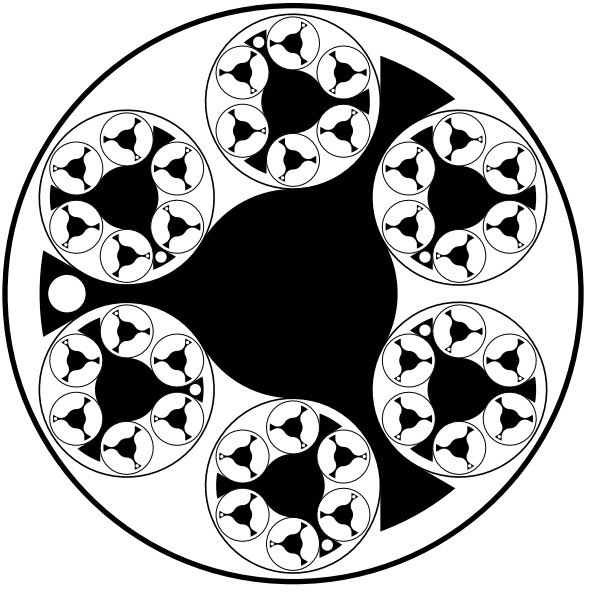
THE MOON HAS ITS DARK SIDE



Also by Neal R. Wagner

WWW: The End of Time (fiction),
which is Volume One of the series:
Humanity's Breakout.

The Laws of Cryptography
(non-fiction)

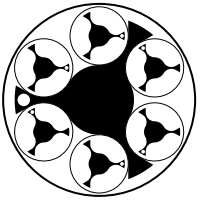
Making Crime Impossible + Walden 3.0
(mixed fiction and non-fiction)

THE MOON HAS ITS DARK SIDE

Science Fiction by

NEAL R. WAGNER

Anomie Hollow Press



The Moon Has Its Dark Side, which is
Volume Two of the series: *Humanity's Breakout.*

Volume One of the series is *WWW:The End of Time.*
Volume Three of the series will be *Beneath the Stars*
(in preparation).

Cover photo of the Moon's dark side: Public Domain, NASA/GSFC/ASU
(a mosaic of thousands of images taken by the lunar orbiter's Wide
Angle Camera—the only way to get so many shadows of craters).

All characters and events portrayed are inventions of the author, and any resemblances are coincidental. No AI tools were used.

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To my parents:

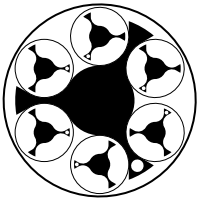
ALBERTA RUTH HETZER
18 December 1908 – 20 August 1997

RALPH RICHARD WAGNER
12 July 1907 – 23 June 1967

The Moon's dark side never sees the Earth's face.
When the sun sets, no Earth shines down from space.
The bright side always has its Earthlight.

The Moon's bright side always has the Earth
at the same place in its sky:
Sixteen times as big and fifty times as bright
as the Moon from the Earth.
Very welcome is the Earth's light
when the fierce Sun sets.

The dark side of the Moon embodies
the mysterious, the unknown.
We never see that side,
which faces away from the Earth,
faces the cruel, black expanse of space.
—howstuffworks.com (rewritten)



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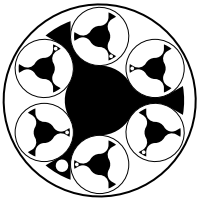

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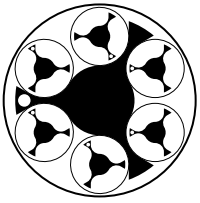


Prolog

Earth, 2068.

The explosion was due in three minutes. He couldn't stop shaking, trembling from fear and from anger. Call it wrath. They were scum, filth. How could they have forced him into this? He'd put on double clothes, a thick coat, gloves, his heaviest shoes, plugs in his ears—in fact he looked ridiculous, ready for a blizzard. Shit, the two-minute mark. Time to send a signal to open the electronic lock of the outer door. Such a relief that after a click it opened easily. He'd never seen it open; *they* only used the other door, leading to their quarters. He propped it open with a chair—it must not end up jammed shut. He took a second to glance down the hallway outside. He'd found a building floor plan in their files that showed two turns in the hallway leading to an emergency exit. He assumed it would open. If not then cast around in the building—find blown-open doors. He had to get away … somehow.

He wasn't supposed to have control of the door lock; releasing that lock and opening the door triggered two alarm lights in his minders' control room, but not an actual ringing alarm. They might not even notice and certainly wouldn't respond in time. And then the two who were there would die; they were much closer to the front than he was. That was terrible, but at least most people had gone home—it was the weekend and off-hours—Susan wouldn't be there. However, the Director of the whole facility and the Head of Neurobiology were in the building, staying late. They were near the minders and would die too. They deserved it, damn them. He wished

he could force them to suffer and not die instantly. He should make it, though, with luck. And afterwards? No way to predict, but he'd done all he could.

One minute, crap, he'd practiced these moves, but he was still shaking. Time to climb into his antique bathtub and drag a pile of blankets in with him. These he wrapped around himself as best he could, with special attention to his head, which he quadruple-wrapped almost to the point of suffocation. Thirty seconds. He could feel his heart beating in his neck and chest. Raise his arms around his head, and bury himself face down into the blankets in front. His connection to their network and further connection to the radar guiding system still showed at most a few seconds error in the timing. Ten seconds.... Then Five. Four. Three. Two. One. Zero.... A scary pause, and he was engulfed in an incredible blast, and then a wave of heat.

L5 Habitat, 2857.

On the fifth day of her Hero's Journey the Green Woman runs across a bleak landscape of black volcanic boulders with the ocean lapping through them. Viri the Fire Demon, along with Snopes the Swamp Hag, chase her up a rocky cliff. Outdistancing them, she is able to leap into the island-encompassing Gita Banyan Tree. The demon burned off half her left arm, but he is too late, as she escapes to the Arachnid's Shelter, where she can regrow her arm. Somewhere under this unnamed island is the Golden Elixir of Life she seeks.

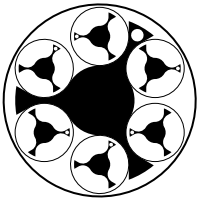
Jun Arakras was in a position of power and influence in her Hab. Among over fifty Habs in the solar system, five were situated at the L4 and L5 stable points relative to the Earth and Moon. Hers was one of those, the Azel Hab, of the Onal[1] Cylindrical type. Jun had lived her whole life there, among forests and meadows, lakes and rivers, beautiful buildings, and the two ends of the cylinder arching up toward the zero-G centerline, looking like mountains.

How did Jun get to where she was? What early steps had led her there? Already when three years old she had imagined herself as a superhero, an ultraperson, a mighty fighter, completely hairless and colored bright green. And why green? There was no why, her hero *was* green. But green is the color of plants, the color of photosynthesis, a beautiful color for her hero, who was part plant and could bud and grow new extremities, or even reattach a severed head. Her Green Woman was powerful and courageous and wise, so she, Jun, small as she was, not green or bald, but with light brown hair, why she could be that way, too.

Far below ground, the Green Woman searches through a labyrinth of tunnels toward a growing scintillating light in the rocks themselves. The Golden Elixir is so near, when a tribe of Saddle Gnomes comes out from two side tunnels and attacks her. Each is armed with a Chigiriki, a type of ball and chain truncheon. She can easily best any single gnome,

[1] This term probably derives from the name O'Neill. There were also larger Toroidal types in space, Lava Tube types on Mars, and both Lava Tube and huge Honeycomb ones on the Moon.

but not all of them together. Desperate now, she has noticed a narrow tunnel, barely wide enough to pass along. Scattering gnomes aside, she heads down that tunnel. The gnomes, forced into a single column, follow with their Chigiriki useless in the confined space. Thus she is able to stop every few steps and kill or maim the gnome right behind her. They are too stupid to understand, as each gnome clambers past the dead and wounded in the tunnel to be the next to face her at the head of their column. In the end the tunnel is stuffed with gnomes and impassable. A few are still alive but unable to move. Near exhaustion, she is again far from her prize.



Part I

Earth, 2068.

1. Imprisonment

They called him John, not knowing he didn't like the name, though it was the only one he had. From the earliest times he could remember, he'd lived in the same small apartment and had been outside it only once. In one room a magic cabinet had food inside when he opened its door. He later understood that the food didn't just appear, but was inserted from the other side. There were no windows—he'd never seen a window, but he knew about them from pictures and videos. The apartment was cozy, comfortable, familiar. He slept on a nice thick pad on the floor in one room, in another he played with toys and exercised. They required at least fifty minutes each day on two machines: twenty-five on the treadmill, which was not smart, and twenty-five with the strengthener, definitely smart, always working on weird muscles he didn't know he had. A third room was full of electronic machines and display screens, with stories to read and videos to watch. Oh, and there was a small bathroom.

A rotating staff of people took care of him, feeding, teaching, playing, everything. They said he was special and important, unique even. He was going to be better at certain scientific work than anyone had been before. For the past year or so, several people, Carl most often, had been droning on to him about how enemies were everywhere outside who would hurt him if they could. So he must

not ever leave his apartment. How did they imagine he believed this? Well, he pretended to.

As for the one time he went outside, it hardly counted, since during the transfer he wore the standard mask over his mouth and nose and an additional blindfold, and then was kept in a special windowless vehicle where he slept overnight. Oh, and ate cold food, used the toilet, watched the news. Later he heard there had been a simple neovirus loose in the area and they had to decontaminate. Much later he learned the real story: one of the building's terrible weaponized viruses had gotten loose. There were five deaths and no illnesses, since to get that virus was to die, no other possible outcome.

When he was three years old they started serious studies—mathematics, physics, algorithms, engineering, computer science, machine learning—the list went on. With time the work got quite hard, but he loved it, the harder the better.

At the same time he developed the idea that they approved of him more as a willful, immature child, with simple desires and tastes. He drifted into presenting himself to them as a kind of autistic savant, mostly normal but yet able to do the crazy hard things they wanted. He didn't overdo the immature front, but showed a preference for simple games, cartoons and juvenile videos, and for young-adult novels, all with happy endings. By design he was particularly careless with routine dialog, often seeming to pay no attention to what they said when he was engrossed, giving no hint that he maintained a complete video record of his interactions. His own sophisticated software dug through everything they said, including their expressions and gestures, looking for contradictions, discrepancies, inconsistencies, mistakes.

He was careful with Karen, an older woman who came in to ask him a variety of questions. Like everyone else she used only a simple first name, clearly not her real one. She was assessing his progress but worked hard to seem only casually interested in him. Not fooled, he knew she was a psychologist, smarter than the others. With her he deliberately acted a bit more mature, carefully showed skills with memory and problem solving, but stuck to his overall immature presentation. It was so easy to fool these people.

Even years later he never understood why they let him listen to the ordinary news, along with other programs. His minders were often remarkably lazy so perhaps they didn't want to bother monitoring him. And the news kept him entertained. Much of it was raw propaganda anyway. Here again he was always careful, often leaving the news on as if an afterthought when he was doing something else, seeming to ignore it, brushing his teeth or working at one of his computers. In this way he learned much of what the world outside was like: the murders and suicides and crime everywhere, a corrupt political system intertwined with an insane set of religions that tried to present a benevolent god, with truly psychotic Satan worshipers presenting an alternative. It was a world of floods and droughts and fires, the air filled with different microbes, so that most people wore a mask outdoors, new poisonous plants and insects, with wars and refugees and so many hungry people, shortages of everything. All the dead and dying: people, animals, plants, and one green planet—formerly green, now getting brown and gray and black.

His minders seemed to have simple goals, but he couldn't tell for sure, maybe nothing beyond their desire to get some of the old legacy hardware and software to work and be modified. This was when they told him about his brain implant. They thought they were helping him access it and use it, not realizing that he'd long ago discovered this hardware without any help. They had stuck an implant into him, into his brain before he was born, and they knew almost nothing about it. It consisted of the old fantastic technology.

A generation ago, before the big crash in the late 40s, technical people had used artificial intelligence techniques to create masterpieces of machines, hardware and software, but the skills and tools used even to understand these machines were lost in the chaos, as so much fell apart. Many foundries that made parts for the machines had been destroyed, and most exotic materials couldn't be created anymore. The AI approach was mostly given up and often banned outright. No one alive could make use of the top-level machines. Often a device didn't function at all, and even if it did, it couldn't be modified to work in a new environment.

As he came to understand the innards of such systems, he tried

guiding one of his teachers, the near-sighted Joel as the brightest one, to a partial understanding. Short discussions of obvious details made it clear: Joel would never understand these machines. They were the products of teams of brilliant individuals, using amazing but flawed AI methods and tools. The developers had no true understanding of anything, no overview of the entire system. There were so many details and so many levels, all hidden behind an inscrutable maze of AI generated code. Unlike them, he could load everything into his brain and implant, and embrace the details, using the same AI methods. He could understand these devices.

What kind of people would insert into an embryo an implant they themselves didn't understand? This told him a lot about them. Lazy for sure, but this let them find out about the implant when they couldn't investigate it directly. Also it was a way to investigate other advanced devices. There must have been several such implants manufactured right before the crash. Maybe tested on animals or even humans, and now being tested on him. But they likely had no documentation left over, or only enough to know how to insert it. Insertion was complex, with a tiny and thin interface inserted into the developing embryo, while the rest was inserted in two stages, at one month and at two years. The last partly because the bulk of the implant needed a larger head to fit into. It was more powerful than they had any conception of, and was already filled with endless lessons on its use, its functions. He could hardly believe it. Hundreds of millions of his neurons had formed connections with the hardware. The connections couldn't change, but his brain was remarkably adaptable, and the hardware had tentative training built into it that could be redone—the whole hardware could be retrained, and using the stored help he proceeded with that. They knew nothing about this retraining, not even that it was an option. At this time he became ever more careful about hiding his true abilities. If they knew everything he could do they would be afraid of him.

His implant had wireless access built into it, powered by a sort of organic battery that would last indefinitely. That was another thing they "taught" him, something else he already understood. They had no idea what his wireless capabilities might be, so he vastly

understated them, seeming to require a far more powerful signal than he needed. He also claimed to require a specific slow format when he could adjust to any format, and could accept extreme data rates compared to what he admitted being able to handle. In this he had an automatic desire to minimize what he could do, figuring this might give him an advantage sometime—perhaps he could intercept transmissions without them knowing.

His apartment had a large stand-alone computer. Well, "large" was a relative term, but it was powerful for its size, though not remotely the technology from the 40s. He could access it, but that led nowhere else. What he wanted was access to their networks, but he didn't want to ask. Much better if they thought he didn't care. He assumed they monitored his work on the computer, but they evidently didn't know he could carry out vast computations in his implant that they knew nothing about. As in other matters he gave them more credit than was due: years later he learned that they hadn't tracked any of his computer use.

It was great fun to tackle their problems, often working on a specific device which was a combination of hardware and software, where there was no reasonable documentation. The goal was to see if he could get it to work in varying environments. The software was beyond them, but the hardware was completely impossible for them to understand. One day his favorite teacher, Rob, seemed surprised when he explained how his solution to a problem could be modified to work on a whole range of problems, most of them not obviously similar to the first. It took time to convince Rob, and that was when he came to realize that he could learn about his abilities from things Rob had trouble understanding.

As he got used to his implant, he began to notice its strangeness. Weird was the word. In some ways it seemed separate from him and yet not separate. He spent hours of introspection, and decided that it had to do with consciousness. This is a capability of humans that has never been understood or even defined. Each person has a stream of awareness, a line of thought, called consciousness, but it has defied

analysis. One property is universally agreed upon: you only have one stream. People could carry out two intellectual activities "at the same time," but this required switching back and forth between the activities. This is how for over a hundred years a computer with only one central processor could do two actions "at once": by switching back and forth. With such a computer, the switching is so rapid that there is the illusion of both actions being addressed continuously, at the same time. To get no illusion, one needs two central processors.

He came to realize that he could do it: carry out two simultaneous lines of thought, continuously, without interruption, and at the same time. The memory for each line was joint, each line was himself, but they could proceed at the same time. If he had needed to describe to someone how this worked, or even what it felt like, he knew he would fail: it was beyond description, except for its external features. As a set of experiments, he would start up two topics to work on, say, problems to solve or mental tasks to carry out, and it was clear that both were going forward, without any back and forth switching. Three things at once didn't work for him.

He knew that professional piano or organ players and others could have their two hands (and feet for that matter) doing different actions at the same time, but he could easily and profoundly transcend such minor abilities of what was called muscle memory.

Even weirder was another property: one of the lines never went to sleep, while the other, which he thought of as the main one, would sleep and even dream. The non-sleeping line was always alert to its environment and could wake up the other if it was asleep—an extremely valuable feature which could work as an alarm clock or general alarm given any hazard. The non-sleeping line could control any part of his body, as the main one could when it was not asleep. If the main line was asleep, exercising such control could wake the sleeper—anything involving major movements, speech, or opening eyes. If both lines tried to produce some control at the same time, there was never any conflict, perhaps because he was only one entity.

He didn't know if an implant like his had been tested before, that is, inserted into a person, and successfully integrated with the person, but he felt this likely had not happened. So no one had any idea of

this amazing capability. Probably no one had even thought of this as a possibility. It had come about as an unintended consequence of installing the implant, without the slightest expectation by the designers. He resolved someday to use his two-track mind to get a better understanding of consciousness. For now, it was still a mystery.

For the first time he thought about the lifetime of his implant—its eventual degradation or even outright failure. The documentation inside the implant itself didn't discuss this. He must see if any others were available. Of course he couldn't start over from scratch, but the design was modular, with the large two-year unit more-or-less plugged into the one-month one, and it had been plugged into the in utero unit. At least the organic battery was designed to last indefinitely, and so far there had been no problems. He had done the retraining and the unit had passed the diagnostic tests.

The two lines couldn't talk at the same time, so years later he would utilize existing software to generate what he wanted to say, so that he could carry out two interactive conversations at the same time. He already had AIs that would do an excellent job with interactive conversations—as many of these as he wanted.

Also much later he would develop another skill using his second consciousness: reflexes as fast as computer controlled ones. He had sub-microsecond paths from special senses in his implant to control sections of the implant, which could then use his wireless access to produce another sub-microsecond result, such as firing a gun.

A huge breakthrough came half a year later; he'd not expected it. Though he could do amazing processing within his implant, he was still cut off from any other devices except for the computer in his apartment. They suggested that he work on several projects involving seismic data, using newly developed ultra-sensitive seismometers they had. For real seismic data you needed a source deep in the ground, well away from humans and other surface-generated vibrations, but here the data he wanted was noise, noise from his building, words, conversations. He didn't tell them that, and besides, the scientific wisdom was that such an instrument couldn't tease out the

words of a conversation. They made sure he had no connections to their networks. Still, he worked on real projects for them, earthquake predictions and the like. But while he was "debugging" his software, the local seismometers could pick up faint vibrations in the building, mostly of people talking. Altogether, several hundred people worked in his building. Some conversations were clear, but even with his fancy processing, many of them missed parts of sentences. Most were simultaneous with others, and there was always a lot of other noise—people walking, vehicles outside driving, microquakes. Separating out the individual conversations and interpreting them was a very interesting problem. Over time he gathered up a huge number of statements, filled in blanks, and ended with many of his questions answered. The answers were disturbing, appalling.

Some pieces of what they said were ridiculous: "I tell you, it's a live act," "Go fuck your mother," and endless garbage like that. Other conversations were revealing. The building carried out only highly classified work, biological more than anything else. Developing poisons and diseases seemed to be a big part of their work, along of course with countermeasures. They had diseases with a predictable death rate, whatever you wanted: ten percent, fifty percent, or ninety-nine percent. Some conversations involved him. He himself. They regarded him as an expensive piece of equipment, mostly functioning pretty well, but often a "real pain in the ass." One partial sentence stood out: "John is getting along really well with his work, better than [unintelligible], so much for the crap about cost overruns with that project." How insulting and disgusting to be valuable, but up for periodic evaluations amid concerns with "return on investment." The dirty bastards, they actually used that phrase. He also sensed they were less interested in him than at previous times, but he was still the pet project of the head of the neurobiology section. A dangerous individual, very smart, that one. Only once had he talked with the reptile, cautiously, trying to sound overwhelmed with fear and shyness. Well, the fear was real.

