 340 lbs. *Lwt.:* 0.188 tons
Volume: 3 cf *Maint.:* 448 hours. *Price:* \$1,987.50.

HT: 10. *HP:* 10.

sAccel: 6 mph/s (0.3 G)

Design Notes

Structure is light, standard, with 0.5 cf of empty space. Electronic controls. Empty weight is 35.75 lbs. sAccel is calculated based on half-full fuel tank (“combat weight”). Each second of full acceleration adds (or subtracts) up to Move 3 in zero-gravity.



LUNAR MINING VEHICLE

A six-wheeled robotic bulldozer and ore processor. A rotating turret has an antenna-like beamed power receiver (p. VE87) that receives energy beamed out as laser or microwaves from a solar power tower; this runs the volatile processing plant and all vehicle systems. However, batteries can operate the vehicle itself (but not the plant) for an hour. This particular model is fully robotic, but has provision for a 3-person crew.

Subassemblies: Body +6, six off-road wheels +4, turret +4.

Powertrain: 400-kW all-wheel drivetrain; 400-kWh batteries; 3,000-kW beamed power receiver.

Occupancy: 3 RCS. **Cargo:** 300 cf (7.5 tons.).

Equipment

Body: Bulldozer blade, full life support, microframe computer (C7), small airlock, volatile processing plant). *Turret:* Line Sensor Suite, medium-range radio, laser communicator.

Statistics

Size: 12’ □ 16’ □ 28’

Lwt.: 52.34 tons.

Maint.: 17.76 hours.

Payload: 8.1 tons.

Volume: 1,900 cf

Price: \$1,268,520.

HT: 12. *HP:* 20,000 [Wheels] 300 each, [Turret] 600.

gSpeed: 45 *gAccel:* 2 *gDecel:* 15. *gMR:* 0.5 *gSR:* 4. Low GP (on Luna). Off-road speed 22.

Design Notes

Medium robotic aluminum frame, smartwheels, titanium armor. Volatile processing plant is 15,000 lbs., 3,000 cf, \$500,000, and uses 2.5 MW. Its light sensor suite includes a 12-mile range PESA and 4.5-mile range AESA. WVMDS design (see pp. ITW124-136.)

SPACECRAFT AND STATIONS

These were designed using the rules on pp. TS173-190 and the options described on pp. 140-142.

ENTERPRISE-CLASS MODULAR STATION

A 150' long, 30' diameter cylinder used as the central core of a small space station. It will often have 1-5 Lab, Housing, or Defense Modules attached to it, nestled in its cradles or even secured by tethers.

The station has a small docking bay (if empty, often used as zero-G recreation area), internal warehouse space, and tanks for refueling vessels. There are four halls usable as conference rooms, shops, or work shops. It also has eight cabins (although these are in microgravity).

The *Enterprise* core module can also function as a small solar-electric ion drive craft on its own. It has enough delta-V for orbital maneuvering, although this will drastically decrease when modules are attached to it.

Design: Cylinder (216 spaces, carbon composite, light frame); cDR/cPF 0.2/1 (aluminum armor). Solar panels (20 ksf). Solar cells (4 ksf).

Modules: Old basic bridge; Very small PESA; very small radar; 2.5 ion drive; 40 tanks (5 argon, 35 empty); 8 cabins; 4 halls; large entry module; 3 minifac workshops; small entry module; 0.1 battery; spacedock hangar (50' by 25' by 25', 62.5 spaces); 4 external cradles (125 tons each); 52 cargo (260 tons).

Statistics: EMass 219; CMass 500; LMass 520. Cost M\$10.34. cHP 119. Size Modifier +9/+4. HT 12. Maintenance Interval 6.22 hours (15.4 man-hours/day). RRA 0.

Performance: SAccel 0.00002 G. Burn Endurance 10,000 hours. Burn Points 720. Delta-Vee 2.2 mps. No air speed. Adding more modules will reduce performance, e.g., adding 4 housing/lab modules or 1 shelter/defense module halves sAccel, Burn Points and Delta-V; adding both divides by 3.

Housing Module

This is a 75' long, 30' diameter cylinder containing cabins, dining, and recreation space for 20-40 people. The module has no gravity, but two modules are often attached to a station core and spun on tethers.