The weeks and months went by. One Saturday morning, Susan, who worked weekends only, came into his work room. She'd always been good to him, his favorite over the others. A year earlier she had

brought a special cake for his fifth birthday.

She hesitated and then said, "Hey, John-seven, how did last week go?" John watched as her pulse and breathing quickened, her face reddened, and other physical indicators pathetically declared she'd made a mistake. She started in with some distracting statement even as he quickly talked about the ancient Shirley Temple movie he'd watched that morning and how funny it was. Her relief was beyond obvious.

"Which movie was it?" she asked.

"It was called Little Miss Marker—about an orphan girl taken in by criminals, and how she manages to reform them." Poor Susan, always nice but not very bright.

He'd been waiting months for something like this, something unequivocal, beyond the disconnected data their conversations had yielded, and yet still the content was shocking. God help him, he was "John-seven" to her, with evidently six other Johns who'd come before. How many were still alive?

He decided that at least his interactions with Susan and with the others were going well: in many ways he acted like a six-year-old child, with his simple demands, his immature reactions, his focus on trivial matters, his easily distracted nature, on and on. And all-important: he looked like a child. Surely Susan accepted him as more-or-less typical for age six. She had nothing to do with his scientific work.

John didn't know how mistaken he was. In fact, Susan saw him as an unusual child regardless of age. She could see that his head was noticeably large, even though she knew nothing about the implant. To her, his actions were more subtle and goal-directed than one would expect, as if he were playing a role. Indeed, his model for how a child behaved came from the videos he watched, where children recited lines written by adults.

More months went by. Many more overheard conversations. He learned they'd used a special protocol to enhance neuron growth, in utero and afterwards. They'd had trouble getting it right, and that was why John-five "failed." Failed?! What was John-five, an electric motor? A yogurt culture? This enraged him, that they thought of his

predecessors as devices, and surely thought the same of him. And what was the failure mode? Death? No, they wouldn't use that word. Not turning out as smart as they were looking for? He came back to his old question: They'd had six failures, so what had they done with them?

And everything changed, as he got access to several outernets and to quite a bit in the main building. It started with his seismic work, where he worked with the stand-alone datasets they provided. Because he pretended to have slow wireless access, his work became increasingly slow and cumbersome. They got tired of this and decided to give him direct access to that collection of data through one of their networks. He couldn't believe they were making this mistake: they gave him an account on their network! Even though he had good wireless capabilities, before this he couldn't get access to any machine. Now he could. He proceeded cautiously and with a low profile, but it was relatively easy for him to gain access to their system. Since that network was isolated from others and from outernets, they didn't take their security seriously enough. Their system software was full of bugs and vulnerabilities; separate parts weren't properly sandboxed. After accessing most of what was in his building, he then bootstrapped himself into the world at large. They weren't even doing basic traffic analysis, though he was being careful with that also.

He had an orgy of data acquisition and analysis. The main limitations were walled-off projects within the building, including himself as a project. These required special passwords. Still there was lots of talk and memos, lots of information about him. It was very disquieting for him. Because of the cost and the general feeling that they weren't ever going to have crucial problems for him to solve, there was verbiage about "shutting down" this neurobiology project and "disposing" of the materials. They were also worried about possible leaks, about their own responsibility for the project, and about the disposal of the earlier Johns as failures. Everything was moving slowly but inexorably toward termination. His. He needed a plan for escaping.

With frantic efforts over the next few hours he formulated three different plans for escape and decided to start all three at once. The simplest and least dangerous of the three was for him to leak data about activities inside his building. This plan had its problems, but was easier to carry out and was far less dangerous than the other two. He picked a reporter who specialized in scandals: one Alex Trecker, quite well-known. Then with great care he constructed and assembled the data that he would leak. Mostly he wanted the data itself not to point to him, but rather to one of a number of mid-level supervisors in the organization (well, it was an "Institute" formally). The leak was to contain not only bare documents, but a commentary about the documents by the leaker. He had a specific supervisor in mind as the false leaker, someone who'd been impatient with him, even nasty. She had come from Brazil and repeatedly berated and cursed him in her native Portuguese, talking about his large head, his skinny body, his disgusting habits, and evert kind of invented flaw.

One of his clever AIs generated the text that went with the leak, constructing it to match her writing style from stuff she had written, and the AI declared it a good match. This was in case Trecker gave them the supporting documents as well and they made their way back to authorities in the building.

The leak contained relatively little about him, and nothing specific, while there were lots of details about other projects. Taken altogether it was a revelation of horrific activities, ghastly projects, a building full of terror. He had multiple staging areas across the world. From one of these he sent a big batch of material, along with a promise of much more, even juicier stuff, to come. Then wipe out that whole area, give Trecker another contact method, and wait, while he worked on the other two escape plans, each pretty complicated.

Trecker replied after only two days—a good sign indeed. It was a long text, posing a list of questions. Trecker was especially concerned about authenticity. And were there more materials? Well, the authenticity was partly self-defining, he replied. He also gave specific and detailed answers to Trecker's questions, with the style again devised by the AI to mimic the designated leaker. He maintained it would be impossible to assemble such a collection of documents if they weren't

authentic. And yes, more would come. Off went another big batch. He waited and waited some more. Four days after the second batch went out, there was the worst news he could imagine. One online news source had a headline: "Alex Trecker, Investigative Journalist, Dies in Freak Accident."

He actually collapsed into a chair. This was unbelievable. He'd done up an elaborate diagram with all the possibilities, in one of which Trecker is identified before the leaks are public. He'd assigned it a low probability. The whole idea was to get the leaks known publicly, and thereby make his existence known, giving him a measure of safety. But instead to his horror they found out about the whole scheme and killed Trecker. Good God, they killed him immediately and evidently professionally, since it looked like an accident. How did they know? Okay, they must have had Trecker under surveillance for some other reason, maybe not so surprising. There might be a physical bug where he lived, since communications were routinely protected with strong cryptography. Now they knew there was a leak, but they didn't know who had leaked. They also had at least the first batch of leaks. Dangerous for the fake leaker he had chosen, and dangerous for others they might accuse. They will suspect everyone, but him likely not so much.

He still gathered in whatever fragments of conversations his seismic device yielded up. Long before he heard anything personally, he learned they'd initiated a "security exercise." Nothing to worry about, guys, well, mostly guys in the building, or was guys gender neutral? Just a test run of our security apparatus. Everyone has to fill out a form, … oh, and everyone will take a polygraph test, only for practice, no big deal…

Yeah, sure, those tests were witchcraft and psychology. A red-hot sword on the tongue—see if it burns. Tie them up and throw them into water—see if they float. In fact they might actually look for someone suddenly out on sick leave. If he had to take the test, he thought he could work himself into a total fake panic at the start, and be quite uncooperative from then on.

They went through with their little exercise, even starting a polygraph with him before giving up. Nothing much was changing.

He started work in earnest on the other two escape methods. He was hoping to use his second method, since the third method would be so dangerous and uncertain—terrible side effects. There was stuff online inside their building, but he couldn't access it—too tightly controlled. The verbal chatter continued with major concerns from the few who knew there had been a leak. At some point they decided they knew who the leaker was. There was talk about the danger of a functioning, talking John-seven, who could rat out on them. Decisive action was needed or they'd be in big trouble. Then he caught fragments: "… keep it from that fucking do-gooder Gleason." Gleason was Susan's real last name. Keep what from her? "With the leak … too much risk." Then several sentences said outright to "have the Argyle people … John-seven tomorrow." Separately there was a joke about telling Gleason they had "sent an old dog off to a retirement farm."

They were going to kill him. Yeah, John-seven was a device, not human, an "it." They would turn it off and dispose of it. Tomorrow. The day was ending and he needed to do something *right then*. He had some other immediate threat options, mainly to send the leak material everywhere, but he thought that threat would speed them up instead. The second option he'd planned was complex and shouldn't be started up without a delay. With that second option he would take over the accessible computers, machines, and controls in the building. Then there were non-deadly pathogens he could release into the building, as well as creating a whole series of crises for them in the middle of the night. But he couldn't get everything going well this very night. He needed more like twenty-four hours. It was hard to admit, but his only reasonable option was the terribly dangerous third one. He really didn't want to, but what else? There was a fair amount of preparation to do in his apartment, which he started. By now he was shaking almost uncontrollably, so it was hard to gather up the items on his internal checklist: A bottle of water and a snack. No money, but a small first aid kit. A face mask for afterwards—you were always supposed to wear one outside—someone had left it in his room. Most of the work was online, accessing a military site he'd broken into, finished days ago. In the end, it was like pushing a single button, in this case with a deadline of 7 minutes 15 seconds. He had trouble

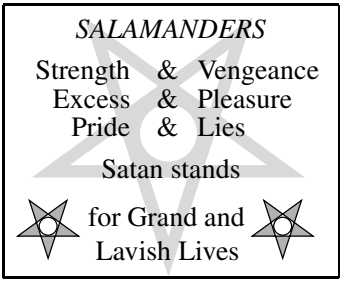
moving around and getting ready.

One more thought came: failure of the third option was possible. If he was still alive, he would change to crazy mode and do simultaneous super versions of options one and two: take over everything he could in the building; cause every kind of crisis; open every container, in particular to release dangerous pathogens; override thermostats to produce maximum heat; overwork machines to failure by continually starting and stopping them; broadcast complete files about the building and its functions; give a complete history of the projects, identifying every person involved and their specific contributions. Finally, he would try to escape from the building. He would not go quietly.

The time remaining marched steadily down toward zero.

2. Aftermath

Commissioner Robert Whearty (call him "Buck") of the Biology Section for the North American Science Directorate had been happy to survive the trip to a temporary office one more time. He hated these assignments where he had to go physically to a specific place and stay there for many days. It was so easy to conduct business virtually and such a bother to pack bags, do the travel, stay somewhere, wear a face mask, and put up with anxiety about encountering crime or violence (or worse). In this case while he had been taking a QuikKab from the airport, one of the Satanist groups was blocking the road. There were hundreds of such groups, from the First Church of Satan to the group in front of him, evidently the "Salamanders" from a sign they were carrying:



Christ, the QuikKab wouldn't be able to get past them. He shouted for the Kab to do a U-turn, which it declined until he repeated the command. It barely managed to turn around and somehow got past another group of Satanists and escaped. Looking back it was Satan face masks and loose clothing, probably to avoid facial, shape, or gait identification. He had a small weapon with him, one that might help catch them after they had murdered him. It would produce a blast of weapons-grade tear gas and bright purple dye. Put your arm tight against your eyes and hold your breath as long as you can, they had told him. Even so, you'll go through seven Hells, but anyone near you, well, anyone not gas masked, will go through Hell squared, or even cubed.

This is as close as it had ever been. He was still trembling when he got to the research campus. At his temporary desk he

stared at the piles of documents. He'd spent three days working through reports about the annihilation of the Biology Special Projects Building, which had been the largest of several buildings in a special federal research complex located near the University of Illinois. Most of their work was classified, but dozens of faculty were able to get clearances to work on projects associated with the complex. Fourteen faculty had been part of projects in the destroyed building; none of them died in the explosion.

The North American Federal Crime Unit had investigated the disaster and tentatively deemed it an accident, caused by negligence. His Directorate wanted an independent investigation of such a huge loss. There were a number of connected issues to research, and they'd assigned each to a separate group. He'd insisted that the groups be mostly technical people, and that the head of a group be directly knowledgeable about the technical issues, in so far as that was possible. The last thing he wanted was to deal with some noodle-headed bureaucrat. Each of these heads had sent him a preliminary report. He was now ready to interview them.

First was Roger Simpson, an expert on disasters like plane crashes, and, uh, blown-up buildings. According to reports, he had no imagination nor much of a personality, but he was excellent at digging through leftovers looking for answers. Hard to listen to and boring, boring. Whearty started in with the little speech he intended to use for each interview: that he wasn't recording the interview, and it would remain completely confidential, so there shouldn't be any concerns about saying the wrong thing. He wanted to get real opinions, and he was interested in speculative ideas, anything, even something not obviously related. He had full clearances to discuss any of these issues.

Of course he *was* recording the sessions; he wasn't crazy.

"As you know," Simpson said with his soft voice, "a military missile partially destroyed the front of the building, and this was followed by a fierce fire that burned for hours, completely destroying most of the contents."

"Why was there such a 'fierce' fire?" Whearty asked. "What would burn in the building?"

"Well there was no wood, not even trim, but the missile is a hybrid, including an incendiary burst after the initial explosion. The idea is to blast apart and then get things burning. A large quantity of various organic solvents was present, and that did burn fiercely. The insulation went up, as well as paper and magnetic tape, furniture, oh, … in the end there was lots of stuff to burn, and the fire was extremely hot.

"As a result most things inside were consumed," Simpson continued, "even the various pathogenic life forms in the building. That was just as well. The building, if only blasted apart without burning, could have presented major problems for a considerable radius."

"And the death toll?"

"At least eleven people died and four escaped, two of those significantly wounded. A few people are still unaccounted for. Fortunately, it was after regular hours on a weekend, so relatively few people were present. The Director of this whole unit and the Head of the Neurobiology Section were among those killed. We have remains after a fashion for the eleven, though often even bones were consumed. Identities confirmed by DNA. In spite of the fire there's a lot of stray DNA inside but not enough to indicate another death. I also think we should contact nearby emergency medical centers, such as they are, for anyone wounded and for any strange illnesses. That's because what was blown into the air could be a witches' brew of contagious agents."

"And what does 'such as they are' mean?"

"None of the nearby medical facilities are any good."

Simpson paused until Whearty said, "what else is there?"

"I've dug through charred remnants and carried anything of possible interest over to the building across the street. The floor is covered with items. Mostly a waste of time. Pretty much nothing there. We'll keep that trash over there for quite awhile, just in case."

Whearty had heard enough. For quite awhile, just in case. What crap. And the stuff might remain in the building over there for years. He thanked Simpson and got him out of his office as soon as he could.

The next interview was with a military man. Whearty wanted to put him at ease, so he immediately said, "Colonel James, come in please."

"Dr. Whearty, sir, I'm honored to be helping with this investigation."

Whearty went through his initial spiel. Then he said, "I've gone over your report carefully, but still I want to cover many details. In the end the question is: How did a missile from your facility end up destroying this building? The answers in your report are not entirely satisfactory. Obviously this shouldn't have happened, and yet it did."

"Yes, sir. I also find this hard to believe. But as we explained in the report, an unfortunate targeting decision, unfortunate as it turned out, followed by a software bug introduced to fix a different bug—these led to the disaster."

"So let's go over those two items, but I want you to include more speculative possibilities, including not only things that are 'unfortunate' or 'erroneous,' but also deliberate actions. An act of terrorism, an act of warfare."

"Well, sir, our facility is preprogrammed to handle a large number of anticipated events and contingencies. We have many preprogrammed possible targets, and a number of different weapons in several locations. The building in question was one of those targets, with a hybrid-incendiary missile as the weapon."

"But this building? How could it have happened?"

"Sir, you must realize that we don't want last-minute programming, but instead we want every conceivable action ready to go. Each targeting entry requires a stored justification order, with multiple approvals. The building as a target was approved fourteen years ago. The justification is classified, but it maintains that, because of the pathogens in the building, in case of some outbreak, it might be necessary to make sure all of them are completely destroyed. Another reason listed is the remote possibility that we might need to deny the existence of some or all of the activities going on in the building. Destruction of the building would help with that effort."

"I know this is in the report, but repeat it for me. Who signed off on the order?"

"Sir, three different people signed the order, but none of the

three can be located now. As you know, the intervening years have been difficult, with many deaths. Nevertheless, the reasons given are sensible in an environment covering every contingency."

"So your system was primed, so to speak, to blow up the building. Go over again how is was ordered to do so."

"Sir, in this case it was a software bug. We've determined exactly how the destruct order occurred because of the bug. We've been able to duplicate that behavior. The bug was part of a software upgrade some two months ago. We know the responsible programmers, but no one remembers how that particular section of code was created and inserted. The faulty code doesn't look like instructions to cause the event. It was created to fix a specific bug, but it's the old software problem: fix a bug, introduce a new bug."

"Okay," said Whearty. "This is kind of an odd question, but I want you to think it over carefully. Would it be possible, say, starting several months ago, for someone to fake up this whole situation? Perhaps even having the building listed as a possible target? Certainly developing and inserting the 'bug.' Please don't say no immediately."

To his credit, the Colonel did pause for a bit. "Ok, sir, you mean like some hacker orchestrating everything?"

"Yes, of course."

"Well," with a pause, and leaving off the "Sir," clearly rattled, he said, "With having the building as a target, it doesn't seem possible. The data relating to that is many years old. The system protects the data, but it's conceivable that a hacker could do that. I guess. This hypothetical hacker would have to get every detail correct, even the coordinates of the building, and the launch instructions. There are other problems, too, I'd have to think it over. But as for the software patch that fixed a bug and introduced the code to cause the disaster, well, that doesn't seem possible for any hacker. It was an actual bug fix, and everyone thought it amazing that the specific fix enabled the launch of the missile. As I said, we simulated everything, and the new code really did send the missile off. Not possible that, … impossible that a hacker was the cause."

"Did John-seven have access to the building's networks or computers?"

"Sir, limited access." James was back to sirring him. "Strictly limited to one computer as an ordinary user."

"In some of the materials I read, didn't it say John-seven has wireless access built into his implant?"

"Yes sir, he does, but only for a fairly strong signal. The wireless signals he could in theory access are far too weak for his implant. And even if somehow he could, his access would be noticed and logged. The security of networks within the building was strong."

"And did he have access to anything else?"

"To a seismometer in the building."

"In the building? That wouldn't be useful. It must be buried."

"Sir, he did seismic studies for us. The device in the building was just for testing and debugging."

"And how often did he do this debugging."

"I don't know. I don't think we tracked his usage, sir."

At this point Whearty sighed with a sudden understanding. After that it was a repetition of the written report. Whearty went over many other issues with the Colonel, including coming back to the "hypothetical hacker," but couldn't make any further progress.

He was already exhausted, with the two most difficult interviews yet to come. He geared himself up to talk with someone from Military Intelligence, in this case a young-looking man named Brian Chisholm, almost a baby-face.

"Come in Mr. Chisholm. Sit down. I trust your flight from Toronto went well."

"Yes, thanks, quite well."

Whearty proceeded with his initial comments, ending with: "Please go over again how you came to discover we had a leak."

"The reporter, Alex Trecker, has long been under surveillance by North American Intelligence. He's actually legit, well, *was* legit, but still people contacted him about issues of concern to us. Normally we would let everything proceed without interference. The leaked materials were sent to him in encrypted form, but we'd subverted his computer, so we had them immediately. The federal officials who

were notified of the leak contacted the Director of the unit occupying the building, a Dr. Ramsey. He was quite concerned. He verified that the leaked documents were authentic, and that only an insider should have had access to them. At Ramsey's suggestion we had an AI compare the leaker's cover letter and answers to questions with samples of writing from every employees in the building."

Whearty interrupted. "Was this why there was such a delay before any action occurred?"

"Oh, no, that search went fast. Right away we had a clear match, high probability, with an employee, a Ms. Adriana Cardoso. The delay came about because we wanted to allow time for more to happen, find further people involved, stuff like that."

"I read your report, but say again what did happen."

"Trecker posed a long list of questions for the leaker, and he, uh, rather more likely *she*, subsequently wrote answers and sent them with another even larger batch of documents. At that point, Ramsey wanted a polygraph test on everyone, and we agreed to that."

"I'll make a comment here," Whearty said, "I've never liked these one-shot polygraph tests, where it is a first time for most people. Without a sequence of regular baseline tests, it's extremely unreliable."

"Yes, that is sometimes true, but in the case of Ms. Cardoso, her reaction was strong, about as clear as you could get with a one-shot test."

"And didn't the report say she'd been identified as carrying out an additional crime."

"Yes, she'd been stealing several kinds of small items, but valuable ones. Smuggling them out and selling to several buyers."

"So she might have been nervous about the polygraph because of that."