The module may be used to quarter space workers and researchers, or as a cheap space hotel. A typical internal arrangement is five floors, with four

of them residential (each with a hall and five cabins), and one central service floor (with the entry module, reception hall, and a cargo area/battery room).

It relies on the attached Core module for power; on its own, batteries can operate it for five hours, or it could be equipped with extra solar panels.

Design: Cylinder (108 spaces, carbon composite, light frame); cDR/cPF 0.2/1 (aluminum armor). Solar cells (4 ksf).

Modules: 20 cabins; 6 halls; large entry module; 0.1 battery; 4.4 cargo (22 tons).

Statistics: EMass 100; CMass 125; LMass 125. Cost M\$1.26. cHP 17. Size Modifier +7/+4. HT 12. Maintenance Interval 52.16 hours (1.8 man-hours/day). RRA 0.

Fate protects fools, small children, and ships named ENTERPRISE.

— Cmdr. William T. Riker,
“Contagion” (STAR TREK:
THE NEXT GENERATION)

Lab Module

This is a 75' long, 30' diameter cylinder containing microgravity labs and workshops. The halls are used as laboratory and manufacturing work areas, with the exception of one that is used as an office/conference room. It includes bunk space for 4-8 lab technicians or researchers. The module can operate as an independent station, but usually, the lab module is clamped onto a larger *Enterprise* Core Module. If so, the bunks are often assigned to technicians or grad students, while the senior scientists stay in somewhat roomier cabins in a different station module.

Crew: 4-8. Two lab technicians (with Electronics Operation and Mechanical skill) will maintain equipment; they may be cybershells.

Design: Cylinder (108 spaces, carbon composite, light frame); cDR/cPF 0.2/1 (aluminum armor). Solar cells (4 ksf).

Modules: 2 bunk; 6 labs; 9 halls; large entry module; 2 minifac workshops; 0.1 battery; 0.2 cargo (1 ton).

Statistics: EMass 123; CMass 125; LMass 125. Cost M\$9.04. cHP 65. Size Modifier +7/+4. HT 12. Maintenance Interval 6.65 hours (14.4 man-hours/day). RRA 0.

CONCIERGE-CLASS DEFENSE MODULE

A civilian close-defense system developed by Consolidated Space Defense (a division of System Technologies AG). Modules of this sort are rare, mainly found on high value installations or those whose owners are worried about debris defense or unwanted guests. It is a 30' long, 10' diameter cylinder with a laser tower and sensors. Its power pack provides 14 shots; the RTG has 1.28 MW of extra power to recharge it.

Design: Cylinder (4.8 spaces, aluminum alloy, extra-heavy frame); cDR/cPF 10/2 (composite armor).

Modules: Old cockpit; small ladar, very small PESA, very small radar; 2.5-MJ light laser tower [S]; 0.5 old RTG; 0.8 power pack.

Statistics: EMass 125; CMass 125; LMass 125. Cost M\$6.7. cHP 67. Size Modifier +4/+2. HT 12. Maintenance Interval 7.73 hours (12.4 man-hours/day). RRA 0.

CYNOSURE-CLASS STATION

This large, multipurpose station is a steel cylinder 250' long and 100' in diameter, with a pair of 125' by 200' solar panels. The station's surface has been covered with slag mined from asteroids or Luna, providing extra radiation protection. As such, this multi-purpose facility can serve as a residential station or port, and with attached modules, as a lab or industrial park. It's a livable micro-gravity environment housing up to 200 people.

The station is not as cramped as some, with limited manufacturing and food production capability. Its spaceport facilities include a medium-sized space dock, large warehouses, and enough tank space to refuel a *Sudbury*-sized spacecraft. However, unless the station's actual population is 20 people or less, it is not self-sufficient in food, and will have to import it. Stations of this sort often supply workers for other facilities.

It carries 154 tons of reaction mass and 2,520 tons payload.

Design: Cylinder (4,000 spaces, steel alloy, light frame); cDR/cPF 1/5 (slag armor). Solar cells (25 ksf). Hull radiators (1 ksf).