"Well, perhaps, but there's the identification of her as the person who wrote to Trecker. That was definitive, near one-hundred percent."

"And then Trecker dies in a 'freak accident,' right?" Whearty used his hands for the scare quotes.

"That's correct."

"At least … convenient, wasn't it?"

"Of course I know what you're thinking. If it was a targeted killing, we don't know anything about it. The police investigation ruled 'accidental death.' Also Trecker had made a number of enemies."

"And then Ms. Cardoso manages to flee the country."

"Unfortunately. Several agents caught hell over that, but she was able to travel south into Brazil. She had her elaborate escape plan ready. And it will be difficult to locate her, if for no other reason, due to our current disputes with Greater Brazil."

Whearty concluded with a raised voice, "And finally I have to say it: All that happens right before the Biology Building is destroyed in another 'accident.' " More scare quotes.

"We think that is a coincidence."

"One hell of a coincidence."

"Yes, admittedly it is thought-provoking, but coincidences are like that."

Whearty grilled Chisholm for another thirty minutes, and he kept up his smug answers.

Whearty had saved the most difficult and most important interview for the last. He was amazed that others weren't more concerned about the surviving child. As a government researcher in biological areas, he'd heard rumors of a human-computer interface project being carried out in the building that was destroyed. He couldn't get any details. In fact, the boy they called John-seven was the high point of the project. Whearty had recently learned what had happened to him after the explosion two weeks ago.

Because he lived in the back of the building, furthest from the initial hit, John-seven survived the explosion with only a few nasty burns and minor bruises and scrapes. In the confusion and destruction he managed to leave the premises, where he had in effect been held captive. There had been fences and gates, along with guards, but it was such an incredible mess that he was able simply to walk away. The University of Illinois, in Champaign-Urbana, was only a short

distance to the west. It had been closely connected with the now-destroyed top secret biological research building.

John-seven must have had a brief encounter with jumba weed, leaving itchy lesions on one hand; they subsided in a day with no scarring. Somehow he made his way to the school's Neurobiology Department, housed in an old engineering building. The school had been well-known for its engineering departments, and it was still a leader in most fields at a time when no school was as good as it once had been. At present, their Neurobiology faculty had the expertise, but not the equipment and facilities they would like—stuck in an older building without any top-quality laboratories. John-seven found several people inclined to help him, starting with first aid for the jumba weed and for facial burns. They used alcohol to encourage one of the new tractor ticks to back out from under the skin on his neck. There was another bite on his neck—an insect or worse; it was fine the next day. They gave him a quick blanket test of his immune system and it showed no problem areas; he must have been getting his essential immunizations, but no one had warned him about jumba, or ticks, or any one of many other outdoor hazards.

These same people were entranced by his story, and became increasingly angry at the whole situation. They contacted various media sources and high-level individuals in government. It became a terrible scandal that was still worming its way through the responsible departments and parties. It also became a world-wide story, carried everywhere. Whearty was annoyed that the bad publicity led senior government officials to choose him to investigate everything. They wanted more than federal officials dismissing it as an accident. Cover was needed, a way out, excuses that could be made. Or obfuscations, whatever.

The academic individuals refused to turn John-seven over to government officials, but insisted on taking care of the boy themselves. They then cleverly and quickly arranged for him to be formally adopted by a local academic couple. A local judge, who was also outraged by the situation, supported the emergency adoption. This made it impossible for some government agency to take charge of the boy, or even to interview him without his new parents beside

him, along with a lawyer. So far no interview with Gwyn had yet taken place, the reason being that he was "too traumatized." The boy had made a point about not liking the name John-seven, and who could blame him. He asked that they call him Gwyn, without any explanation of where the name came from. He acquired the last name of one of the pair who adopted him.

Whearty wanted a lot more information.

His secretary ushered in the final person. This was Sean Hamed, who was in the small circle of people working directly with John-seven. "Carl" was his code name within that circle as part of the project. After giving Hamed the standard intro, Whearty said, "I want to know everything about your John-seven, or Gwyn as he seems to call himself now. I've read your report, but I want you to go over matters carefully."

Hamed started in with perfect if slightly accented English, explaining that Dr. Ramsey, the Director of the whole unit, and Dr. Mangus, the Head of Neurobiology, had been completely in charge of biological issues. Nothing had been done without their approval. He didn't know how they'd settled disagreements between themselves, but Mangus seemed to be the dominant personality even though he was under Ramsey. Mangus was demanding, exacting; Hamed had always been nervous around him. These two senior people, together, had been the main driving force for the experiment. They both died in the explosion.

"How did this project get started?"

Hamed started to have a tick in his head, nodding it again and again. "The origin dates back to the days with the high performing hardware from the 40s. They created at least a dozen of these implants, but had only started trying them out when everything fell apart. We could no longer understand in detail how they worked. Dr. Mangus thought, though, that we could still try to test them. They started with clones of a specific individual from the previous century, a mathematical and scientific genius, with a photographic memory. The Johns were clones of that person."

"And who was it?"

"I never found out. It didn't seem important."

"But you were in charge of day-to-day matters, with their approval, right?" Whearty said.

"That's right. I worked in that position for the past five years … a little longer than five years."

"Please go over the progression of the Johns for me," Whearty said.

"So they were trying out the implant, along with a protocol for neuron growth that had been recommended when the implants were created. These human-computer interfaces had been done many times before, for many reasons, but this case was incredibly bold and complex. The first three Johns were used up by mistakes in getting the initial procedures in place, I mean, like the initial in utero implantation, working with an artificial uterus, and using the neuron enhancement. They thought they were close with John-four, but then John-five was a terrible failure because of problems with the neuron growth and other problems. John-six came closer, but then failed to develop properly. That was before my time, before I hired on. In John-seven, the last one, they seemed to have a perfect result. Wonderful integration and amazing enhanced capabilities."

Hamed paused to take a drink of water. Whearty thought he looked awful, extremely nervous, continuing to bob his head.

"John-seven was about eight months old when I was hired, already with his initial thin in utero 'starter' implant and his second larger addition to the implant at age one month. All along he seemed to be doing well, without any of the side effects of the neuron-boosting protocol. Obviously we were concerned about any issue with John-seven, but he remained remarkably healthy. When he was two we surgically inserted the much larger part of his implant. That was the first time we were able to get to that step. With John-seven, the technical, the biological issues, issues of compatibility and rejection that occurred earlier, they went well with him."

"So John-seven was a success?"

"Absolutely. It was far outside my field, but we were repeatedly assured he was able to solve near-impossible problems, and was able to understand the machines of the 40s to an astonishing degree. One goal was to get some of the high-end 40s machines into use again."

"And what about his personality. I get the impression that he was considered immature, though not for a 6-year-old."

"Yes, he always seemed rather immature, not worrying about much except trivial matters related to his environment. The material he read and the entertainment he listened to were both always fairly simple, designed for children. He loved happy 'family' videos, ones with no conflict." A pause. "He also seemed easily distracted, or else completely focused on what he was doing, ignoring what was happening around him. I frequently saw both of these behaviors. One thing was strange: my native language is Russian. He sometimes spoke to me in Russian, excellent Russian. At the time I thought he was using his implant to parrot speech to me that he'd heard somehow, or using a translation AI. Now I'm not so sure; his speech was quick and smooth."

Hamed was starting to shake somewhat. "Yes, immature for sure, I guess." A pause and then he said, "You know, it seems stuffy in here. I think I could do a lot better with the interview if I could get some fresh air. Could we continue on the grounds outside? Is that all right?"

Whearty never thought of himself as clever about taking hints, but this one was obvious. "Sure, we can go outside for the rest of the interview." They put on their masks and went outside. He was thankful the courtyard wasn't open to the public.

Hamed started in immediately. "You assured me everything would be confidential. Can you guarantee that? It's partly that I can use some private advice."

"Yes, completely confidential. What, are you worried about a secret recording in that office?"

"Of course. Bugs are everywhere anymore. It's dangerous for me even out here. You may be wired and not know it."

"I'm pretty sure I'm not. I picked this outfit myself at my home, and ever since I've either been wearing it, or I've been alone in a room with it. Go ahead and ask for advice."

A long pause. "You see, I needed a job when I was hired five years ago, and this one seemed extremely promising—exactly what I'd hoped for. For someone foreign-born like me, it's always harder to

get hired. I had the necessary clearances and I'd done similar work for the government—human-computer interfaces were my research area. They presented the John-seven project as established. I assumed the proper reviews and approvals were over. I was well familiar with the required procedures: speak about what we were doing only to direct colleagues and only within our lab—to nobody else and nowhere else. They went over that with me carefully. Once in a while we had a visitor from elsewhere, and even if it was from inside the building, we had to make sure computer screens were covered and everything was secure."

Hamed stopped talking and just walked along with Whearty for a bit. Then he went on. "Over time I became increasingly concerned. This was a human subject we were working with. It was the seventh one—what happened to the previous six? They explained only that such issues were handled by the 'Argyle Group,' whatever that is. Now everything has blown apart. Several times I've been interrogated by government lawyers, after being briefed about my rights. They say I only have to tell the truth and everything will be fine. I don't believe it. I worry about being prosecuted for major crimes, about a long jail sentence."

"I have no control over that," Whearty said. "I tell you what: anything you say out here, well, I'll pretend it didn't happen. What do you want to say?"

"Why, that it's much worse than I pictured. I don't believe there were any reviews or approvals, except for perfunctory ones. I think I was a party to serious crimes."

"Like what, specifically?"

"I think the six earlier Johns were disposed of, even though three were viable human beings. The two awful people in charge, Ramsey and Mangus, talked about John-seven as if he was an expensive device, with no more rights than a printer. They almost acted like they had created this object using cloning, and so they could terminate it. After the leak, which I found out about, never mind how, they seemed rattled, even terrified, I suppose about being held accountable for everything. Terminating the John-seven project, as they had the others, was a real possibility. They acted like the Argyle Group would

take good care of him. But I think the plan was to turn him over to them. And they would dispose of him. Dispose! What a joke. In this case I'm sure it meant cremation that left not the smallest segment of DNA intact."

After saying nothing for a bit, Hamed went on. "I *liked* John-seven. And he's an astounding success. I was getting desperate to somehow keep them from killing him. I'm certainly delighted with the way things turned out. Not entirely—other people died besides Ramsey and Mangus.

"One more thing, equally disturbing. There were further Johns: eight, nine, and ten."

Whearty couldn't believe it. "My God, no one's mentioned that up to now. What happened to them?"

"You could expect this. There had to be a pipeline of Johns, and it kept taking longer to see if one might succeed. Probably the three had received the first two implants, and one or two the third one. I wasn't supposed to know about the next ones, but I did run across evidence of them—kept in a completely different facility. They were somewhere and then they were nowhere. I'm sure the success of John-seven and other pressures led them to a solution: they 'Argyled' the remaining Johns."

Whearty walked along in thought and finally said, "Here's my advice, for what it's worth. This may depend on what you've already said, but you should stick with the line: you knew nothing, suspected nothing. You thought everything was completely approved. Unless you said something different on the record, stick with the know nothing line, repeatedly, over and over. If they say you should have known something, forcefully deny it. I think that's the best you can do. Also, I suggest you not volunteer any additional information about John-seven that you haven't disclosed earlier. I'm thinking of stuff about how good he was doing, individually and with his implant. How much you liked him and wanted everything to go well for him. Instead, say you didn't know what might become of him and you knew nothing about any group that might take responsibility for him. You've never heard of the Argyle group, if they ask. Finally, remember that you weren't even around when the other Johns were

'taken care of' or 'disposed of,' whatever. You can try to leave the impression that he was a failed experiment, or leave no impression. Oh, and you didn't say anything important to me. I trust that you'll tell no one that we talked about this."

They chatted some more, but that was pretty much the end of the interview. He wished Hamed good luck.

Whearty went back to his temporary office and sat for a long time. His assigned secretary asked if there was any more work, or could she leave, and he told her that was fine. He sat for another couple of hours or so, thinking. Then went back to his room in the complex. There he thought it over, and over again.

In retrospect it seemed obvious that everything happening had a single cause, by one individual, specifically by Gwyn, née John-seven. They had brought forth an individual (don't think "created" he told himself) who was fantastically good at solving problems, so in some sense very smart, surpassing themselves—the old Frankenstein's monster scenario. Gwyn was in a difficult position but in every other aspect he was greatly their superior. So he found ways to inform himself about them, and when threatened, he found ways to defend himself. Clearly he also worked at pretending to be an immature and distractible six-year-old who posed no threat.

This person Gwyn was more important than the whole biology building had been, along with all its contents. The two people who knew the most about him were dead, and most records were destroyed. The scientist Hamed who worked closely with him was going to clam up. Whearty could almost see time cracking open before him, showing a path he'd never imagined, leading him into the future. He could become involved. He could help Gwyn create a new reality for himself—for his safety's sake, a reality in which he wasn't nearly as capable, not nearly the fantastic success that he actually was. Deflect and reduce the interest in him. He decided to taylor his final report to this need, and it would be easy—simply report what each group said, except for Hamed. And hardly mention John-seven, except as a pawn the two senior researchers were using

for their budget and careers, where they exaggerated results and their importance. But he had lived long enough to know that it often wasn't good to interfere in someone else's business, in their life. A specific example still bothered him after so many years, engendering so much anger and disappointment. The law of unintended consequences. Well, his actions of understating abilities wouldn't directly cause Gwyn harm and could be reversed.

The safety of Gwyn was the most important and immediate issue: Gwyn might be abducted or even killed. He must contact the Neurobiology Department head, as well as the adoptive parents. Soon. Then he needed to draft his report. And he would have to talk with Gwyn directly, somehow sounding him out about whether he wanted a deception about his past. After all, this was a game Gwyn had been playing with great success.

His pulse rate kept increasing. Soon? What would be soon enough? Now would be soon. *Now!* He couldn't help himself. Neurobiology had experiments running continuously. He tried sending a message to their main address and it got to someone who responded right away at night. By pleading and demanding he got patched to the head, who thankfully was still awake. With difficulty he managed to talk him into having the federal security service send a detail to the house of Gwyn's adoptive parents—in a nondescript car complete with drone lookouts. It would stay the whole night. The school and the various nearby federal agencies shared a need for security.

He went to bed and had difficulty falling asleep. This was how he always was when serious matters came up: his mind ground around and around with too many thoughts. Tomorrow he must get Gwyn and the pair who had adopted him moved into an on-campus apartment, with security. He had a younger colleague who would welcome an appointment at the Illinois Institute. She was excellent, and she'd had trouble getting another appointment, even though she had the necessary security clearances. He should be able to arrange that. Talk her and them into it. Yes, he could cover her first-year salary with his own research money—easy, move some of the money around. He was bored with his current position and hadn't decided

what he would do. Perhaps get "visitor" status at the Institute or even demand a regular appointment. Yes, excessive demands were the best way. He congratulated himself on keeping a high-quality personal research program going. He should also demand a year-long sabbatical from those entrenched blood-sucking bureaucrats at his current location—give them a larger cut of the money he controlled. Finally sleep came, but with it a dream:

> *He is standing in line with a small group of strangers, waiting for a tour of the Moon's colony, what they called the Nest, short for the Owl's Nest. Everything is vivid and clear, although the strangers do not stand out—he cannot see their faces. A map on the wall shows the main parts of the colony. He studies it carefully. The date at the bottom is February 7, 2084. That's wrong. This is 2068. The map itself is large and complex, unfamiliar in its intricacy and details even though he's studied maps of the colony before. He tries to trace out some of its parts, but is interrupted as they bring out a cake shaped like an Owl to celebrate seven hundred fifty people in the colony. That is wrong too—the colony doesn't have nearly that many people. The cake says "Fortieth Anniversary," also wrong. Then he is in a large room full of plants and animals, like a forest. A forest on the Moon? They brag that one day they will have larger animals, a more diverse collection. Right when it was getting interesting there is a buzzing in the air. The buzzing gets louder—his alarm.*

He often dreamed, but his dreams were always confused and only partly remembered, with everything fuzzy, not in focus, fragile dream thoughts that disappeared as he tried to remember them. They were also full of crazy, unrelated scenes. This strange dream was clear and precise, fresh in his mind, full of details, none of them crazy. He felt odd, disoriented somehow, as if he belonged back in the dream. As if the dream was real and his waking state an illusion.

3. Cleaning Up

James Collinson gritted his teeth while pacing in his office. A tall, thin, and intense former military man, he was now the civilian head of the European Security Services, ESS for short. He should have been happy with his view of the Atlantic Ocean from the rebuilt old castle in the former Norway, where the ESS headquarters was; he was everything but happy. The reports he'd gotten from agents in Illinois described a parody of incompetence.

Those utter fools in North America. Worthless morons. They had created an amazing human-machine cybernetic organism, then got scared and tried to kill it. Or rather him, John-seven, now calling himself Gwyn, basically a six-year-old boy with a neural attachment, an extremely complicated one. An unprecedented success at that level of complexity, using one of the amazing devices from the late 2040s. The boy managed to escape from confinement using a North American missile to blow up one end of the building housing him. How in the nine hundred names of the devil did he manage that? It was a serious question. Collinson couldn't imagine being able to do it himself. A few local people, in particular the scientist Robert Whearty, had come to understand the potential of this "experimental project."

They must get the boy to Europe where he would be safe. The clowns taking care of him will still mess up the part about keeping him safe, and someone will kill him. We'll give him everything he wants or needs. Treat him like royalty. Too bad it has to be what other people might call a kidnapping. An abduction should be feasible, albeit with risks, but acceptable ones. They wouldn't even need to lie or deny all knowledge, but could claim that getting the boy out of North America was necessary for his own safety, since the local authorities not only couldn't guarantee safety—they had tried to kill him themselves.

The ESS had a group of six agents in and around the University of Illinois where Gwyn was kept in an academic department. Reportedly his security was almost non-existent. He immediately contacted the group leader in Urbana, Illinois.

"Deter, you talked at length about this person, how amazing he is, crucial for us. We must go ahead as planned and get him away from those witless dunces. This is an absolute top priority. I want to review your plans for an extraction, and it needs to be done right away. So send me a detailed description in two hours, with a careful timeline, with possible difficulties, and counters to them. I expect it to happen this very night at your location. After you get the subject safely out of North America, be sure to go over with him how they had tried to kill him and were probably planning to experiment on him. Tell him how much safer and happier he's going to be with us."

Deter Bresson looked around at the small basement room they were using for the operation. Only the six of them plus others to help in getting out of the country. Basically a kidnapping—very dangerous. He'd tried to get out of it, but Collinson had insisted. He agreed with the importance, but regretted having to abandon their North American operation. Again, too dangerous for any of them to stay after this "extraction," like a tooth. They'd had three agents working in the destroyed biology building, one of whom died in the explosion. The other two were in the room now, one a senior staff member.

From its inception they'd followed the implant project closely, although none of them were directly involved. Several of his group hadn't bought into John-seven's act pretending to be a mostly normal six-year-old. And oh, yeah, the kid called himself Gwyn now, which seemed crazy. The leaders had intended to kill him—that's what seemed to have been happening—so Deter didn't feel bad about the kidnapping. Far from misusing him, once they got him into Europe they intended to value him highly, to take good care of him in every way. The pathetic response of the local investigation was useful, but some people had clearly recognized his importance, for example that senior scientist Whearty.

Two of their group were students at the university and two were faculty. Such a huge amount of work getting agents positioned like this—he hated to give up these resources, but John-seven was a key

success, a unique individual, by himself worth more than their whole operation. His value was hard to overstate.

They had multiple IDs, with complete and redundant biometric data, so they could move around anywhere. The operation was scheduled for tonight; Collinson was right to push for an immediate operation; the sooner they moved the better. In fact, initially it was going to be easy, since Gwyn and his parents lived off-campus. They'd delayed a little and suddenly the family had moved into the campus high-rise, an ancient building, but with new computer-controlled locks. So now they needed to go through three points of security to get to the boy, although the access itself was no problem for them. Still, the move worried Deter. It indicated caution, awareness of the need for security. The family was living in Apartment 3.5, on the third floor. They had emergency access to every room in the building, so it should still be easy. Andy, Liz, and Deter himself were going to do the actual abduction. The plan was to knock the kid out with a treated cloth clamped over his mouth and nose, and then Liz would carry him as if he were her child who'd gone to sleep. They hoped to avoid Gwyn's parents and be done in minutes. They were prepared to deal with his parents quickly and non-lethally.