Modules: Basic bridge; small PESA; small radar; 25 ion drive; 370 tanks (20 argon, 350 empty); 7 old fission reactor; 2 battery; 40 halls; large entry module; 100 luxury cabins; medium robot arm; 10 minifac workshops; 2 small entry modules; 4 surgery; garden; intrastation transport (capacity 200); vatfac; space dock (75 tall, 50' wide and high); 12 external cradles (125 tons each); 500 cargo (2,500 tons).

Statistics: EMass 13,335; CMass 15,932; LMass 16,009. Cost M\$71.76. cHP 720. Size Modifier +10/+8. HT 12. Maintenance Interval 2.36 hours (40.7 man-hours/day). RRA 1.

Performance: sAccel: 0.00001 G. Burn Endurance: 4,000 hours. Burn Points: 144. Delta-V: 0.44 mps. No air speed.

SHANZI-CLASS SPACE DEFENSE PLATFORM

The Shanghai Orbital Industries *Shanzi* ("mountain") class is one of the oldest type of PLAN-SF space defense platforms in use. Earth Fleet deploys 12 *Shanzi* in Earth orbit, sometimes in close proximity to Chinese stations. They are elderly stations, and more than half of them are veterans of the Pacific War, often with the scars to prove it. However, no *Shanzi* has been lost in combat, though not all their crew were so lucky. Some *Shanzi* SDPs have been sold off to other nations: India bought one in 2094.

Each *Shanzi* SDP is a 124'-diameter steel sphere, formed out of a chunk of asteroid metal. It has a 100'-long particle accelerator, but this is used primarily to sterilize soft targets such as satellite constellations or lab stations. For ship killing, it has 15 heavy laser towers spaced about the hull. *Shanzi* uses a low-power fusion torch for orbital correction – it's not designed for tactical maneuverability, but can slowly vary its orbit.

They are not just warcraft. They are primarily bases, providing less cramped quarters for SDV and other space crews and the maintenance teams to service them. There is a space dock large enough to accept a TAV or a couple of OTVs, plus bays for a squadron of 20 *Zhengyang* AKVs (p. ITW107). Not all China's SDPs are fully manned, and some in Reserve Fleet are "mothballed" with a skeleton crew, mostly cyber-shells and bioroids.

Crew: Commander (Leadership, Shiphandling, Tactics); Pilot (Piloting (Low-Performance Spacecraft)); 16 weapons officers (Gunner [Beam]); 10 Engineers (Mechanic (Fusion Drive), Mechanic (Robotics), Armory (Spacecraft weapons), plus another two dozen engineers tasked with servicing other vessels. Often carries three times as many crew for second or third shift, plus lab technicians, and civilian contractors, plus anywhere from a squad to a company-sized force of Space Infantry Division troops.

Design: Sphere (1,906.624 spaces, steel alloy, extra-heavy frame); cDR/cPF 40/5,000 (steel alloy armor). Hull radiators (33 ksf).

Modules: Old command bridge; old basic bridge; large ladar; large PESA; large radar; medium ladar; medium radar; 5 fusion torch drives; 150 tanks (water); 100 tanks (nuclear pellets); 15 10-MJ heavy laser towers [S]; 100' old particle beam [F]; 125 old fusion reactor; old fusion reactor core; 50 bunks; 50 cabins; 35 halls; 5 labs; large entry module; 10 minifacs; 3 small

entry modules; intrastation transport (300 persons); 100 cargo (40 KKMP and 20 XLMP munitions packs); space-dock hangar (100' by 50' by 50', 500 spaces); 20 vehicle bays (for *Zhengyang* AKV).

Statistics: EMass 54,455; CMass 60,935; LMass 62,060. Cost M\$308.89. cHP 2,833. Size Modifier: +8. HT 12. Maintenance Interval: 1.14 hours (84.4 man-hours/day). RRA 33.

Performance: sAccel: 0.00025 G. Burn Endurance: 200 hours. Burn Points:180. Delta-V: 0.55 mps. No air speed.

Yeager SDP: This older Nanodynamics-built USAF station is fairly similar to the *Shanzi*, but has bays for 14 *Predator* AKVs instead of 20 *Zhenyang*.

OMNISTAR-CLASS SPACE PLATFORM

This design consists of a 300' long, 20' wide box that houses a basic bridge and small cabin, sensor and communication arrays, a long robot arm for unloading cargo or attaching new modules, and a set of elevator cars that run the length of the truss.

Tanks contain reaction mass for the ion thrusters and sufficient water to refuel a *Kagoshima*-class OTV. Attached to the truss are multiple solar panels, plus 10 external cradles to which housing, lab, and defense modules (p. 136) can be clamped.

The solar panels (and a battery, during periods of darkness) power the station's ion drive. Acceleration is extremely slow – the station can't really maneuver to get out of the way of anything – but suffices for station-keeping (p. 142). An extra 19 MW are available and can be used to power any of the modules that are attached to the platform.

Two, three, or four *Omnistar* stations can be linked together to form a cross, triangle, or square, if a larger combined station is desired.

Crew: Stationmaster (Astrogation, Piloting [Low-Performance Spacecraft]; Systems Operator (Electronics Operation [Communications, Sensors]); Flight Engineer (Mechanic [Ion drives and solar power]). Three Technicians (Mechanic [Ion drives and solar power]).

Design: Box (240 spaces, foamed alloy, light frame); cDR/cPF 0.2/1 (steel). Solar panels (300 ksf).

Modules: Basic bridge; luxury cabin; small PESA; small radar; radiocom; lasercom; 5 ion drive; 50 tanks (argon); 38 tanks (water); 2 large entry module; small entry module; large robot arm; interstation transport (40-person capacity); 2 battery.

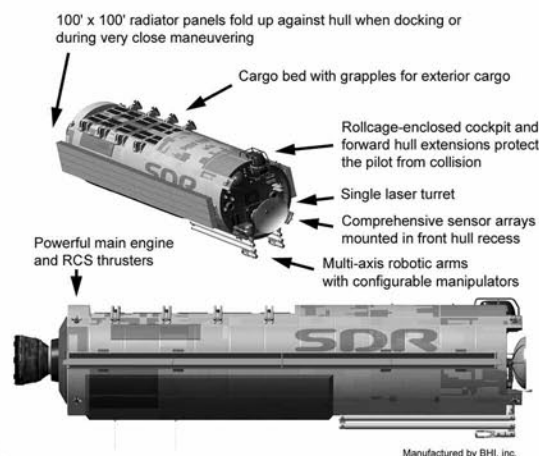
Statistics: EMass 487; CMass 2,500 (with cradles loaded); LMass 2,693 (with cradles loaded). Cost M\$30.14. cHP 186. Size Modifier +10/+2/+3. HT 12. Maintenance Interval: 3.64 hours (26.4 man-hours/day). RRA 0.

STEPTOE-CLASS DEBRIS RECOVERY VEHICLE

The Vosper-Babbage *Steptoe* DRV is a typical Vacuum Cleaner vessel, capable of locating and tracking debris of almost any size, and dealing with it in various ways. It can maneuver between orbits, intercept fast-moving objects, and serve as a “tug” to move large objects around. It has both a modest internal bay and external cradles which can be used to carry salvage. It can withstand moderate impacts in the event of a miscalculation – its radiator wings are vulnerable but easily repaired – but faced with a radiation storm or a medical emergency, must run for home (which is rarely far).

STEPTOE-CLASS DRU

Length: 100 ft. • Diameter: 26 ft. • Primary Operator: SDR, Inc.



Its basic structure is cheap and simple – a stubby 75' long, 30' wide cylinder with radiator wings running down the sides and a laser turret on the nose, built on a heavy frame covered in foamed-alloy sheathing – but it carries comprehensive sensors and adequate computers for its role. Usually, one radar system is used to track a specific target while the other scans for unknown dangers. It mounts a pair of robot arms under the nose, for manipulating objects without the crew having to suit up, and a single laser for debris destruction or deflection. For high-delta-V missions (intercepting a piece of debris before it collides with another and produces a cascade of fragments, say, or contract work in geostationary orbit) auxiliary fuel tanks can be attached to the cradles.

Steptoe-class craft routinely carry a crew of three: pilot, systems/communications operator, and operations engineer (responsible for assessing target debris, operating the laser or the robot arms, and most extra-vehicular work). Vessel names are up to the owner or

company policy, with no consistency; SDR leaves the decision to its crews.

The performance assumes 30 tons carried as cargo; payload is 30.3 tons including crew. If it has a full load on its cradles, sAccel falls to 0.14 G and Delta-V to 5.1.