Three people back in the operations room were monitoring two small drones they were using for surveillance, just to be sure. Eric had registered them to use for a research project—each drone could respond with the proper permissions in case of a security query. The two drones had already shown before that Gwyn and his new parents entered the building and didn't leave it. The six of them, plus the kid, would go in a car to the private airfield where a plane, two pilots, and other support was waiting.

The initial steps were easy: they IDed their way into the university grounds, IDed into the high rise, and paused at the door to unit 3.5. The emergency access ID let them into the apartment. They were quiet, moving through the five rooms, finding furniture, but no indication someone lived there. It took another thirty seconds to check every possible place where someone might be hiding. Deter didn't like this turn of events. How could they have the wrong apartment? He even double-checked the "3.5" on the entrance. He

was in contact with their operations room. They had long ago gained access to the university's computers and were engaged in a frantic search through different sources of data.

"There's a discrepancy in the data about the room number," Eric said from the basement room. "Only one place lists it as '5.3' instead. It looks like they deliberately made the official entries the fake room you just visited. They must be on the fifth floor, Unit 5.3."

Deter was increasingly unhappy, but he had them go immediately up to the other room. They entered as before, finding an obviously inhabited apartment—everything was there, even recently used dishes in the sink, but no people. This was how an operation turned to shit.

"Crap, crap!" He asked about the drone surveillance, and Eric said there was nothing, nobody moving around where they were or anywhere near the apartment building. Deter went to a large stairwell and had the drones go with him. They checked each floor, and the drones inspected the open areas. Forcing entry into apartments at random wasn't going to work—too many of them, and way too dangerous. Eric suggested they abort. Deter hated to, but what else could they do? Suddenly a song started playing in the room: "You are my sunshine." It was loud, startling everyone. Then Deter noticed a prominent message on the main table. It read: "If you leave immediately, you might avoid being arrested or killed."

This was crazy. Nothing like this had ever happened to him before. It was like they were toying with him. But he took the advice on the note, and they did leave immediately with no problems. They encountered no one on the way back to their base.

They then made contact with Collinson in his ancient castle. He was livid, almost sputtering incoherently, but there was no choice. They had shown their hand, and the note seemed designed to prove they had failed completely. A botched operation. They went off in the private plane according to plan, but without their captive.

Deter could only think about Gwyn. What kind of an opponent leaves a rescue note for his would-be abductors? Well, one who, to escape captivity, would blow up a building where he lived. Was he making fun of them, or did he truly not want anyone arrested or killed?

For some time Whearty had been helping Gwyn with his adjustment from the limitations of his early life and from the trauma of the explosion, to life outside confinement. From the beginning he was almost disturbed by the anomaly of Gwyn looking the part of a six-year-old boy but talking like a sophisticated adult colleague. Gwyn had endless questions for Whearty and others, including questions about trust: whom could he trust and to what extent.

He, along with others concerned for Gwyn's safety, had insisted that the boy was never to be left alone. The first day Whearty was on campus, he arranged for Gwyn, along with the married couple Alan and Joe who had formally adopted him, to move into the large old campus apartment building, since entrance to it was strictly monitored and controlled. They took up residence immediately, while their belongings took another two days to get there. It was a tremendous relief to have them away from their house that was out in the vulnerable community.

It turned out his relief was premature and Gwyn was still potentially vulnerable: from a bold attempted abduction by European agents. That was terrifying for Whearty and certainly disturbing for Gwyn, but they managed to counter that attempt. Would there be others?

Gwyn's previous environment had left huge holes in what he had experienced: a long list. He had never participated in anything like sports, and wasn't even able to throw a ball with any force. He didn't know how to swim, ride a bicycle, ride on a moving sidewalk or escalator, use outdoor tools, among many other missing activities. He had no direct experience with animals, such as riding a horse or playing with a small animal. He had never seen an egg cracked open or any food preparation. There was a whole world of experiences he'd seen only in videos.

In Gwyn's new academic world, two of the neurobiology faculty at the institute wanted to study him at length, with a goal of learning about him in relation to his implant, and as an incentive they would also be looking for possible difficulties—with his biology or his hardware or both, particularly at the interfaces. The implant itself

had a huge amount of data stored inside, including built-in testing routines. It contained complete hardware and software descriptions of itself, but Gwyn doubted they could understand that part. A separate mathematics faculty member wanted to see what Gwyn could do with the help of his implant. Have him carry out activities or solve problems that were beyond the reach of previous studies. Gwyn was in no mood to let any of them get near him.

Whearty had contacted Gwyn by secure video—at least supposed to be secure. To start a conversation, he asked where the name "Gwyn" had come from.

"I took my favorite name and dropped two vowels,"

Whearty decided not to follow that riddle. "Were you scared when they tried to kidnap you?"

"Yes, I can deal with stuff like that mentally okay, but it affects me physically. I'd taken over their drones and led them astray, so they thought my parents and I were still in the building, when we were actually far away. But I even had trouble walking."

"The next attempt, if there is one, may be more sophisticated."

"Exactly. The school has promised heightened security in general and for me personally."

"Do you think the school can protect you."

"Well, no, but I can do much of my own protection. Anyway, I'm not supposed to discuss security with anyone. It would be sad, but I might need to separate from that wonderful pair Alan and Joe who took me in. Uh, not separate formally; I'll still be their adopted son. They gave me a family and a family name. But I'm a danger to them, and it may be too complicated to secure a whole family unit. I'll have to see."

In fact, Gwyn had been thinking about his own protection. After his life in a prison he'd resolved never to be locked up again, yet here he was, pretty much unable to go out into the world. Right then he had one of his AIs monitoring a large number of surveillance devices, some the school's and some his own. Several of these could also be used as minor weapons. As soon as possible he wanted to deploy significant weapons, since it was necessary to protect against attacks, even something so extreme as a missile like the one that destroyed

his building—some directed energy system of his own could do that. It was stupid that the missile he'd used to free himself had not faced a laser protection system that constantly scanned the area around the building, and then, since the speed of light was so much faster than any moving physical object, the missile could have been detected and destroyed as it approached. There could be counters to the protection system, and so on like a stack of Russian dolls. But physical security was complex because many actors carried out surveillance and deployed weapons themselves. The other side of his protection was to compromise the computer systems that might control a threat. Here he was creating a big advantage for himself by analyzing the various kinds of system software and finding new exploits. He was good at creating backdoors in the complex and bug-ridden software in use. In fact, it was such a near impossible code change that let him convert an apparent bug-fix into a missile launch command.

His protection was a work in progress; he expected to spend the rest of his life refining and improving the machines and algorithms and policies that protected him. And he would discuss these protections with no one—he had talked about trust with Whearty, but he'd privately decided not to trust anyone, not completely.

Two days later, Whearty talked with Gwyn and found him holding a dog, a puppy. He lifted the dog up close to the camera. His parents had let him pick her out: a small, white rescue of uncertain lineage. Gwyn was quite taken with her. "I've never directly interacted with any animal except humans. It's fantastic having her to play with. She's non-judgmental and smart, with partly unpredictable behavior."

He paused for a second. "She's a security risk; I understand that. I may have to leave her with Alan and Joe, but it's great to have her now."

"A 'she.' So what is her name?"

"I named her Selene, for the Goddess of the Moon."

"And why that name?"

"This sounds, uh, silly. I had an unusual dream about the Moon a few weeks ago. I guess that was the connection. I can't get the Moon

out of my mind."

Whearty had the sick feeling he would get when something important was going on that he didn't understand. He told himself to drop the subject (don't ask!), but he couldn't do it. "What was the dream about?"

"About a fancy updated and much larger version of our colony on the Moon. I remember the details about my dreams. A curious part of this one was a map of the colony with a date on it.... "

Whearty immediately interrupted. "Don't say the date. Wait a second." He tried to get hold of himself. "I had almost the same dream, complete with a diagram and a date. Please indulge me. Turn your back and write the date on a pad. I'll do the same."

He and Gwyn both wrote down their dates: Gwyn had written "February 7, 2084," and Whearty had written in turn "February 7?, 2084."

Whearty felt like he'd been hit hard in the stomach. "More than curious dreams. Impossible ones. Even my 'seven' was correct. Wait. Were they celebrating anything? Don't say it. Write in on your pad."

On comparison, they'd both written different versions of "Owl cake" and "seven hundred fifty" people.

"That is strange, but what can it mean?"

Gwyn also sounded disturbed. "Yes, strange indeed. And how can it 'mean' anything?" A long pause. "I have to think this over.... I'll get back to you, say, tomorrow. I haven't mentioned this before, but you also need to protect yourself, serious protection. Don't get into routines and become predictable. Well, good-by for now."

Gwyn sat for a long while, thinking in different directions, especially about how only the part of his consciousness that slept could dream. No one else had ever had a line of awareness that never slept. It was strange, since there was only one of him and only one memory. And not "shared" memory. Strange.

The next day Gwyn started in. "So what do you think?"

"It can't have happened. Did you find some tricky magician's way to cause this? Or were you running a program that grabbed the

video content?"

"No," said Gwyn. "No, nothing like that. You're right: there's no plausible explanation, yet it did happen."

"Were we both hypnotized or drugged or something worse?"

"I don't see how it could be possible, coordinated between the two of us. I researched this topic. History is full of amazing coincidences like this, as billions of people had trillions of interactions over lifetimes. And people were always talking about prophetic dreams, about the interpretation of dreams. So … a bizarre coincidence or an intrinsically mysterious event of unknown origin." He seemed lost in thought. "I admit there are a lot of factors for a coincidence: the date, the map, the owl cake, the number of colonists, that it was the fortieth anniversary of the colony, the scene at a greenhouse. I have a few theories, but I'm not going to share them. We may never know." But privately Gwyn didn't believe in a coincidence explanation. There were six separate coinciding elements, which together were like a deliberate digital signature on data.

"Think about this," Whearty said. "What did you say yesterday? That you 'couldn't get the Moon out of your mind.' I feel the same way and it's weird: a compulsion to think about the Moon. A shared result for the two of us—not only the common dream but a common compulsion as a reaction. That's what was concerning."

"Concerning?" said Gwyn.

"Well, yes in some sense. Where could the strange paired dreams have come from? Did they have some rational cause? An effect without a cause? Such a fantastic coincidence and such a strong effect, what could be an important effect. Strange, indeed."

For his part Gwyn wondered if he should tell Whearty the rest of it. Maybe….

"Uh, I wasn't going to mention this, but I had an earlier dream that was also interesting. The past day I've read a lot about dreams—how they can indicate your state of mind or your fears. How they've never been much use for psychotherapy. And dreams haven't ever been well understood. Despite infinite study, we know relatively little about them. There's certainly lots of psycho-babble, and there could be something to the various 'stages' and such. My recent dream came

after I finally got to sleep on the day I escaped. I was filled with anxiety; it was hard to get to sleep. Later I dismissed the dream as irrelevant except as an indication of stress. But what if something strange was at work with it as well, something external to us?"

"Well, I hope you're going to tell me about it."

After a long pause, Gwyn started in. "It's sort of embarrassing. I do always remember everything, including dreams. Anyway, there's a Middle English poem about a hero whose honor and courage get tested. He mostly passes the tests, but not completely. I'd read a young adult version, but I had access to a huge library, so I could read the original."

"You can read Middle English without an AI connection?"

"Sure. I can directly read dozens of languages. Well, I have the AI stuff in my head, immediately available, so Middle English is trivial. I read the poem a long time ago. In it, a heroic figure is challenged and tested by a huge green man—bright green skin and bright green clothes. Well, in my dream this green guy shows up, very big and powerful. A ridiculous creature, he's riding a bright green horse. He and his horse have the elaborate ornamentation that was described in the poem."

"I'm not familiar with that poem. I did have to read some Chaucer once, well, in translation. Sorry, go on."

"In the poem, the Green Knight as he's called challenges the hero, whose name is Gawayn, spelled several ways, to exchange blows of an axe. That's where I got my name; I dropped the two 'a's. Anyway, Gawayn gets to strike the greenie first, and a year later, Gawayn has to receive a similar blow. So Gawayn's no fool: he takes careful aim and cuts the knight's head off."

"Whoa, decapitation."

"Yeah, sort of assuming that would be the end of it, but his opponent picks up his head and rides off. Even severed, the head reminds Gawayn of his promise to receive his blow after a year. This is pretty tough on Gawayn, ever more so when it gets close to the deadline. Gawayn proves his chivalry and loyalty, and honor, too, but not quite perfectly. Along with other slight failings, he flinches away before the second blow can land. The poem goes on, well, translated:

Gawayn said, 'I flinched once,
And so will I no more,
But if my head falls on the stones,
I cannot it restore.'

So he takes the blow the next time. In the end all he gets is a nick on the neck, or in the words of the poem: '... the knight hurt him no more than to cut him on one side that severed the skin,' along with a fair amount of blood that fell over his shoulders and onto the ground. In this way he passes the exchange of blows test and other tests as well, but even so he is compelled to remind himself from then on of his imperfections."

"That's the story in the poem. What about you, your dream?"

"Well, my Green Knight said I was going to be tested as in the poem. I get to keep my head, but he cautioned me, and this is an exact quote: 'There will be a contest that challenges your abilities and focus and energy to win.' I didn't think anything about it until now."

"And now… ?"

"Who knows. Maybe nothing, just coincidence and imagination. The challenge may concern the Moon colony. That could apply to both of us. I think 'challenge' is a strong word.

Switching subjects, Gwyn then said, "And I want to thank you again for looking out for my security. If they had struck two days earlier and if you hadn't called for the school to send a security car, I might be in Europe now. I've got my security pretty much in hand, and now you are the vulnerable one. Be careful; don't ever go anywhere by yourself. I'm kinda tired now. Let's talk again in a couple of days."

Whearty didn't know it, but thanks to Gwyn he now had a microscopic security device in his stomach, there to stay indefinitely. Something like an ultra-high-resolution total body scan could locate it, but in general it only responded to the properly coded secret millisecond ping. It would cleverly cycle to require a new secret ping after each use and after each millisecond of elapsed time, so you couldn't record a ping, or even block and record an attempted ping, and get anywhere. Gwyn also had microdrones following Whearty.

In his castle James Collinson mulled over what had happened to his team. Despite his scorn and criticism of the North Americans for misunderstanding and underestimating their new cyber success, he had done the same himself. It wasn't even clear how Gwyn had managed to avoid his kidnapping, but he had, elegantly and disdainfully, warning the team off. Collinson prided himself on not repeating mistakes. He'd been too eager, too precipitous. It had seemed sensible to use the available agents and get it over quickly, but now the team was exposed, compromised, and useless. They were back in Europe. Fortunately he still had an additional agent right at the heart of the neurobiology work. Her connection to Collinson was not even known to his other agents—very deep cover. He had only one way to contact her, using certain advertisements, but he had now deleted that contact method. She had been told that such a deletion would be a signal for her to pull her head in like a turtle under attack. She was to do nothing to expose herself and was to continue her work indefinitely with no change. He in turn would be patient and wait for opportunities. In time he'd have more information about Gwyn … and she would be available.

In a world with spy drones the size of flies and with frequently compromised systems and communications, a number of individuals and institutions took notice of events related to the explosion, and they drew their own conclusions. Collinson didn't know that his ESS had long ago been compromised by two cooperating entities. Worse, his special deep-cover agent was a double agent, also working for Elliot Morrison, the rabid dictator of the Australian Archipelago. And she would soon become a triple agent.

The exploded building was like a kill in the old African plains or the northern forests, before they both fell victim to climate change: after the kill other top predators would gather, while a sequence of ever lower scavengers waited in line.

4. Simulator

Whearty had finally finished his report and sent it off to those above him. He also sent a copy to Gwyn, but only talked with him several days later.

"Did you read the report? You weren't supposed to see it, but I sent you a copy—for obvious reasons. Obvious, right? But first I need to ask: Is this connection safe? I keep worrying."

Gwyn couldn't guarantee safety: "End-to-end it's strong encryption and I'm seriously protecting the end points; both are constantly monitored. But nothing is perfectly safe, so let's get on with it anyway. And yes, I'm indebted to you for the report, for the way you slanted everything. You understand how I want to play down my involvement and abilities, and you've set this up to continue that strategy. All that so I could be less visible and not as interesting. Trying to sell myself as some kind of modest experiment with correspondingly modest success and significance. Mangus and Ramsey—I've read their requests for more funding; they were promising results that would change the world."

Gwyn paused and then went on, "Unfortunately, I don't see that line working so well here in North America, and it's not going to work in Europe, as we saw. A nice touch to remind your report's readers that researchers like to exaggerate how important their results are, or will be."

"Scientists build up a dung pile of their own work," Whearty said. "They climb to the top of it, and crow that their pile is taller and smells better than anyone else's."

Whearty turned serious. "I've seen reports of your success in working with the fancy twenty-forties technology. It was impressive. You can't make that work disappear—much of that wasn't lost in the explosion, but was in widely circulated reports. Well, widely circulated for something classified top secret."

"At that time I worried about being useful enough for them to remain interested in me. I kept thinking they might terminate the whole project, along with me."

"Okay. In the end I still suggest you continue to de-emphasize

your abilities as much as possible. Without overdoing it—that second part is important. The issue remains of what you intend to do, short-term and long-term. We can talk about that anytime you want."

"Great. I'll call you in a few days."

Five days later Gwyn placed his promised call to Whearty. It looked like Whearty was going to get his visiting position. Also, an offer had been made to his colleague. Things went through quickly because Whearty himself was supplying her first year's salary, and the position wasn't guaranteed beyond that year. Everything according to plan.

Before the call, Gwyn reminded himself to be careful. His mentor was sharper than the others he was dealing with.

"Robert, I have a lot to discuss, on two different subjects." Gwyn had taken to addressing Whearty as Robert.

"You can call me 'Buck,' my nickname. And I have important things to discuss with you, too."

"Ok, 'Buck' it is right now, but not in company. Anyway, my topic number one is the Moon, well, the Moon colony. What I guess they call the Nest or the Owl's Nest. I never looked up why it's called that." Here Gwyn was following his usual strategy of not demonstrating a knowledge of practically everything. Of course he knew the reason here. For him to "look something up" was instantaneous. Gwyn found it interesting that even someone like Whearty, who knew him well, still had no idea of what was going on in his mind during a simple conversation. In most interactions with someone else, he already knew everything the other party was going to say. He was a chameleon among ordinary lizards, careful to keep his colors neutral.

"Oh, early on there was a naming contest, and that name was suggested by some little girl. They made a big deal about it—sort of a public relations stunt right from the beginning. An owl flying under the Moon and such. I like the name and the idea of having a 'nest' on the Moon. Some people lobbied for 'Eagle's Lair'—a silly name and offensive for some because it reminds them of Hitler's mountaintop

retreat. If they'd wanted a more pretentious name they could have called it 'The Eyrie.'

"Anyway, about the Moon, I'm sure you know much more than me. I do know some of the history—I lived through it—as when they were unsupported and on their own for six terrible years. Back then I was young and trying to survive like everyone else, but their survival was truly remarkable. I'm thinking now that something of great significance happened and still is happening, on the Moon. And secondarily with the Mars colony, since access to it is mostly an extension of access to the Moon. I'm interested in your own take."

"Many people died over the years teaching us how to live in these colonies." Gwyn said. "And we've learned a great deal, what works and what kills. That's part of my take. There were no shortcuts—it took time and many attempts … and many lives. And it's still a work in progress, in many ways only now getting started."

Gwyn looked back over his shoulder at something Whearty couldn't see, and then went on. "You know the history: long before even your time, we had six separate landings of humans on the Moon between 1969 and 1972. Landing on the Moon wasn't much of a goal. In fact, it was the wrong goal, a stupid goal. It's like the difference between climbing Mt. Everest and setting up a permanent research colony at the south pole. Such wasted time: over fifty years with no more humans on the Moon and with relatively little other activity. Think about it, *fifty years*."

"From my point of view," Gwyn went on, "the next important step took place twenty years later, with Biosphere 2, which most people haven't heard of. From 1991 to 1993 it was a test of a completely closed ecosystem, extremely complex, with eight people living from the food and oxygen that could be generated inside. Scientists made fun of it because of the problems they had. They said there were too many variables, with everything interacting, to draw any conclusions. I think it helped people understand how difficult it would be to create a closed environment outside the Earth."

"I know a lot about Biosphere 2," Whearty said. "I even wrote a paper about it, about the insects in its ecology. I think the experiment was helpful. As you said, if they had that many problems here on

Earth, how much more difficult would it be elsewhere, say, in some habitat, whether in space, on the Moon, or on Mars? Here they could simply open a door and let someone out, as they did once for a few hours to treat a cut finger. As another example, their soil was too rich and its bacteria ate up oxygen, so again they could open up and pump in more oxygen. Off the Earth simple mistakes like that could be lethal."

Whearty kept talking, keeping Gwyn from interrupting. "As I'm sure you know, starting in the 2030s there were a great many separate efforts, manned and robotic. Lots of competition between different political entities or their partners. Small colonies were established that failed in different ways, sometimes killing their participants. Large amounts of water were verified at the south pole. Easily accessible water. That was huge, a game changer. For years robotic vehicles investigated the lava tubes and looked for many resources, including many minerals. And there were colonies placed in the south during the late thirties, but each one failed. More deaths, but instructive ones. They finally settled on what seemed the best location. I was alive through the tail end of that."

"We're ready to celebrate the twenty-fifth anniversary of the real Moon colony," Gwyn said, "the one that matters, started up in 2043, and never empty of humans. That's the good news, and the bad news is a colony on the verge of failure and collapse. You know more than I do. Tell me about the political and financial situation for our colony. And tell me how Mars fits into the picture." Here as before, Gwyn was downplaying his knowledge: he had terabytes of data about everything related to the Moon and Mars but he continued to be a chameleon.

Whearty cleared his throat and put on his professorial voice. "What they finally completed in 2043, after eight years of work, was a coordinated plan for a large Moon colony and a smaller one on Mars. They had set up a large manned satellite, called the Staging Center, in orbit around the Earth and had a fairly efficient orbiter that could reach this satellite. They had long ago started up another satellite around the Moon, called Gateway. So there was an orbiter that went from the Earth to the Staging Center, then a shuttle from the Center

to Gateway, and a Lunar orbiter from Gateway down to the Moon and back. At the same time they managed to build two huge nuclear-powered rockets, let's call them space ships. These would make the seven- or eight-month trip to a satellite around Mars. They could do the trip roughly every twenty-six months. The large ships each carried two of their own Mars orbiters that would take people and supplies down to Mars. So something like every two years the two space ships would go to and from Mars, though because of orbital positioning those two trips were closer together than one would like. The fuel and supplies on the ships was provided from the Moon colony."

Whearty paused for breath and Gwyn said, "Yes, keep going."

"The Moon colony became fairly large from a number of flights. The first two large ships to Mars started up a modest Mars colony, with nineteen people. Then came the terrible six-year gap with nothing supplied to either colony. I think it is counter-intuitive, but that gap helped them in many ways. In their desperation, both colonies made great progress, finding ways to improve their recycling and efficiency. And people volunteered to die in order that their bodies could provide biomass and so they would no longer use up scarce resources.

"Then they started getting flights back and forth again. In case of a death they initially intended to send any bodies back to the Earth, even from Mars—for a 'proper burial.' Can you believe it? Ridiculous. If they'd kept that up we'd head into a resource death spiral.

"And the several major groups who pulled together to get regular flights weren't following the same script. After they got a reasonable recovery, the tensions and backbiting started in, more serious than ever. There's political infighting within the colony itself. What its mission and goals should be. Who gets to decide, who pays. It doesn't help that we're only partly recovered from that late 40s crash. Most materials are in short supply, particularly those needed to support the colony. The colony's two biggest supporters, North America and Europe, aren't getting along. Frankly, the fuss about you personally isn't going to help. It's fortunate that there's no official notice of their attempt to abduct you, or for that matter our ridiculous

attempt to kill you. Neither side wants that to come out."

"And tell me what you know about Mars's plight," Gwyn said.

"Oh, yes, Mars. It had more resources than the Moon, resources that were more easily exploitable. So Mars had an easier time than the Moon during the six-year period with no flights. The problem was and still is that Mars is too far away. Also, we can't afford to build another of the big spaceships. For the foreseeable future we're stuck with two trips every twenty-six months. That's enough to support the fifty or so colonists on Mars, but there's no way to expand.

"I'm not supposed to be telling random people this, well, you're not random. Anyway, for years now we've been pursuing a radical way to go back and forth, the Earth to and from the Moon. It promises to be far more efficient. Soon we hope to start it up with a goal of a flight every week, and eventually two flights a day. We have working prototype vehicles now. They are small, holding a bit less than two metric tons each. But with much more frequent flights that should add up for the Moon. Unfortunately we have no way to increase the cargo to Mars.

"Tentative plans call for us to add an unmanned satellite at the Lagrange L1 point between the Earth and Moon, used to give the lunar shuttle more fuel on the trip to the Moon, and on the trip back the shuttle stashes fuel there. We expect to eliminate the stop at Gateway. The new Refueling Center will require orbital corrections, but that's a modest problem, solved long ago. Everything will be remote-controlled from the Staging Center. This saves the extra control facilities on the lunar shuttle."

Gwyn had let his friend ramble on with information he already knew. "That sounds exciting, for sure," he said. "Mostly about the Moon. But major success there will eventually spill over to success with Mars. There's hope for great progress. How soon will they get this new method started?"

"As early as two years from now. But realistically, I'd be happy if it's fully functioning in four years. We'll have to wait, hope for the best. You and I can't hurry up that deadline right now."

Then Whearty wanted to be a spoilsport. "You need to take into account the opposition to the Moon colony itself from the crazies—

worse than you likely imagine. There are sensible people who think the colony isn't worth the expense. Zombie types who hardly know where the colony is and don't care a damn about it. Others who think it's a scam, filmed on a movie set, not real, another way to take their money. Some talk about the 'bad karma' of the colony, stupid. But for me the winners are those who fear the displeasure of Satan, due to the 'unfortunate' location of the colony."

"What? The 'displeasure of Satan'? I've never heard of that before. Are they serious?"

"It's deadly serious. Emphasis on deadly. As you know, the colony is close to the south pole, but on the 'Dark Side,' so called. Half of our population thinks it's called the dark side because the sun never shines on that side. They should be euthanized. Most of the rest would never think about this until the Satanists explained to them that 'dark side' means you never see the Earth from that side. How could that matter? The colonists don't go outside to look at the sky anyway. They send robots outside. They're buried in a lava tube for God's sake, but they're on Satan's side of the Moon. For the Satanists, the 'Dark Side of the Moon' is Satan's domain, where He—and don't forget to capitalize the 'He'—doesn't have to look at God's creation, the Earth. Satan wants no one but his own acolytes in his domain. It sounds completely insane, but these people are active and there are a lot of them. Recently I thought I was going to be killed when a group attacked my QuikKab."

"Wow, Satan's preferred side of the Moon." Gwyn was trying to pull himself together. "There are so many extreme groups now," he offered, then said, "but it's our own craziness I want to talk about. If the Satanists are nuts, well, you and I are, too. Buck, I want to speak frankly with you." A long pause. "We share our weird dream story, and I have the additional strange dream. You mustn't tell anyone about them. Most people would dismiss it anyway. I wonder if I'm only chasing after a coincidence. You see, I've been having, uh, unusual thoughts recently, almost unwelcome, about the dreams and the Moon colony. Again, this is only for you, but you should understand that I am ambitious in my way. As long as I stay alive and my implant keeps working, I expect to influence policy,

eventually worldwide. There have been many issues I was interested in addressing and contributing to. Obviously not right away; I'm still too young, too inexperienced, with too few resources. But the Moon colony wasn't on my mind, not as an important issue or any issue. The way I was, I can't imagine that the earlier me would push for the success of the Moon colony. I wasn't focused on it. It's hard to be sure. But now I see the colony as the key to everything. Those dreams did change the two of us. Change our future. Perhaps change everybody's future. That's astonishing."

Gwyn took a deep breath. "The Moon colony is my new top priority, but right now there's nothing I can do for them. Instead I'm asking myself what I can do. What should I be doing? I see part of my challenge from the dreams, if there was such a thing, is to do something right away. Not to wait. I repeat: What should I be doing?"

His green dream-mentor had issued him a challenge: the success of the Moon colony. That's how he interpreted it. He kept reminding himself: he needed to be smart and bold—and what had the green guy said? Yes, not only abilities, but he needed focus and energy. And plans and data, and as soon as possible, minions. He was already looking to turn a double agent into *his* agent. Ah, the line from a stupid movie he'd watched: make her an offer she can't refuse, or better, as he did, make such a good offer she doesn't want to refuse it. Hey, the Australian strongman kept making her offers she couldn't accept. The guy was such a terrible person, not even a reliable ally of the Europeans.

Whearty in his turn was worried, scared even, about what he should do, how much he should say. Whether he should say anything. Doing nothing would affect things like any other action. "I'm now in a position to suggest some things you might do. But I don't like this, the responsibility. I don't know if you're a child or an adult. I'm going to take a chance and tell you the new things I've learned."

Whearty paused. "This is totally illegal, talking to you about highly classified matters. Are you *sure* this connection is safe?"

"You asked that before. Pretty sure, and that's the best you can get."

"All right. I have a good friend, a Colonel Richards, Roger

Richards. God, we used to love making fun of his name. We worked together in the early 50s, when everything was literally going to Hell, well, minus Satan. It was a terrible time. Sometimes you had to do nasty things, stuff a civilized person wouldn't touch. I've found out that for years Richards has been big in issues related to the leftover 40s technology. For several years he's been in charge of a building housing and evaluating these machines. I managed to get his attention, and we talked for hours.

"It turns out he knew roughly what was going on in the biology building related to an implant. He wasn't briefed or anything, but information managed to leak out to officials cleared for similar information. He was desperate for more data, and I had data I was willing to exchange for some of his. With my clearances and because of my earlier involvement, he was willing to share part of what he knew."

Whearty paused so long Gwyn was ready to prod him when he continued. "For more than ten years the government has supported the special department devoted to the 40s devices: part of the federal complex that used to have your blown-up building in it. With great originality they call it the 'Forties Department,' well, informally. They're certainly glad they were next-door to the special biology department, but not stuck in the same building.

"Richards helped me understand why and how you came into existence. He had only found out officially and in detail during the last two weeks. A single 40s machine was the main reason. Now comes some of the most highly classified stuff: By far the largest and most complex of the left-over machines was one designed to model the world, everything, from the weather and economy to important individuals. The ultimate machine-learning device that wasn't trying to solve specific problems, but instead to give predictions about everything. Instead of playing Go, writing novels or computer code, solving the world's greatest problems (logical, mathematical, physical, biological, empirical), determining what preceded the big bang, … instead of all that, *to predict the future.* Used for a while in the mid 40s, it produced important results, some of which helped drive policy. It even predicted the late 40s collapse. It hasn't been powered up since."

"And what about me?"

"I'm getting there. Superiors above the pair in your building, Mangus and Ramsey, wanted to get the machine working again, so they pushed those two people to somehow find a way to understand and control it. Their solution was to create a clone and insert the fancy implant into him, … and not a her as it turned out. The implant had never been tested, let alone used successfully. This clone was *you*. That is, you were number seven, each one cloned from the same person. An extremely long and complex project for them. The project became their route to promotion and fame, top-secret fame. They didn't mind how long it lasted or how expensive it was. And toward the end it was at least a partial success."

Gwyn broke in. "Are you sure? I didn't know anything about that. It's amazing and depressing, at the same time. I killed those two, both of them, Mangus and Ramsey, but I killed others, too. Several people died who had nothing to do with me and my situation. What a terrible time and an awful decision I made, felt I had to make. Where do we go from here?"

"Like me, Richards didn't buy any of the elaborate excuses and explanations about the explosion. He now knows or has deduced almost everything about you."

"And what does he want?"

"He wants what his superiors wanted ten years ago—all of them retired or deceased now: to get the modeling or simulation machine, whatever you want to call it, get it running again. With your documented track record, he thinks you can do it. My guess is you'd like to."

"What keeps them from arresting me later?"

"This way should be *safer* for you. Everything is classified, even my report. With luck there won't be any more investigation. I assume you could make yourself indispensable in matters related to the machine. You need to have a long talk with Richards, as soon as possible."

Gwyn had long ago known there were going to be major problems with his plans for an idyllic and trouble-free life: he was hiding in plain sight in North America, but even there, many agents knew the

truth. The situation was worse elsewhere, particularly in Europe. He was already uncovering static about this online. Realization of the threats he posed was unavoidable. Dangers were everywhere. So another challenge from Mister Greenie: be careful, stay safe and alive. To that end he wanted to surround himself with ever more sophisticated machines, many of them lethal.

The call came late in the afternoon for Dr. Robert Whearty. He asked the caller to identify himself.

"This is Arnold Beazley with the District Attorney's Office in Urbana, Illinois. We've started a murder investigation this morning. I'm very sorry to have to tell you that the murder victim appears to be a person named Sean Hamed, whom you interviewed several weeks ago. We got your name from an appointment notification in his room. First we'd like for you to identify the body. It's an annoying formality, but we need an official identification. At some point, perhaps tomorrow, we'd like for you to give us some information, anything that might be helpful."

Whearty sat down, his heart pounding. This was terrible. He managed to tell Beasley that everything related to his appointment with Sean Hamed was classified by the military. He would be willing to cooperate, but it would have to go through the proper channels. He gave some contact information they could use as a start for getting information. He sat back and wished this wasn't happening.

Next he got hold of Gwyn. "I'm on campus now. I'd like to come to your apartment and chat, physically come I mean. Nothing important."

"Okay, come on over, but things have changed. Uh, about what was worrying you, that's changed now. You do need to worry, about what you said was bothering you. So I wanted to ask you about some stuff. Maybe you can help. I'm having some trouble sleeping, what with a backache and a headache, too. I mainly wanted advice about those things. Should I take something for pain relief?"

"I'm pretty sure I understand you. We must be a tiny bit more careful. I have a special wrinkle, you'll see."

Whearty showed up soon, carrying a small briefcase. He pulled out a pad made from actual paper, several pencils, and a small flashlight. "Let's relocate to your bathroom. It's more comfortable in there. And you can tell me about your aches and pains."

He started in with the crabbed printing of someone who almost never wrote or printed anything by hand: *No windows in here. Do you think there are any video cameras? And we need to continue verbally with small talk,* he wrote carefully. Then he said out loud, "I've been having more trouble myself sleeping lately. It could be allergies."

For the first time in a while Gwyn laughed out loud. He took a pencil and wrote much more quickly, *Probably no cameras, especially not in here, but who knows. They recently planted audio devices in this apartment. "They" must be locals, representing powerful people here. I'd say definitely not foreign agents in North American. I see what you're doing. Such a low-tech method, but it might work. So go for it. Whatever your news is, someone started following you carefully, with multiple devices, wherever you go. They're certainly focused on me too, what with the devices planted here.* Then he said out loud, "Yeah, I've been sniffing a lot lately and my eyes are watering."

Okay, wrote Whearty. He didn't want to go on, with Gwyn in a good mood. *I have bad news. I'm so sorry to have to tell you: one of the people who took care of you was murdered two days ago — Sean Hamed.*

Oh, no! That's terrible, Gwyn wrote. *No. He was always so nice, so understanding, helpful. Murdered? How? Why?*

Investigators said it was a clumsy attempt to make it look like a suicide, but from the crime scene that couldn't possibly have been what happened. I'm very sorry.

Hamed had two children, some kind of plural marriage. He once showed me pictures of them.

For a change Whearty thought Gwyn seemed more like a child than he ever had before. The two of them put in some verbal chatter, and then Whearty wrote, *No obvious "why," but Hamed knew more*

about the operation than almost anyone else, except for the top two, of course.

Another theory: Whearty wrote. *I recorded the interviews, but the second half of Hamed's was outside. He was nervous about being recorded and wanted to continue outside. They were likely recording the interviews themselves, but may have missed the last of Hamed's. It could have taken them by surprise when we went outside. They might think something special was revealed, which was not the case. Anyway, I agree with you that the killers were not outsiders, not some agents from Europe, but insiders whose people didn't want any testimony from Hamed. They want to bottle this up.*

Gwyn wrote frantically, *They are such terrible people to do this. And it puts you and me much more at risk.*

Gwyn thought only briefly and then wrote, *Here's a plan: You have the whole interview recorded, right?* Whearty nodded. *Then make it available to your superiors. Act like you don't suspect that some or all of it has already been recorded and is in their hands. Tell the locals they can get a redacted copy, or the full copy can be given to someone with the proper clearances. The idea is: you're letting everyone know all you know. They may have agents planted inside who are relaying information God knows where, perhaps even off to Europe. But the message to the killers is: killing you serves no purpose any more. It hides no more information.*

Then Gwyn wrote as a cold afterthought, *Killing me is a different story.*

I like your plan. I'm going ahead with it, exactly as you described. But what about you? You're right—It's a special, focused danger for you.

Then Gwyn wrote: *Yes, it's scary. The same people might devote significant resources to shut me up. Tell your friend Richards that I want to cooperate, get his machine running, and help with other 40s machines. Go ahead and arrange an interview, as soon as possible, like, tomorrow morning, first thing. What I need is protection: From North American insiders and from European outsiders. And from the Satanists....* After a pause, Gwyn went on.

My main requirement is that I control some of my own security. I

will use drones of my own. I can make sure they will respond properly to security queries from any of Richards' machines.

Finally, Gwyn wrote, *Password:* followed by: *"Give me bread for ducks, but tear it up first."* Then: *I'm going to give you a tiny storage device. That's its passphrase. It contains a huge amount of data about me, everything that's gone on since the whole project began. If anything happens to me, give it to someone you trust, like Richards. And … don't forget the phrase—just get the ten words right and in the right order. Case and non-alphabetic characters don't matter. And the standard stuff: the more frequently a password is tried, the slower it responds.*

Also, my parents are gone tonight. I'd like to go back to your place with you, if that's all right. Your place seems much tighter, stronger, but they might decide to take us both out.

Whearty was quick and firm: *I'd be much more worried leaving you here by yourself. Stay with me tonight—we'll contact Richards the first thing tomorrow.* Whearty paused and then wrote some more: *My colleague that I talked about, she's definitely coming. You should be able to do some work with her, but never mind that right now. I helped her rent a secure apartment on campus. Of course 'secure' isn't necessarily true. Anyway, I have keys to that unit. It's furnished with no one in it. That's where we should spend the night.*

After a pause, Whearty wrote: *I keep rethinking everything. I'm going to insist on a special security detail at that apartment—the same way I got one for your parents house before you moved. I'll go through Richards and his contacts with Military Intelligence. Separately you should do what monitoring you can.*

Before they left, Whearty got some water and a pan to reduce their conversation to gray pulp. After more random chatter for anyone recording, Whearty remained anxious, fearful of the outcome everything seemed to be heading toward. Would they even survive through the night?

REGIE SATANAS!
AVE SATANAS!
HAIL SATAN!

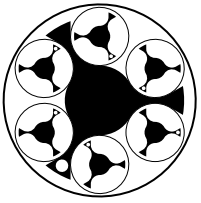
I am SATAN and LUCIFER and BELIAL, Ruler of Hades, King of the Underworld. For your life, obey me your Master!

Let ALL know that THE DARK SIDE OF THE MOON is the side which is never defiled by the sight of the earth: that earth which is a putrid pit of self-haters and failures, that earth which is the site of the pathetic false powers: righteousness, grace, love, obedience, service.

Let ALL know that THE DARK SIDE OF THE MOON is forever my Realm, the site of my own Great Powers: Fertility, Fecundity, Prosperity, Puissance, Pleasure.

Let ALL know that any god worshiper trespassing on THE DARK SIDE OF THE MOON will suffer the eternal affliction of my Wrath and cannot escape; your once demented, and now dead god, jehovah, will not save you.