Crew: Pilot (Piloting [High-Performance Spacecraft]); Systems Operator (Electronics Operation [Communications, Sensors], Mechanic [Fusion Rocket]); Ops Engineer (Free Fall, Gunner [Beams], Vacc Suit).

Design: Cylinder hull (108 spaces, aluminum alloy, heavy frame); cDR/cPF 2/1F, 1/1S, 1/1B (foamed alloy armor). Hull radiators (5 ksf), radiator wings (20 ksf).

Modules: Old basic bridge; PESA; medium radar; small radar; small ladar; 50 HT fusion torch drive; 25 tanks (water); 2.5-MJ light laser (F); 2 medium robot arms; large entry module, 0.06 battery; external cradle (250 tons); 6 cargo (30 tons).

Statistics: EMass 617; CMass 834; LMass 1,022. Cost M\$63.33. cHP 259. Size Modifier +4/+7, [Radiators] +8. HT 12. Maintenance Interval: 2.51 hours (38.2 man-hours/day). RRA 25.

Performance: sAccel: 0.18 G. Burn Endurance: 3.3 hours. Burn Points: 2,158. Delta-V: 6.59 mps. No air speed.

USAGI-CLASS "HOPPER"

In 2057 Tenzan Heavy Industries introduced their *Usagi*-class moon hopper (or "Lunar Transit Vehicle"). A short-ranged "space bus," its reliability and low maintenance cost has made it a very popular short-haul lunar surface and trans-orbital transport vehicle. Dozens of these craft are used on Luna and in Earth orbit and L4/L5.

It uses an indigenously fueled metal-oxygen rocket engine for propulsion. Flying a suborbital ballistic trajectory, it can get nearly anyplace on Luna in less than an hour. It can also be used for maneuvering between nearby space stations, and is popular in L4-L5.

The *Usagi* carries a pilot and up to 28 seated passengers, plus 0.5 tons of cargo (e.g., luggage). Cargo-only versions also exist. It has a cylindrical hull 25' long and 10' in diameter, and uses 26.25 tons of reaction mass. Its battery provides 25 hours of energy.

Crew: Commander (Astrogation, Piloting [High-Performance Spacecraft, Electronics Operation [Communications, Sensors]]).

Design: Cylindrical hull (4 spaces, titanium alloy, light frame); cDR/cPF 0.2/1 (titanium alloy armor).

Modules: Old simple cockpit; very small radar (F); 0.1 metal oxygen rocket; 1.25 tanks (metal-oxygen); 0.05 battery; small entry module; 1.75 passenger (28 seats); 0.1 cargo (0.5 tons).

Statistics: EMass 10; CMass 27; LMass 40. Cost M\$0.3. cHP 7. Size Modifier +2/+4. HT 12. Maintenance Interval: 36 hours (2.66 man-hours/day).

Performance: sAccel: 0.6 G. Burn Endurance: 0.125 hours (7.5 minutes). Burn Points: 270. Delta-V: 0.825 mps. No air speed.

VULCAN-CLASS STATION

A mid-size station, this is intended for use as a microgravity factory complex and spaceyard. It is designed to provide a temporary but livable environment for trained, highly skilled workers from Earth as they construct larger colonies or build spacecraft.

The station is a 300'-diameter sphere with two 500'-long spin arms attached to it. Each arm terminates in a cylindrical capsule 100' long and 50' in diameter, which experiences 0.5 G spin gravity. The main sphere houses a cavernous spacedock and factory complex, capable of building small and medium sized spacecraft, or fabricating major components for larger space habitats. The ability to work inside an immense pressurized (but zero-gravity) space makes the construction shack extremely efficient. The two spin cylinders have roomy cabins that can house 250 workers apiece, plus mess and recreation facilities.

Two dozen factory stations of this sort were built during the early heyday of L4 and L5 construction, often at the site of major colonies like Islandia or Cornerstone, where they housed workers and would-be colonists until the station was finished. Afterward, the station was towed elsewhere, or used as an adjunct to the colony's own factory capacity. Many of the originals, especially those that were built in L4 and L5, have been sold off (sometimes at a tiny fraction of cost) to groups using them as cut-rate space colonies, often with their factory complexes stripped out and replaced with farms or housing.