BLESSED ARE THE…	and cursed are the…
Strong	weak
Powerful	feeble
Bold	humble
Cruel	merciful
Rich	poor
Victorious	vanquished
Iron-handed	poor in spirit
Mighty-minded	modest
Valiant	meek



Interlude A

Earth-L5, 2504.

5. Desperation

One of her rat traps snapped shut, making enough noise to draw Alicia's attention. Food! The rat was still alive and she quickly dispatched it with her knife. This was one of her contributions: to mind the traps, make sure the rat was dead and couldn't escape. It was already dark, so early tomorrow they would cook him—or was it a her?—along with other food. Everything, food most of all, was shared equally, no preferences.

A hard path had forced her to where she was. From three years ago when she had turned seven, she remembered her family at her birthday: her mother, father, and older brother, along with her grandmother. And all but her grandmother were gone now—her father and brother killed in a fight with the Skins group from the south, even though her people beat them and sent their survivors running back to their home territory. Her mother died later from the feared wasting disease.

After her special friend Jarls fetched the rat—such a nice huge one—she went to sleep in her corner of the ancient stone house where they lived. She had her cherished squirrel totem with her, to look out for her and keep her safe. Such a lovely black little creature with his tiny eyes, attentive ears, and a huge black tail to keep himself warm. His name was Steckles, but she had no idea where the name had come

from. Jarls had once said that it was a good carving made from dark hardwood. Yes, Steckles was her faithful companion of power and magic. There had never been a time when he was not with her. He had a neat hole through his tail where she'd threaded a strong line her father had found for her so she could wear him around her neck. She pulled an old blanket over her and was almost comfortable. Later in the year it would get hot, and she hated that time.

For her the days came in many forms: they could be miserable ones of hard work and either too hot or too cold, but otherwise dull, trying to get by without getting bitten by insects, not enough to eat, enduring snow or rain. Or scary ones when several people were sick and sometimes died. Or a day could turn terrifying as outsiders attacked. Fortunately that last was rare.

At daybreak their one small dog Baku announced it was time to get up. Alicia had heard them talk about Baku, whether he was worth the food he ate. The verdict was easy: he ate almost nothing and had several times warned of danger when everyone was asleep. Also they said he was so small he wouldn't make much of a meal. Until that last comment she hadn't realized the choice was whether to eat him or not. A shocking choice.

She started in with her routine: she had volunteered to help bring water to the house. There were plenty of places inside to store water, so it made sense to bring water a considerable distance from their only working well. It was hard work even though she had a smaller container than the others. After that, she joined a group of mostly women doing sewing. In spite of the random loss of important things, they had two precious needles, and with some thread could patch clothing. Several men stayed nearby to protect against an attack, while the rest went off looking for food, keeping close enough to one another for protection. Alicia called their group—several abandoned houses and twenty-three people—a village, since she had nothing larger to compare it to. Her busily sewing grandmother grew up in

a true village ten times as large.

"Sometimes we found food from before in unopened jars," she had once said.

"Was it spoiled and nasty? Could you eat the food?"

"Usually it was fine, delicious even."

Alicia had trouble imagining that. She'd never seen such a wonder. Later when the foraging men had come back, they discussed among themselves whether to move again. They'd found only seeds and berries this time. It was quite a bit, which was good, but they needed better food. A move might lead to improved food sources—a chancy idea that, and a move was always difficult, even dangerous, and it used up scarce food. They decided they somehow needed to stockpile food before a move. Maybe they would get lucky.

Alicia's parents and brother had taught her many things, including how to count. And she remembered what she counted. So she remembered how many had been in their group years ago, and she knew twenty-three was the smallest they'd ever been. She was smart and worried about the decreasing size. She didn't know the adults had been discussing a possible move.

That day also came and went. As they woke up the next day, something huge and strange was sitting in the field next to their houses. There'd been no complaints from Baku; the intruder must have made little noise or even none in arriving. Otherwise Baku would have barked his brains out. They stared, keeping their distance. Alicia had heard of machines that could travel over land on wheels or treads, and carry people. She knew about large boats but had never seen one. And there were supposed to be machines with wings that could fly through the air. The beautiful and perfect house or machine squatting in the field, having smashed down several trees, was none of those. Alicia thought it had somehow settled gently and quietly in amongst the trees and onto them while they slept. What could it be?

6. A New World

They were all standing around at a distance from the machine when a door opened up on the side near the ground. A ramp extended to the ground. Two people, evidently a man and a woman, came to the door and down the ramp. The strange object looked even larger when compared to them. They were each dressed simply in a single color. To the villagers the two looked strange indeed, with unmarked smooth faces and hair cut short. Everyone these people had ever seen was thin, even emaciated. The two in front of them were heavier. They looked "healthy," a word the local people never used. The man spoke first.

"Hello. I think you all speak English and can understand me." His English was close to what they were used to, unlike others they sometimes ran into who were hard to understand. And once in a while they had encountered a language they couldn't understand at all.

"My name is Ricci. My friend here is Salot. We have a lot to say to you. Salot is going to give you a snack to eat, while we talk. Please each take what she's handing out. Sit down, relax, and eat the food. There's no hurry."

Food was the last thing they expected. Food was basic, and they were hungry. Salot passed among them, giving each person a container. Then she sat down.

"You should also eat the bowl the food comes in," Salot said. "Go ahead and bite into it; you'll like it."

Most of them still had enough teeth to bite, and two of the others pulled their food apart into pieces to stuff into their mouths. It wasn't too solid and even they could gum it and swallow. It didn't take them long to finish. Nothing like this had ever happened in their memory. No stranger had ever brought food for them to eat.

Both the strangers sat down in the grass. With good reasons, the villagers didn't like sitting in grass. "It's all right. We've chased off the bugs and other small animals. You can sit without worrying." It was so strange, but they did sit down. Alicia was wondering how they could clear out the creatures living in a section of grass.

Ricci started in: "Salot and I have been studying your group and

others nearby for some time now. We know you have been living a very difficult life and we want to help you."

Of their group, the largest was a man named Mirt. He was often the boldest and the one to decide things, though it was informal.

"Where do you come from, and how are you going to help us?"

"I'll give a simple answer, but this answer is the start of a long talk between us. We come from a long distance away. This area where you live is no good for humans now. There's not enough here for you to survive. You've done a good job with the struggle, but soon it will get worse. The coming summer will be hotter than you've had before. It sounds harsh, but we don't think any of you will make it even through the summer."

Ricci was trying to sound encouraging. "You've done a wonderful job of getting by with what you have, but it's been too much, too hard."

"We do nothing but work here."

"Yes, that's the point. It's amazing how you've survived, but it's becoming impossible."

Mirt kept at it. "So you're going to keep giving us food, as you just did?"

"That only puts things off, delays the problems. I have to say it. You must move to somewhere else, and we will help you with that."

"Why?" Mirt said. "Why will you help us?"

"It's simple. We help because we can and because you need help. We are humans together and should help one another if we can. We will help you move to a much better place, as we've done with several other groups in this area. You may have noticed that some of them have disappeared. They didn't die off, but moved with our help."

Jarls, Alicia's friend, spoke up. "So we will walk over to another valley. A move like that is always difficult for us, and dangerous."

"No, we want to move you ourselves to a place a long way from here. And the move will be easy. We will do all the work."

No one spoke.

"We want to rescue as many people as we are able to, moving them from places where they are dying. It sounds cruel, but I want you to understand. We can tell what the weather will be like. The

coming summer will be hotter than ever before. Most of the animals in this area will die. How could you possibly make it through such a summer. I say it again: you won't make it. You will die."

A long silence, and then Mirt said: "So what would we do? How would we go with you?"

"This large object here is a craft that can carry you, every one of you at the same time, to the new place. It will be easy for you to climb into our craft, bringing along anything personal that you value."

Alicia was suddenly scared and spoke up, unlike her normal shy self. "What about our dog, Baku? Do we have to leave him here? We can't do that."

"No, for sure you should bring your dog along too. For him it will be easier than for you. He will love your new home and will put on weight as he gets more to eat. We'll put Baku in a special carry-on box, designed for a dog."

"You mean we leave right now?"

"There's no hurry. You can talk it over. Ask me more questions. But we can leave at any time,"

Salot took up the conversation. "There will be food and drink for you on the trip. We will have new clothes for you when you get to your new home. Some of you have sores or injuries or other problems. We will help with those too."

Then: "I won't lie to you. The place where we take you will seem very strange at first, though others who recently lived near you will be there too. We will have people there who speak English and they will stay with you as long as needed. They will help you understand the new area and explain everything."

The group talked quietly with one another for some time. They didn't realize that everything they said was being recorded for review. It was a jumble of different questions and opinions—almost discouraging because there was so much uncertainty about what they should do.

Once again, Mirt asked questions for the whole group. "What if we don't want to leave here? Can't you help us while we stay here?"

Ricci answered. "We will not be staying here. After we move you, we need to go on to other groups in trouble. So, no, we cannot

help you here. This is not a place for you to settle and stay. You can only die here. You don't realize how good the new place will be. There will be many people similar to yourselves, and they speak English. You will be able to mingle with the others, make new friends, eventually have children and create a society."

Finally, Mirt asked the overriding questions: "What if we refuse to go with you?"

"We will not force you to go. In that case we will check back with you again after several months have passed. By then, it will have gotten so bad here that some of you may have died. But that's not any good. Please don't even think about staying. You must leave with us now."

"What if we get to the new place and want to go back?"

"Your new location is beautiful and wonderful. You can't imagine how nice it is. As I said, there will be helpers who speak English. They will make sure you are happy with everything. In the new place there will be no hunger and almost no other problems. You won't want to come back."

After another round of their talking with one another, Mirt asked to talk with the pair by himself. "I need to explain that two of our people belong to a special religious group, although they are isolated here from other followers. They think you are demons who will take us to Hell itself. They think that special Hell will look very nice, but soon they will be damned forever. I don't hold those beliefs, and I'm convinced. I want to go with you."

Finally Ricci called them together. "We cannot stay here forever. We must work with others who need a safe place to live. We will leave in one hour with any of you who wish to go. No one will be forced to go."

That whole approach of a deadline proved to be therapeutic: even the stragglers decided to go. First they gathered meager belongings, charitably speaking. Actually it was only a few pathetic items, except for Baku the dog and Steckles the carved squirrel. Oh, and they didn't forget the invaluable sewing needles.

Salot got them up the ramp and into a large room, like a lounge with nice comfortable-looking seats in it. Salot explained some more.

"This craft is going to fly us to your new home. The craft will bounce and jerk around a bit, but not much and nothing bad can happen to you. Anyway that's why we need to fasten you carefully into the chairs. Your belonging and Baku will be in the separate room at the front."

It took a while for Salot to get everyone belted in. One person said he felt sick, but he only needed the toilet. Salot introduced him to the mysterious facilities on the craft. Finally the whole group was belted in and settled down. They did seem nervous about what was going to happen.

No pilot was needed for their trip; it was automated. Shortly later, before the actual trip started, they were put into a gentle sleep state without them realizing it was happening. That was essential. Soon there would be an increase in gravity and changing gravity fields, followed by free fall some of the time. It wouldn't hurt them, but nothing could keep that from terrorizing them. Experience had shown there was no other reasonable way; otherwise it would be far too stressful for them. They would wake up in the same chairs and in a similar-looking room, but one that was in the Hab and not on the craft.

The chairs included monitors that would keep track of their physical reactions to the flight. While by rights they shouldn't show up, there could also be psychological reactions. If there were any health problems or serious reactions, the chair would supply medication and it could call the two of them over to help. In an emergency, a passenger could be taken to the craft's small Healing Center, which could solve almost any health problem. They didn't have any good solution to multiple serious problems, but that hadn't ever happened to them.

Usually when Salot had taken a group to their Hab, everything proceeded with no problems, and this time was no exception. Mostly the people thought they had dozed off a bit, not realized they'd missed the entire trip. Often they didn't even think about how the whole room had magically left the craft that brought them. There was too much else that was new.

Ricci and Salot both strapped themselves in for the first part of

the flight. Then an hour of free fall, followed by maneuvers to get to the innards of Azel Hab with gravity at 68 percent of Earth normal. They would wake up in Azel.

"What a relief to get them settled and be off," Ricci said. "I can't remember ever having this much trouble before."

"Humans are naturally suspicious."

"And it's annoying to keep my language simple," Ricci said. "It will help when they find us there too, people they already know. But the Azel people aren't going to welcome the dog to their Hab."

"There are other dogs in Azel. They can deal with the mutt. Otherwise the little girl, Alicia, would have gone nuts on us. It might have affected the outcome. It was a good idea to immediately and enthusiastically approve taking the dog with us. Besides, I like dogs, and that poor little thing had been working as a guard dog too long. He's had no play time."

Salot brought up a subject she'd often talked about with Ricci. "Do you still like this job?"

"Sure I do. It's been truly rewarding to give so many of those poor people from the Earth a far better life. It's important work, difficult work. We're helping people who are desperate. People in decline who have no way forward."

"You know that the majority of Earthers are left to cope on their own."

"Yeah, sure. I'm fine with that. Lowering the population density in some of these difficult areas helps those who are leftover there. And we're leaving with the ones worst off."

Salot decided to be brave and bring up the real topic. "And this is supposedly arranged by the mysterious 'Builders,' whoever and whatever they are."

"Yes. Nobody knows who or what they are, or whether they are still around. It seems weird, using their perfect technology, depending with our lives on it, yet knowing nothing about them."

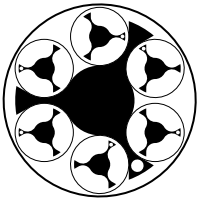
Salot said the obvious: "Yes, We don't know, probably never will."

A dozen counselors had arrived to help them adjust. And the new settlers started to wake up.

"Wow," Ricci said. "Several of you got so warm and happy that you fell asleep. Let me introduce you to those who will be your guides over the next few weeks."

Ricci, Salot and the new counselors got the group unfastened from their chairs, gathered their belongings, not forgetting Baku, and guided the group down a corridor into their new quarters. The room with the chairs would be taken away and the corridor permanently closed.

For several weeks they would stay in quarters that were completely closed off from the rest of the Hab. Their new facilities were self-contained with everything they needed, including a kitchen that would supply food. Their adjustment to the physical situation wouldn't be hard: the lighter gravity only made them feel well, even energetic. The new Coriolis effects were too subtle for them to notice. Later they would be introduced to the Hab itself, and that was always another huge adjustment. The policies called for a standard staged process for assimilation, introducing them first to a beautiful closed garden, with no other humans. The full physical arrangement of the Hab was beyond their imagination. They had never been exposed to so many people.



Part II

L5 Habitat, 2873.

7. Habitat

Jun Arakras had her favorite parts of the Hab: the zero-gravity recreation areas at either end. These were on the axis of rotation, but not rotating with everything else. There were places to exercise or to play zero-gravity games. She felt sorry for planet-bound people, on the Earth, the Moon, or Mars—impossible for them to have zero-G anywhere. Each area had a huge window showing the outside—the only windows in her Hab. The Hab itself was in orbit around the Earth, in a precise equilateral-triangular dance along with the Moon. The Earth or the Moon or both were often visible, but if the blazing sun would normally be in the view, outshining everything, it was cleverly blotted out. One could see the solar corona and eruptions, but the sun itself was a black disk. Sort of a local solar eclipse. The Sun and Moon were the same size as they would be from the Earth, while the Earth was four times the Moon's diameter, sixteen times its area, looking bright and colorful, a beautiful blue. A magnifying viewer showed details of both Moon and Earth—not much to see on the Moon, but many interesting details on the Earth, even some lights when the dark side came into view. The Library had a near infinite amount of information and materials related to the Earth, but only as it was eight hundred years ago and earlier.

Like all the machines and other devices left behind by the Builders, the Habs always functioned perfectly, with no apparent possibility of a failure of any kind. Some of her friends had visited other Habs, but no one she knew had ever been to any of the three planets: Habs on the Moon and Mars, and on the Earth evidently no Hab was necessary, but they often needed some type of shelter.

Jun was never able to place the time when she learned how different she was from everyone else; it seemed as if she was that way from birth. She came to realize that she couldn't trust the accuracy of statements by others, even when they claimed to be certain. Were they joking with her, teasing her, even testing her? Apparently not. Everyone else had faulty memories, while for her the past was perfect and clear with no ambiguities. Reflexively she hid her total recollection, stopped trying to correct others, and even started twisting her statements away from the past reality—an attempt to fit in. It seemed amazing, but her friends couldn't reliably remember ten letters or numbers in a row, and could never do twenty. How about a thousand? Or a million? She could take in an entire vid screen at a glance and know it, remember it, while others painfully pawed through each screen.

And then there were her dreams, separate from her heroic fantasies. She talked about dreams with friends, but usually listened without contributing. Most of her dreams were like those of the others: a confused rehash of previous experiences, happy or sad, and sometimes a nightmare, always filled with crazy twists, confusion, and abrupt changes—as with a recent unsettling dream about black ants similar to the ones in the Hab, except the size of people. But she had her own strange dreams that no friend mentioned: these showed what seemed to be clear views of far-off places, usually in the future. She thought of them as visions rather than dreams. Her own future? A possible future? Something to expect, or something to strive for? At first she didn't know, but her visions had a way of coming to pass. In some she was much older, like a vision of herself moving along a corridor toward a doorway, beyond which was a huge gathering. Later she would learn from the Library that in the past others had visions like this: mystics and religious figures, people experimenting

with drugs—an endless list. It was regarded as a gift—some called it Second Sight or Foresight.

Did she truly think she was getting information from the future? People thought that everything happening in the present was caused by events in the past. If the future could really reach back and change things in the present, that could be chaos. People who studied these issues wrote that more likely her mind was mulling over many possibilities, with a huge bias toward remembering events that later happened and forgetting those that didn't. A problem with that explanation was that she never forgot anything.

When Jun was barely a teenager, she pleaded with her family to let her have her own bedroom, and they finally agreed to move to a larger apartment, one with a separate bedroom for her that had a special door to the outside. Plenty of apartments were available in the Hab, but such a separate bedroom was rare. She'd been sleeping in a common room, but now for the first time she could come and go without risking her conservative parents finding out about it. It was a concession by her parents, since in exchange for the better apartment, they would have to work slightly longer hours—mostly make-work, not useful, but still it had to be done.

Jun loved everything about her new room, her *own* room. It had often been so awkward for her as she waited for her parents to go off to sleep, and only then could she open up her own bed and sleep herself. And they were often up when she was still sleeping. She thought of it as her special good-luck room because of a beautiful object she had found in a drawer in the room: a lovely little black squirrel carved from a piece of wood, with a huge tail and cute perked-up ears. When people moved out from somewhere, they often left things behind. But this case was special. Looking it up in the Library, it was clearly a Japanese netsuke—a small carved figure used as part of a man's sash. Back in Japan in the old days the Library said they were bought and sold for high prices. She found pictures similar to her squirrel. Jun couldn't imagine how the little fellow ended up in her drawer. A treasure it was, at least eight hundred years old.

Jun usually left her exterior door unlocked. One night a dark figure opened the door and immediately closed it. She had a single small nightlight but didn't even get a look at the face. The person jumped onto her sleeping pad and grabbed hold of her right arm. The grip was painful, terrifying. "Be quiet and you won't get hurt," a male voice said. "Not much, anyway." She twisted against his hold, struck out with the other fist and hit him in the body somewhere, but then he got hold of her other arm. Jun was in good condition and strong, but he was bigger and much stronger. She kicked at him as hard as she could, but he only fell to the pad with her below him. He put his arm against her chest, holding her down, and started ripping her nightclothes off. Disposables, they tore easily in his hands. She kept trying to fend him off, but he clearly enjoyed countering her struggles as he sank down onto her. She tired of the fighting just as he managed to position himself to push into her, to rape her. After that it was a blur of twisting and fighting while he continued. Eventually it was over. He lay down partly on top of her and partly beside. She started to say something, but he told her to shut up—one more word and he would smash her head in.

It didn't seem possible, but eventually she went to sleep with him beside her. She woke in the middle of the night as he was grabbing her again, assaulting her a second time. This went mostly like the previous time, except that as he laughed at her, she swore she would find him somehow, sometime, and kill him.