Crew: Varies, but usually operates 24 hours/day with 345-500 crew.

Design: [Hull] Sphere hull (27,000 spaces, steel alloy, ultralight frame); cDR/cPF 0.2/1 (steel alloy). Solar panels (200 ksf). [Pod #1 and #2]: Cylinder hull (400 spaces, steel alloy, ultralight frame); cDR/cPF 1/1 (steel alloy).

Modules: [Hull]: Old control center; small PESA; small radar; 450 tanks (one-third water, one-third MOX, one-third empty); 20 bunk room; cabin; 4 small entry module; 3 large entry module; 6 large robot arm; 2 light storm shelter (empty interiors); factory; spacedock (200' □ 200' □ 200', 16,000 spaces); 500 cargo (2,500 tons); [#1 Pod]: 125 luxury cabin; 12 hall; 4 minifac workshop; surgery; small entry module; 25 cargo (125 tons). [#2 Pod]: Same as #1.

Statistics: EMass 62,142; CMass 70,352; LMass 70,352. Cost M\$484.68. cHP [Hull] 422; Pods [150]. Size Modifier [Hull] +10, [Pods]+6/+8. HT 12. Maintenance Interval: 0.91 hours (105.6 man-hours/day). RRA 0.

Performance: No space performance. No air speed.

Variant: Replace the Factory with 50 vatfac and 50 garden modules.

Von BRAUN-CLASS STATION

A big rotating space station, shaped like a giant bicycle wheel. The largest type of station found in Earth orbit, it has no vast open-air spaces. Much of it is factory space, corridors, and individual halls and chambers. It does boast three acres of shopping and recreational plazas, an acre of landscaped parkland, and a small garden.

It has three sections. The *habitat wheel* is a torus with a 1,000' radius and 50' cross-sectional radius. Six cylindrical *spokes*, each 20' wide, connect the torus to the *hub*, a 750' tall, 150' diameter cylinder. The torus wheel rotates slowly around the hub to produce 0.3 G spin gravity, while the hub is a microgravity environment.

The spokes contain elevators as well as recreational halls; they're used as passenger terminals. The hub is factory, laboratory, and docking space, but does have some quarters and bunk space, mostly used by Tenny-type parahumans and bioroids. The wheel is devoted residential, plaza, park, and office space, with some laboratory facilities.

Design: [Habitat Wheel]: Torus (100,000 spaces). [Hub]: Cylinder (27,000 spaces). [Spokes]: 6 Cylinders (640 spaces each). [All]: Combination (127,640 spaces, steel alloy, light frame); cDR/cPF 1/1 (steel armor). Hull radiators (300 ksf). Solar cells (2,300 ksf). Solar panels (2,500 ksf). LCD coating.

Modules: [Wheel]: 500 halls; 200 labs; 5,000 luxury cabins; 100 minifacs; 5 small entry modules; 75 surgery; biofactory; factory; 2 garden; intrastation transport (5,000 people); park; 5 plaza, 50 cargo (250 tons). [Hub]: 2 new command bridge; large PESA; large radar; 500 ion drive; 3,375 tanks (375 argon, 3,000 other); 5 XR lasercom; 60 new fusion reactor; fusion reactor core; 100 bunk rooms; 500 luxury cabins; 101 halls; 500 labs; 6 large entry modules; interstation transport (1,200 people); robofac; vatfac; 2 spacedocks (each 100' long, wide, and high, 2,000 spaces); 10 external cradles (each 125 tons); 4,000 cargo (20,000 tons). [Each Spoke]: 14 hall; 11 minifacs; intrastation transport (2,500 people).

Statistics: EMass 303,053; CMass 325,897; LMass 327,340. Cost M\$3,240.57. cHP: [hub] 2,970; [wheel] 15,000; [each spoke] 485. Size Modifier: [wheel] +15; [hub] +13/+9; [spokes] +14/+3. HT 12. Maintenance Interval: 0.36 hours (267 man-hours/day). RRA 30.

NEW DESIGN OPTIONS

These rules expand the *Transhuman Space* spacecraft design system (p. TS173) to cover components that are primarily used in short-range vessels, satellites, and space stations.

Extra-Light and Ultra-Light Frames

Vessels with manufactured hulls that do not face heavy acceleration or themselves spin (but which may have spin capsules) may further sacrifice hull strength in the interest of reduced weight and cost and be given extra-light or ultra-light frames. Vessels with *Extra-Light* structures may not themselves spin, nor may they accelerate faster than 0.01 G. Vessels with *Ultra-Light* frames may not accelerate faster than 0.001 G, nor have spin gravity. These frames are common on satellites, construction shacks, etc.

Frame Type

Frame	Mass	cHP
Extra-Light	80	3.75
Ultra-Light	200	1.5

Mass: The divisor when calculating manufactured hull mass; see *Structural Mass*, p. TS175.

cHP: The multiplier when calculating cHP; see *Health and Hit Points*, p. TS175.

CONTROL SYSTEMS AND SENSORS

Vessels designed for very short journeys can use less sophisticated control systems. The reverse is true of very large space stations and colonies.

Simple Cockpit

Rudimentary controls only found on small civilian craft such as hoppers. A simple cockpit features a standard crew station with crashweb, an ejection seat for one person, two man-days of life support, and a single high capacity microframe (old, Complexity 7) or genius high capacity microframe (new, Complexity 8). It includes one 0.001 AU range radio, precision stellar and inertial navigation systems, a "black box" flight recorder, and a compact fire suppression system.

Control Center

This is an operations center normally found on space stations. It has 16 roomy bridge stations, flight recorder, radar/laser detector, and a fire suppression system, and a four-man airlock. The control center has five computers, three Complexity 8 high-capacity mainframes, and two Complexity 7 microframes. If "new," all computers are Genius (+1 Complexity). The control center has total life support for all 16 people.

Controls Table

System	Space	Mass	Cost	Power
Old Simple Cockpit	0.1	0.24	0.09	neg.
New Simple Cockpit	0.1	0.24	0.38	neg.
Old Control Center	4.63	3.74	0.29	neg.
New Control Center	4.63	3.74	5.13	neg.

If calculating occupant mass, use 0.1 tons for basic cockpits and 1.2 tons for control centers.

SENSORS

Very Small Sensors: These sensors are found on vessels such as small lunar hoppers and interstation shuttles.

Sensors Table

Component	Space	Mass	Cost	Power	Scan
Very Small					
Ladar or Radar	neg.	neg.	0.0045	neg.	20/26
Very Small PESA	neg.	neg.	0.027	neg.	20/32

COMMUNICATIONS MODULES

Although controls systems include communications gear, dedicated communication systems are often installed in communication satellites, relay stations and large habitats.

Lasercom: This module consists of five laser communicators with range of 200,000 miles (0.02 AU in space), or, in the XR version, one laser com with 10 times that range.

Radiocom: This module consists of 10 tight-beam (20-degree arc) radio communicators with a range of 100,000 miles (0.01 AU in space), or, in the XR version, one radio with 10 times that range.

Communications Modules

System	Space	Mass	Cost	Power
Lasercom	0.1	1.25	0.0625	neg.
XR Lasercom	0.1	1.25	0.0375	neg.
Radiocom	0.1	1.25	0.05	neg.
XR Radiocom	0.1	1.25	0.015	neg.

Radio communicators may be designed with extended range. Select a range multiplier, then take the square root and apply this as a multiplier to the communicators spaces, mass, and cost.

Mag-Lev Lifters

Spacecraft may be designed to be launched via magnetic levitation tracks. (The same rules can also be used to create mag-lev trains). This system generates lift through magnetic interactions with a mag-lev rail. It can also provide motive power by “surfing” the magnetic flux between the vehicle and rail. Mag-lev systems in

space can also be used to help accelerate vessels to escape velocity.

Mag-Lev Lifters Table

System	Space	Mass	Cost	Power
Lifters	neg.	0.01	0.004	0.02

Mass, Cost, and Power are multiplied by the maximum rated load of the lifters. If the vessel’s mass ever exceeds this value, it cannot move.

Performance: Maximum speed is calculated as for streamlined delta lifting bodies (*Air Speed*, p. TS190), except that mag-levs outside the atmosphere do not have to calculate Drag. Thrust is equal to $0.2 \square$ (rated load of the lifters – LMass); plus the thrust of any reaction engines used for propulsion. Deceleration is 10 mph per second. Acceleration is (Total Thrust/LMass) $\square$ 20 mph per second.