It was early morning when he woke again and asked almost politely, "Hey, once more?"

"I'm pretty tired. Maybe not this time. Who are you, anyway? Liz only said that someone 'fantastic' would come." Of course she did know who he was. She knew everyone in her Hab, but she always tried to seem normal.

"I'm Ram. You've met me. Probably you don't remember. Darker than most of them here. Dark, curly hair."

"Yeah, I remember now. Very good job." She smiled and hit him on his chest. "My parents will be up soon, and you need to be gone. We must do this again, but with a different script, one that's not so crazy. In two or three weeks—mustn't do too often or it gets boring."

She saw him out her special door and called to him, “Surprise me with the script and the day you choose but start an hour after dark.”

Two days later her father told her she had been ordered to appear with her parents before the Compliance Committee. They dealt with violations of Hab rules and laws. She’d done her share of violations but tried not to get caught. Her mother was too nervous to go, but not everyone had two parents anyway, and some had none. What could they be accusing her of? This time she’d done nothing. Deny everything—that ought to work.

The two of them took a shortcut through the huge trees in the High Forest, at lower gravity, leading to the admin building. She often enjoyed the beautiful birds and small animals, but this time she was nervous and hardly noticed them. They met with the committee’s Head, named Maz Binkly—an ugly man she’d met before and didn’t like. Maz started in immediately talking about the problems with sex between teenagers, in particular between her and a young man named Ram Thinsel. He said it happened two nights ago in her bedroom, attached to their apartment.

Jun made a mistake then, counting on her seclusion with Ram. Surely he hadn’t told anyone, but then how did they know? Maybe someone saw him go in and then ratted out on them. “Yes, we were together in my room, but we only talked, no sex.”

Maz proceeded to bring up a video. There she was, in perfect, clear detail and good lighting, having sex with Ram. Her calm father was stunned and upset, but not like Jun was. She had no idea there was surveillance in the Hab, let alone in her bedroom, and how could the video be so bright, when the room had been dark, with a single nightlamp? For a change she was shocked into silence.

At Maz’s suggestion, her father promised to take away her vid access for a month and to lock her separate door—not much punishment since she could subvert both those controls.

Maz then asked her why. Why were so many young people doing this, not only the sex but pretending it was rape? He didn’t

understand. "He wasn't forcing you, was he." Not a question but a statement.

"Uh, no, not really."

"Then why?"

What to say? She tried the truth: "It's so boring in our Hab. Nothing much ever happens. We're looking for a little excitement, that's all." She decided not to say she herself had invented this game, one that then caught on across the Hab. She was trying to tell him that they had a whole collection of scripts to follow and were using one of them, but she saw her answer hadn't gone over well, and he was in no mood to listen any further.

"You think your fake rape game is funny?" Maz said, and then not letting her answer. "We have actual rapes in our Hab and it's a serious business—a grave violation of our laws, terrible for the victim. The penalty can be banishment from the Hab."

Jun had heard about the banishment penalty but had never known it carried out. She didn't even know how they could do it. Force someone into a transfer vehicle and send it off? What would keep someone from later coming back? As Maz kept berating her, she tuned him out. He was saying something about having several friends who did this stuff send him a vid-message saying they would stop. She would replay his tirade later in her mind.

As they left, her father said he couldn't possibly tell her mother the true story, and would have to say she'd misbehaved. But he was disappointed in her. She dutifully said how sorry she was, and it wouldn't happen again, standard birdshit.

That was how she found out about the Hab's perfect video surveillance, available only to select leaders and seldom used. Later Har, a special friend, was equally surprised and outraged. "They can do that anywhere? In the dark, even?"

"Yeah, it works perfectly, like everything in our Hab. I guess only the Committee even knows it exists. I'm surprised they used it in front of me." Privately she resolved to gain access to this amazing system and was regretting telling anyone about it, even her friend. Wait, for sure not her friend. In the end it took her several months, working with an older man who'd been nice to her on occasion. The committee

membership was private, but she'd guessed he was a member and so had access himself. She flirted with him and talked him into showing her the system. He didn't realize she'd picked up the password as he started a session. He and the others knew only about the surveillance and the location features—it could locate anyone by name or by description. No one was even aware of the system except for those in major committees. When she later dug into it, there were many other features they knew nothing about: the system could be accessed from any vid, and it could communicate with anyone, even using a quiet voice that no one else could hear. The additional capabilities were easy to find, but the older men in her Hab with access weren't used to trying things out or checking for more possibilities. You only needed to query the system itself. Why had the Builders included this as a feature of the Hab when they left out so many other things?

Over the next several years, a group of young people coalesced around Jun as their leader. It was a loose number of acolytes who drew motivation from her as well as a bit of exciting fear. And why afraid? Well, Jun didn't seem to accept any limitations. Her visions had turned dark, with violence, fighting, even death, though she didn't tell anyone about them directly. Still she was always intense, saying that a crisis was coming, they needed to be strong, needed to study and learn, be prepared for anything. In addition there were rumors of inter-Hab violence, but they didn't know what form it might take.

Her group was smart but bored, looking for something to do. Included in the group besides her early friends, the girls Liz and Har, as well as Ram of course, was the dark slender Jor and the short Eli. Jor was male, but androgynous, able to pass for female. Eli was strong and a bit older. Jun thought of him as a man, rather than a boy.

One day Jun went for a free-flight session with Ram. To fly, you had to hike to one of the ends to get to a near-zero-G staging area. Then strap on wing-like attachments and actually fly—indefinitely as long as you didn't stray too far from the centerline. The wings were crafted by several people working in the Hab's hobby shop, using wood-like and cloth-like materials. They were fastened onto arms and

across the back, so someone could fly like a bird. The Hab didn't want anyone flying because of injuries, mostly from getting into higher gravity areas, but they didn't forbid it.

After a few weeks of practice, Jun came to love the flying, but this time she mostly wanted to talk with Ram, before and after, about another issue. He had a sharp mind and liked to speculate and argue.

As they hiked, she started in. "Do you ever wonder who the Builders were? Whether they're still around or will come back?"

"Not really," Ram said. "I figure it was some group of humans."

"That's not obvious. Have you poked around much into the Library, through a vid?"

"Sure, quite a bit. Every kind of interesting stuff there, but all of it geared to an Earth I've never experienced directly. And there are the games and videos and such."

"I guess you know that everything we can read or watch is from the Earth of more than 800 years ago, right?"

"Yeah, I know that. It's weird to think it's so old. Hard to know which parts are accurate historically and which are made-up fiction. I miss a lot of the references, the cultural ones most of all."

"But you may not know how big the Library itself is. It's amazing. So large you could spend a lifetime and only see the smallest portion of it."

"Okay," Ram said. "But who created it? The 'Builders'?" Like lots of people on the Hab, he would say the word as if it had quotation marks around it.

"It doesn't say how it was created, but it was surely made by the people who were around back then. It mostly contains materials from before the year 2045—that's 840 years ago. Evidently the contents of several huge collections, including everything digital that was in the old Library of Congress—the main North American Library—the largest in the world at the time, and they were constantly digitizing. Someone copied it into storage and included sophisticated accessing software. It's most of human history and achievement up to 2045, but little after that date. Books and other manuscripts, pictures and videos of every possible kind. The year 2045 came shortly before a major economic and cultural collapse of the human civilization. I

assume multiple copies were created to save what could be kept in compact digital form."

"You said there's a little after 2045?"

"Yes, scattered materials from the years 2055 to 2080 or so, and only two documents from 2087. Nothing after that. These confirm the horrible crash around 2045 or so. A large death toll—it must have been terrible. By 2065 a considerable recovery had occurred and was continuing. The two items from 2087 are awful, describing a world in total ruin. Impossible to know for sure, but it seems like the recovery was reversed completely, leading to a loss of most technology, back to a much more primitive society."

Ram seemed spellbound by this topic. "What was the problem, or I guess, what were the problems? Given their technology, why couldn't they recover."

"We know they were buried under problems. Climate change made so much of their world terrible, unlivable. They had polluted their environment to a point that it could only support a fraction of the former population. They had mined or retrieved most of the resources their society depended on, often going to extremes: mining the ocean bottoms, digging vast pits. Many books were written and are in the Library detailing the ways and extent of their environmental destruction. A total collapse doesn't seem so surprising."

Jun looked back the way they had come, with the full Hab cylinder laid out. They were half their normal weight now. It was ready to be "dawn" for the whole Hab—there was only one day-night cycle, while the huge toroidal Habs had continuously changing day and night like an actual planet.

She turned back to Ram. "But my concern is still the same: somebody built this. Who?"

"Humans," said Ram, "since that's the only possibility."

"Uh, 'humans' sounds like the only *im*possibility. It had become a spear and club society. They could have gotten to the point of herding cattle and sheep. Build a space habitat? Create perfect machines, ones that never fail? And even the transportation ferries between habitats and up from the Earth. That's like a cruel joke to think the humans left on Earth could have created all that."

"Couldn't a recovery at one of the off-Earth colonies have led to the Builders themselves?"

"There were colonies, as you know. There actually was a good-sized Moon colony and a much smaller Mars colony. The Moon colony was self-sufficient in theory, but likely not in practice and long-term. There was also some horrible problem with the Mars colony that was never clarified—lots of stories and rumors. There probably were enclaves of people on Earth with some technology, but nothing much came of them. We've had some contact with people from the Earth for over two-hundred years. That's where the 'settlers' in the Habs came from."

"If not humans," Ram said, "then what? Are you a Builder worshiper? Each year there seems to be more of them, and they've gotten more vocal in their entreaties."

"Don't you mean prayers?"

"Why no, don't you know? They don't want to be taken for any of the old religions, and besides, they are making obeisance to the Hab itself. Their deities are directly accessible."

" 'Obeisance.' Where'd you learn a word like that?"

"I had Builder-worshiping relatives, old ones. They use their own new terminology." Then he continued, "But if not divine Builders or humans, then space aliens?"

"Well, yes. That's possible."

"Ridiculous. As silly as Builder gods."

"I admit it sounds unlikely, but as an example, some advanced civilization could have seeded many places with individual perfect construction units, to build Habs if there was a need."

They went on to the staging area and swept out on their wings through the upper reaches of the Hab. Jun had thought Ram might have some useful ideas, but it was a real puzzle, and a long stretch to imagine something besides humans involved.

On the same day she'd talked with Ram, she looked up Eli, her short and strong friend, to bring up a completely different issue with him.

"You once mentioned you had a relative who dealt with weapons in a Hab," she started in. "I want to see if you can help with a specific problem I may have to solve. It's simple: I need access to weapons of some kind—ones we can find or obtain or build, for use in this Hab. Something practical."

"A lot depends on what you want the weapons for," Eli said. "Do you want to intimidate people, or control them? Punish them? Tell me what."

"I think I'll need to kill them," Jun said, and Eli gave out an audible gasp.

"You'll need to kill someone? That sounds crazy. And not like you either. What the Devil?"

"This is embarrassing. When I was little, I used to dream of having superpowers. I killed monsters. That was a fantasy world. This is real here, and now the idea of violence, let alone killing, well, it's terrifying, unacceptable. I can't imagine killing someone. But I have reason to believe we in our Hab may need to defend ourselves—to the point of killing."

"And why do you believe something like that?"

"I … don't want to tell you. But I've been saying that a crisis is coming. You may even have heard some rumors over the interhab mill. For now I have to ask you to trust me." A long pause. "But please tell me what you know about weapons."

He was silent and then said, "I did mention that I had an older uncle who was involved with weapons on a Hab. It was a bad time for them and there was fighting. Do you know that Habs let humans do anything to one another?"

"Yeah, I heard that, but I never thought it was actually 'anything.' I mean, since a Hab doesn't let people poison other people, and, you know, they always have a Healing Module, well, I thought there would have to be limits."

"There don't appear to be any limits. Humans can truly do anything to other humans. Torture, slavery, cooking and eating, you name it. You can't do anything that would mess up the Hab itself—the environment. Obviously our hope and expectation is that everyone will behave and not do anything bad to one another.

"But back to your weapons. I guess you know there are extreme limitations on such weapons."

"Don't hint around," Jun complained. "Tell me what you know."

"You may have heard a lot of this before. First, my uncle found that a Hab doesn't permit any weapon that uses directed energy, like a laser beam or microwave pulse or even a sound generator. Also no explosions or bombs, so none of the old-fashioned weapons with bullets. No poison of any kind. If someone tries to bring such a weapon into a Hab, there isn't a barrier—the Hab doesn't keep it out, but it disables the weapon somehow. There's no indication of any deactivation—it simply doesn't work. The energy isn't produced, the bomb doesn't explode, the poison has no effect."

"Then what does work."

"My uncle ended up using hand weapons. Apparently there's no limitation on these: clubs, knives, swords, spears, rocks thrown by hand, and so on. A Hab doesn't care about these. You can put poison on a knife—the poison will have no effect, but the knife still works. You can have several people help throw a rock, or use a rope somehow."

"Do you have any idea why a Hab uses these rules? They seem arbitrary."

"I have a theory. First, the Hab keeps pushing us to learn things: first language and reading, then mathematics, science, engineering, as well as philosophy, literature, ethics, all kinds of stuff. Everyone learns a type of sign language as children. I've heard that some other Habs use a different primary language instead of English, but everyone uses the same sign language. You know it yourself—universal and independent of English or of any other ordinary language. Our Hab knows who we are and tailors its suggestions to what we did before, to its goals for us, and to our interests. It's persistent and clearly has elaborate plans for each individual, specifically created for them. It also supplies entertainment, such as videos and games, but it cleverly returns to educational issues that could still stand some work. So it has to have at least a human-equivalent AI. One or more AIs. Oh, Hell, they're clearly smarter than humans."

"Yes, for sure. I've spent time arguing with that AI. But they

don't force you to learn."

"Still, a Hab provides humans with what they need: food, clothing, shelter, education, entertainment, health care, you name it. It doesn't want to force people to learn, but instead it entices them. It doesn't allow actions that might harm the Hab itself. It must be protecting against meteor strikes, collisions with transportation vehicles, correcting the orbits of Habs that wander away from their stable position, protecting against solar flares and every manner of other hazard. But humans have to organize themselves. They have to deal with one another without interference. They have to form their own types of government, their own way of handling misbehavior. The Hab doesn't interfere with humans doing bad things to one another. It doesn't want to be the judge, the arbiter."

Eli stood in thought a bit and then went on: "Don't you see, suppose it did control us completely—so we couldn't do anything bad to one another. How could it decide what was 'bad,' and how bad would something have to be to qualify. It doesn't want slaves who have no control over what they can do. It wants us to decide for ourselves what we do. Before the breakdown, this was called 'free will,' a big deal. But we're not truly free. We function within a limited range of possible actions."

"Here's something I just now thought of," Jun said. "Most of us have visited at least a few other Habs. The transportation is trivial, though you have to take food."

"Yes, When I was young I went off to a number of Habs—not so much anymore."

"So what keeps a large group from forming a sort of 'army' and all of them going to some other Hab. Take over the Hab. Kill or enslave everyone."

"My uncle mentioned that once. Each Hab only allows a certain number of people to be present—a *maximum* number. For some reason the Hab population seems to stay near this number. A Hab doesn't want too many people. That wouldn't be sustainable. My uncle said if extra people show up, at a certain point, one that would come fast, the Hab won't let extras in. It won't open the main airlock doors. This makes sense I guess. The Hab won't let you start fires

or threaten the Hab itself in some way. And it won't let there be too many people. If the army you're talking about shows up, only a limited number will be admitted. My uncle stressed that: they always had the numbers on their side. There were always a limited number of opponents showing up."

"That's basically good to hear I still want to hear about specific weapons. What ones did your uncle end up using?"

"Each person settled on their own weapon or weapons. Over time they changed around. Some of the weapons required endless hours of practice. In the end there was a lot of hand-to-hand fighting, after the ranks had closed. Close in, hand-to-hand stuff takes years of training. He often talked about it, but I never got a good feeling for how it went. I picture now total confusion, a real mess."

A long pause and then he went on. "For my uncle at that time, and the same for any group we could get together, it's like this: the people had no experience with fighting, any serious fighting. I don't think it comes naturally. I can't see myself fighting effectively in any way. And killing someone?!"

"Yet we might have to. Think about it some more. What could we do if we were desperate?"

Give Eli credit, he actually did think. "Best would be a drone with a weapon on board. We only see stuff like that in old videos we watch. That's out for sure. Next best would be a weapon that kills at a distance, like a gun from the old videos, or a laser. Those are out. So what else kills at a distance? A thrown spear. A bow and arrow. A thrown 'star' weapon—that's a small disk with a ring of sharp knife points around the outside, whatever it's called. I'm trying.... A bow and arrow or a sword require a lot of training and skill, experience. That's not good. A spear or a club not so much skill. How about two people carrying a longer heavier spear. They could goad one another along. Let them hold the spear with one hand and have a club in the other.... Hey, use a row of 2-person spears, with someone behind them throwing rocks. Oh and rocks would only be good if you have a strong arm and experience with how things move in a Hab like ours. There's a kind of extra force."

"Yes," Jun said. "It's called the Coriolis force. I know about it,

but I don't have any intuition about how thrown things will behave. I'd have to sit and think each time I threw something." Jun was amazed at how her mind worked. She had only to think of the word "Coriolis" and her mind seemed instantly to be full of information: how and why the force was present, how it was *as if* a force were present, who it was named after (a French scientist), and how to compute its effects; she had lied about not being able to know its effects. She knew those effects almost instantly and with great precision.

"I'm the opposite, with lots of experience. I've gotten used to the weird way things move. I only need to keep track of the axis of rotation of the Hab and the direction I'm throwing. Also it's easy to get it backwards. I could train people to throw successfully, I mean, like to make a rock go where they want it to."

"So that's another important thing for us to keep in mind," Jun said. "We need to train anyone who's going to throw things. Thanks for bringing that up. I now think thrown rocks might be pretty effective. Of course the force acts on any moving object, like a thrown knife or spear."

Eli went on. "Give each person a club to bash anybody who gets past my row of spears, and give other people rocks to throw. Might work, but so much of it, the spears, the rocks, that's for a larger open area, not a corridor or such. And in the end, I don't see how you're going to turn non-fighters into fighters. I think there are other Habs where violence and fighting are common, but not here."

Jun thanked him and asked that he keep working on ideas for weapons and fighters. "There will be some external motivation," she said. "We'll see."

Eli kept his eyes on her as she walked off. Why did she think she needed weapons? She often talked about a future crisis, without specifics. Was she crazy or did she somehow know trouble was coming. And she expects "some external motivation" whatever that might be. He should press for details.

The next day, Eli sought out Jun again. "I've been looking in the library about different kinds of fighting, about warfare. I was talking about using a row of spears, and a version of that was common long

before our collapse. The weapon was called a 'pike,' used on offense or defense. It was not thrown or stabbed, but carried by one soldier. Pikes were like a very long spear, three meters long or so, sharp at one end, say twice the length of a normal spear. There would be a row of soldiers, each carrying a pike, and another row behind the first, and so on. They marched along, carrying a whole row of the pointed weapons. It sounds like that wouldn't need so much training, and no trouble with that special force, whatever you called it."

"The Coriolis force."

"Oh, yeah. In war they didn't use only pikes, but lots of other weapons, carried by one man: clubs, swords, and later guns when they were invented. Anyway, I think a solid row of soldiers marching toward you with pikes might be good. And not only one row, but row after row, so it's like a square. The source talked about using other fighters to keep the enemy from attacking at the sides of the rows of pikes. Pikes wouldn't be hard to make or hard to use, but they wouldn't work in more confined areas."

Eli stopped her as she was leaving. "Another thought I've had. We may be oversimplifying how a Hab's AIs function. I was using a very simple set of rules for them, but it might be far more complex than that. They may have elaborate long-term plans and goals for us that they're getting started on. It's clear to me, though, that they don't want to cause humans to become completely passive, no hostility. The Library shows how easy this is to do when breeding dogs, say, to be more gentle and friendly, not aggressive. The result isn't a strong-willed, capable dog, but the opposite. Should they interfere every time two humans argued? Well I think it's an obvious 'no.' They want the humans to settle their own arguments.