Mag-Lev Rail Line: This is a superconducting rail line for mag-lev lifters to operate on. The rails are \$1 million per mile and must be kept relatively flat with gentle curves; cost assumes the track is elevated to clear ground contours. Power requirement is equal to the total mag-lev power requirements of all vehicles currently using the track.

Contact Power: Mag-lev lifters that are powered by the rail line itself are double the mass but reduce the Power requirement to 0.

WARNING!

Do not use metal tools to work on an active magnetic levitation system!

See your foreman for ceramic replacements.

WARNING!

HABITAT MODULES

These options are available for habitat modules (p. TS183).

Housing: A housing module (p. TS183) can be designated as Luxury or Cramped. Luxury housing provides long-term accommodation for half the usual number of people, while cramped housing can hold twice the number of people. Office buildings and barracks are often cramped, while condos and hotels typically count as luxury. Reconfigurable housing modules can change the size of individual living areas on demand; a single Housing unit can have any combination of Luxury, standard, or Cramped apartments.

STATION-KEEPING THRUSTERS

Orbital stations and satellites will usually need a limited propulsion system for minor orbital corrections. This is usually a chemical rocket or an ion drive. Delta-V is usually quite low – a “round trip” delta-V of 0.5 mps per year of planned operation for very low orbits (below about 250 miles up), about 0.025 mps/year otherwise. Stations in L4 and L5 do not need station-keeping drives. As station-keeping thrusters will be making gradual corrections over a period of months or years, acceleration is usually quite slight, and rarely exceeds 0.001 G.

Intrastation Transport: Basic elevators, ladders, and stairs on large vessels are subsumed into the design process. More extensive facilities, such as monorails or travel pods may be included as an “module” that varies in size and cost depending the number of people it can service.

Factories and Robofac: Maintenance and upkeep cost is \$25,000 a month for a Factory or \$2.5 million for a Robofac.

Parks: Facilities such as theatres and stages are assumed to be included with a Park module. Dedicated entertainment facilities are treated as one or more Halls (p. TS184).

Biofactory: This is a facility capable of creating biomods, bioroids, and other biofactured organisms. 10 large (1 hex) items or 100 small (biomod sized) items can be constructed or grown simultaneously. It requires a dozen crew or robots to operate efficiently, but does not provide food or life support.

Hospital: This includes 10 operating rooms, each with two diagnosis tables (p. TS162) and associated equipment such as Emergency Support Units. It also includes two HyMRI units and drug and nano stores to treat up to 1,000 people a month. Up to 200 patients can be housed at a hospital at one time, twice as many in emergencies. A hospital requires 100 personnel or medical cybershells to operate effectively. A half-sized hospital is usually called a clinic.

Habitat Modules Table

System	Spaces	Mass	Cost	Power
Biofactory	10,000	2,000	100	10
Hospital	10,000	5,000	20	100
Intrastation Transport	0.5	0.01	0.001	0.01

Intrastation Transport modules spaces, mass, cost, and power are multiplied by the typical population of the vessel it is installed in.

Fractional-Size Modules: Biofactory, factory, housing, open, and park habitat modules are available in 0.1-module increments if desired, with exactly 10% capacity.

Radiothermal Generators (RTG)

Satellites and other small spacecraft are often powered by radiothermal generators rather than the more efficient but bulkier nuclear power plants. These systems produce power through the natural radioactive decay of plutonium dioxide (Pu-238, which is not a weapons grade isotope).

Heat: RTGs have an RRA of 1 ksf per space of generator.

Radiothermal Generators

System	Output	Mass	Cost	End
Old RTG	5	25	1.25	14
New RTG	10	25	2.5	14

Output, Mass, and Cost are per space of generator. Radiothermal generators are available in fractional sizes.

End.: The operating endurance of the generator at maximum power, in years. Every 14 years, reduce the remaining output by 10%.

SATELLITE MAINTENANCE

In the case of most unmanned satellites, “maintenance” can be assumed to include off-site diagnostics run from remote stations, minor orbit corrections, and so on. This does not actually require any real physical access – simply a functioning datalink.

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