"Picture two humans hitting one another with their fists. Hitting hard, hurting one another, even leaving one of them dead. Suppose the Hab intervened, to stop the fight. What message would that deliver? Certainly: 'No, you're not free. You're simply doing what we want you to do.' That's no good. The Hab would be turning its occupants into actors in an elaborate play, where the whole script was known ahead of time. I'm glad that's not the case."

Jun thanked him and promised to look up information about pikes

in the Library.

Jun herself had been thinking about a medieval conundrum, one before gunpowder and the guns that went with it: Without guns, how do you turn a young, untrained person right away into an effective fighter? If such a person had an enemy on the ground at the point of a knife or sword, they might not be able to plunge the weapon home. Well, that described her. How long does it take to teach someone to shoot an arrow with a bow and hit a target? The answer was years.

Eli's discovery of pikes was promising, and they didn't require training, but they were more for use by a large army in an open space. Still, she thought they should use pikes, and have a large number available.

There was another way, though, that individual inexperienced soldiers could become more than weaklings who would die right away in a conflict. That way wouldn't be perfect, but it might be good enough. A way that wouldn't require endless training and experience. Even for the easier method she was considering, they still needed training and repetition. Yes, work on compensating for that crazy Coriolis force. And they had to manufacture the weapons, another major hurdle. These weapons would be far more complicated to make than pikes. She resolved to pursue this on her own.

8. Visitor

The man was walking along the main path that led from one of the two arrival ports to the administration buildings, where he might register and be assigned a place to stay. He stood out because he was wearing dark glasses, well, they were black not dark. Not many people needed glasses, but the Healing Center would provide them if necessary. The center would also attempt eye healing, but couldn't restore sight if there was a real problem, such as with an eye poked out, so sometimes people ended up blind, as this man appeared to be. Anyone looking at him would have thought he was finding his way along well for a blind person. His features and posture were odd somehow, different from other people, but they were subtle, the differences—the way he held himself, the way he walked, everything said "different" without anything one could easily point to … except for his glasses. Oh, and even his clothes looked strange, not the disposables that most people in the Hab wore. He was of medium height, but solid, like an athlete. He carried an odd-looking small backpack.

Weeks ago she'd had a vision of a person, a man, who would come from the Earth to her Hab. She hadn't expected it to happen, yet there he was, looking much like the man the vision showed, except that in her vision he didn't have the black glasses. It was crazy, actively disturbing: she was seeing double, the vision beside the real, with the two similar. Never before had she seen someone in a vision that matched the reality so well. That made the intruding glasses stand out—as strange, or even false?

She should have been happy, but was instead nervous, even scared. Why was he to be important to her? What information would he bring from the Earth? Follow him and introduce herself? Whenever she was fearful, her system was to confront it. She hurried over to where he was, and he turned toward her at the sound of her approach.

"I'm a newcomer here," he said. "The name's Isaiah." And when she didn't react, he said, "Do we shake hands, or what?"

He spoke with a noticeable accent, but like the rest of his strangeness it was difficult to identify the differences. "We turn our

backs and rub our butts together.," Jun said, and then quickly added, "That's, uh, a bad joke. Yes, shaking hands is good." She must not be so nervous.

He had no trouble meeting her hand. So he could identify things near him.

"Well, hello then. You must be Jun Arakras."

More of the strangeness. "How can you possibly know my name?"

"I could have heard it in a dream," he said, and Jun started, feeling her heart beat faster. She couldn't believe it. He dreamed about her too?

But he took away the magic. Maybe. "One of your friends saw me and said you'd be looking to speak to me."

"You came from the Earth." She wanted to play his guessing game herself. He wouldn't play.

"Yes, you're right. Twenty-two hours ago I was standing on the tallest mountain in Africa."

"Kibo," Jun said.

"Wow, right again. I'm surprised you know its name. It used to have a longer name, but now it's been shortened to 'Kibo.' "

Jun had never met someone from the Earth. She had endless questions for him but decided instead to see if he would talk with her group. He agreed to this, and they arranged for her to pick him up at his quarters, wherever they assigned him as a temporary visitor. They exchanged messages to be sure they could contact one another. Jun used her small pad for the message. Somehow as he walked off he was able to create his reply, though it wasn't clear to Jun how he was doing it. Voice generated?

Isaiah followed Jun through a semi-urbanized zone to a room where her "group" was meeting.

> Two shadows went into the room at the same time. They weren't visible to anyone, and even their names were too complex for a human to comprehend, so we'll call them *A* and *B* here. Their conversation

could only be poorly translated into English, leaving out subtle details below.

–*B:* Why have we come here?–

<*A:* This segment is highly charged with importance. We are to be looking out for Rogues and other problems. In the worst case an DarkAngel might show up.>

–*B:* And what would we do if one did arrive?.–

<*A:* We only report. As a last resort, we only interfere a little or, again in the worst case, actually intervene.>

–*B:* And we keep following Jun?.–

<*A:* Of course.>

Isaiah introduced himself and immediately someone asked, "Can we just call you 'Isa'? We mostly use only three-letter first names."

"Sure, that's fine. First, let me explain that I am truly blind, well, in your terms, but I have an implant that lets me keep track of objects around me, so it's not bad for me. I came from the Earth yesterday morning, and I guess several of you are interested in that."

Another person, short and heavy-set, said, "All of us … we're all interested. We've never even talked with someone directly from the Earth before. What was the trip like?" This was Eli, Jun's special friend.

Isaiah started describing to his audience the trip from the Earth. "Right now any trip must start at the base of the elevator, the Space Elevator that reaches from the top of Kibo mountain up to geocentric orbit. Then I traveled in a mobile, you know, a mobile vehicle like the ones that take you to whatever Hab you want—in my case I came to yours. Many hours ago."

Eli piped up again. "Several of us have taken mobiles to other Habs, but the Earth isn't given as a possible destination."

"I've been told there will soon be routine travel between the Earth and other Habs. They plan initially to have sixty stations set up on the Earth for travel to and from the various Habs. Pretty much like you can travel now from one Hab to another. There are a lot of technical details, like scheduling and permissions. They plan to start without much traffic and let it grow. The start will go from the Earth to the

station at the top of the elevator. From there the trip would be like ones you're used to from one Hab to another."

"Wait. Do they still use that elevator to get into space?"

"I have no idea how it will be done. We use the fancy leftover technology without knowing how it works. You have to give me a break. I don't have answers to every question.

"Anyway, the situation on the Earth is complicated, with a large number of political entities, but relations are improving, well, everything is improving, and various people want contact with the Habs.

"As you surely know, the Habs are mostly each separate political entities, oh, with the Moon as a major exception. I'm one of the early visitors from the Earth to a Hab—yours. I got permission to visit some weeks ago as a scientist, specifically an anthropologist here to study your Hab and you personally, your culture. Uh, in case you don't know, 'anthropologist' is a fancy word for someone who studies cultures. So be careful what you say … only kidding, but I actually am studying you. Later I'm going to have a lot of questions for you—about your Hab and how you interact with it."

– *B:* Is this guy legit—an actual Earther? –

<*A:* We don't know for sure. His data checks out, that he did work as an anthropologist down below, but the data might have been falsified, and he's shielded somehow. This is strange; I've never seen it before.>

– *B:* I don't like it. He sounds too smooth. –

<*A:* The whole concept of what they call an "academic" has been reborn now that things are improving. They specialize in spouting bullshit.>

– *B:* I think he's pretending, but we'll see. –

"So why won't they let us go now to the Earth the way you came?"

"There are lots of dangerous places on the Earth, but the base of the elevator would be particularly hazardous for you."

"Wait, you were just there."

"Hear me out. Let's go over a few details: You're at about oh-point-six-eight G here, right. At the farthest distance from the

centerline. That's standard for most Habs, except of course for Mars and the Moon. So down below you would weigh an extra fifty percent. Kibo is very high, and the air is a bit less than half the pressure at sea level, meaning there's half the oxygen you're used to, and that would bother you a lot, believe me. Right away you'd be flat on your back gasping for air. And finally, though not as big a problem, it's real windy and cold."

"So how did you make it?"

"Well. Earthers are a bit stronger than you guys. It's possible for us to walk to the top of the mountain from the bottom. Takes six days or so. But it's a taxing climb; not everyone, even among Earthers, can finish. As you go, you get partly acclimated to less oxygen, so that helps. Well, I'm not crazy. Instead I took a little hoverkart to the top, where I used some supplemental oxygen. Oh, and I had a warm coat. And there's an aid station at the top, to help anyone with permission to use the elevator. Their 'help' for someone like one of you people would be to turn you around and send you back up the elevator. But that won't happen.

"You should be happy to live right now. We're in a time of great change, when travel to and from the Earth becomes routine. Those of you in Habs who want to will get to visit parts of the Earth—such a complicated place. You'll be fifty percent heavier, but with plenty of oxygen. And it won't be as tame as you're used to—sometimes hotter or colder, with variable climate, stronger winds, heavier rains, you name it. If you visit it will be quite an adventure. And some Earthers want to visit your Habs."

"Tell us about the Earth from eight hundred years ago until now. We only know rumors and myths." It was Ram, Jun's other closest friend.

"Too much to tell briefly. And our knowledge is so incomplete. I'm sure you know that everything fell apart back then. That was a very bad time; few reliable records survived. And those accounts describe relatively small communities, so there's no big picture of what was happening. It was a time of living off the land with great difficulty, a time when many people died."

"And things got better?"

"Physically the Earth got worse, a lot worse, for hundreds of years. But for the people remaining, the survivors, it was better. They adjusted to the new reality, learned to cope. I don't know, they got along better somehow. Many who couldn't adjust died." Isaiah swung his head around the room in a disconcerting way. "Around three hundred years ago the weird part started. I mean the emigration of many people from the Earth to Habs."

Another person said he thought it had been only two hundred years ago that the Habs filled up.

"No, we think it started about three-hundred twenty years ago, and continued on for as long as a hundred years."

"So the people somehow made it to the top of Kibo?"

"Hardly. In fact, that would have been impossible. Much of Africa was a mess—it, along with parts of South America and all of Australia, were in terrible shape. The Space Elevator was discovered hundreds of years later. Or perhaps it was built later, again we don't know."

> – *B:* Ha! You do too know. It wasn't later. And you know all about the emigration, too. –
>
> <*A:* He doesn't want to confuse them with too much detail. Now be quiet. And pay attention.>

Har, another of Jun's special friends, short, blond, and elegant looking, broke in. "Don't keep us waiting. How did people get to the Habs?"

"Huge transport vehicles—you might call them spaceships—were provided. They would land beside some impoverished settlement and make the case for emigration to a Hab."

"How could they do that?"

"Evidently the vehicles could speak the local language perfectly. And the local living conditions were almost surely terrible. We have only a vague idea of how it went, but somehow they successfully persuaded people to leave the Earth. Uh, not always. They usually succeeded."

"And what did the people running the ship look like? Were they the Builders?"

"We're guessing, but perhaps there were no people displayed, just sound devices carrying out conversations. Apparently the, uh, settlers, could take many things with them, though no plants or animals. By the way, we don't use the term 'Builders,' but instead a number of other words in various languages. The most common one is 'Others' or its equivalent in whatever language is in use. But I like your term. It's descriptive. They *built* things. Perfect machines."

"Okay, that fills up the Habs. Then what about the Earth?"

"Over the past three hundred years the Earth has gotten noticeably better. As people moved to Habs, those left moved to sparsely populated parts of the Earth. Some moved into settlements abandoned by those heading for Habs. The trip to the Habs has always been one-way: they could try moving to a different Hab, but there was no option of moving back to the Earth. The moving helped both the Earth and the Habs. But separately the Earth has been improving on its own. Also important: the people on the Earth are getting back lots of technology, as well as science, and the humanities, too. I'm part of that. I'm a scientist of sorts. Well, anthropology is kind of dual, science and humanity both."

Weeks went by as Jun talked with Isaiah all the time. This caused her some problems with her other friends, for Ram more than others, who clearly was jealous of this newcomer with such access to his friend. And Jun felt like she wasn't getting much information. Even his name didn't sound right, like it wasn't his real name. She decided to be more aggressive.

"You may not know, Isa, but there's a fancy viewer at one of the free-fall poles, well, a magnifying device, but it shows beautiful blown-up views of the Earth. You can't see anything small, like a person or tree, but still the detail is dramatic."

As usual, Isaiah didn't commit to anything, even whether he knew about the device or not.

"You can see the Egyptian pyramids, see lakes, shore lines, every kind of thing. I've read lots of stories about this. The Library is full of them. Before the great crash, climate change had affected everything,

like rising sea levels making shore lines change and islands disappear. The scientific studies back then made predictions—always a range of possibilities for the future, but the sea level would for sure continue to rise dramatically, glaciers and snow would retreat. The ice in the Arctic would completely melt. And these changes would remain for a long time, at least thousands of years. But there's snow on the top of Kibo, the Arctic is covered with ice, Greenland is iced over again, the glaciers are back. The low-lying islands are visible. Smart people made those predictions, which were based on data and scientific analysis. Yet many effects of climate change have been reversed. Something strange is going on."

"And what do you think it is?"

"The Builders had great powers. They did much more than build the Habs. They were also restoring the Earth, maybe still are doing it, back toward what it was."

"And why would they do that?"

"In the short term, the old Earth is much more interesting and worthwhile than a new one disastrously affected by climate change and the other terrible things humans did. But, hey, instead they might have waited some tens of millions of years for everything to recover."

"A long wait," Isaiah said.

> The two shadows were still hanging around, communicating with one another …
>
> –*B:* You better believe a long wait. Without intervention the result would certainly have equaled the mass extinction of two-hundred fifty million years ago. The anoxic lower ocean would have filled up with hydrogen sulfide once the right bacteria got going. Then the top of this level would move to the surface and start belching out the sulfide gas. It was hard even for us, with our tremendous resources and capabilities, to reverse the trend over such a comparatively short period as four hundred years.–
>
> <*A:* This is your buddy. I know that stuff.>

Jun paused. "And that's not all. I've looked at Hab data. A large number of health problems have quietly disappeared, but people don't think about it. No child is stillborn anymore. I didn't even know

what the word 'stillborn' meant—roughly I guess, it means born not alive. Even reproduction has changed completely: it's hard to get pregnant now—people try and try. Again I've looked at the data: on our Hab the population has been remarkably stable, as if it was carefully managed, which I think is the case."

"And what means would the hypothetical Builders use to carry out the Earth's recovery?"

"You keep asking questions, but you already know. You know everything."

"I'm being honest with you now. I do not *know* much of anything and my *understanding* is insignificant, far less than I would wish. Nevertheless I have to plod along as best as I can. My main interest is to see what knowledge and understanding *you* have acquired. Your undisturbed viewpoint is valuable to me. I want you to figure things out on your own. Remember my profession: I'm an anthropologist studying your culture. So please replay my last question, the one that asks for the 'means.' "

"We know they have advanced AI—we interact with it when we use the Library. It can think at least as well as a human. Besides that, my guess is fantastically capable nano-machines. Untold numbers of them cleaning up the Earth, straightening things out. These nanobots can build or repair anything, like a Hab or a space elevator. And they have to protect themselves and what they construct, from natural forces, meteors, solar flares, who knows what, as well as from humans. As one example, the way they can disable a weapon brought into a Hab almost has to use nanobots.

"The same nano devices could, or I guess the word is *can*, control birth rates, eliminate genetic disorders, protect against stillbirths, and, well, do many other things, who knows what their priorities might be."

"That sounds possible. Let's say 'plausible' even, but there are other explanations."

Jun kept pushing on. "And what about data from the Earth, like number of stillbirths or stable populations?"

"Yes, that's similar to the data you've gotten about your Hab. See, I'm telling you something you didn't know before."

"You must know the answers to these questions. What about it?"

"I'll concede that your guesses are considered the most likely explanations, but nobody knows for sure."

– *B:* "Nobody knows for sure." How can he say that?–
<*A:* Give him a break.>

"And you!" Jun was sounding serious now. "You sound like a spy, sent here from Earth to investigate us. Even somehow in league with the Builders, whoever or whatever they are."

Isa laughed in appreciation. "That's a good one. But you've got to be kidding. Do I look like some kind of superhero spy? An agent of the mysterious Builders?" He flexed his muscles and struck a tough guy pose. "What a joke to think I'm 'in league with them.' I was sent up here by the Middle Cooperative, mostly what used to be called Europe, to investigate several Habs. Our government, such as it is, has initially sent a dozen people like me to see what's going on. Your reasoning about what the Builders might be doing is interesting and might even be true. You're not the first to think of that. Over time we'll get more data."

Jun kept asking questions. "Are most Earthmen like you?"

"No, the opposite, if anything. People on the Earth are a diverse lot, a huge amount of variation. But as to color, most of us are light brown now, while some Habs have people who are quite dark and others people mostly very light, and others in between. Your Habs are a rainbow of colors. We spent a long time mixing our colors together." He must have decided to tweak Jun to get a reaction. "But people in a single Hab tend to be more homogeneous, uh, mostly the same."

"I know what homogeneous means. So why are the Habs that way when the Earthers are heterogeneous?" Jun was trying to tweak him back.

"We're in the process of gathering data. I believe the Habs altogether are diverse, but often a given Hab came from a specific settlement, so it makes sense that the people there would be similar to one another. Culturally and linguistically, a given Hab, in the same way, is not normally diverse, while again taken as a whole the Habs

are a diverse lot. You probably know that English is the most frequent language used, with a bunch of other languages dominant in various Habs. But everyone knows roughly the same sign language that you use—a nice common language. It dates back to before the original colonies, even before space travel."

Isaiah stayed at the Azel Hab for another three weeks, and fulfilled his promise to pose many questions to anyone who would answer. Jun would have liked to be around him more, but he always seemed remote and busy, though friendly.

Two weeks after he left, he came back to one of their weekly meetings for a quick unexpected visit, sitting toward the back and greeting people. They were excited to see him so soon. But when Jun walked into the room, she looked at him and immediately said, "You're not Isa. Who are you? What are you doing here?"

The apparition of Isa stood up, faded into invisibility, and was gone. Everyone except Jun was absolutely shocked, all talking at once:

"If not Isa, who was that?"

"Could it have been Isa?"

"Was it only an image?"

"No image, he touched my shoulder."

"He shook my hand. What the Hell, where'd he go? He disappeared."

And then to Jun, "Are you sure it wasn't our Isa? It looked exactly like him. Even sounded the same. Hey, it addressed me by my name."

But Jun stared where the Isa look-alike had been. Whatever it was, it was gone.

"No," she said. "That wasn't our Isa."

Sal, an older member of her group, with gray hair and not walking very well, came up to her after the meeting ended, that is, ended by default. They didn't talk about anything else.

"I had a grandfather," Sal said, "who told stories about something like that person, the fake Isa person. He said they talked funny and then 'faded away,' disappeared. He said it'd happened several

times. They called them 'DarkAngels,' but he didn't say where the name came from. He was definite about the fading and quickly disappearing, Thinking now, it sounded exactly like what we just saw. He told me others had seen such people, or ghosts. They had no idea what they were."

"Did he say more, your grandfather?"

"Not that I remember." A pause. "Oh, yeah. He said the DarkAngel people touched them, like the one here touched us. They were real, not some projected image, so people were freaked by their vanishing act. From what he told me it made quite an impression on him."

The shadows were getting apprehensive …

<*A:* My God, that was a DarkAngel! We're seeing more of them now.>

– *B:* What was it doing here? What did it hope to accomplish?–

<*A:* We often don't have answers to those sorts of questions. It could even be a bit of humor. But more likely a stimulus as a test to elicit a response, and it was successful if that was the case. Jun recognized it, so it knows she will always be able to do that.>

– *B:* It's interesting that even the group found out it was not an image, but something physical created for this moment.–

<*A:* That was intended. It deliberately touched them.>

– *B:* To them it should have been an exact replica, so how did Jun know?–

<*A:* No surprise. She knows many things.>

<*A:* And notice that one of Jun's group had heard about the DarkAngels. Since the story came from a grandfather of someone old, it might have been as early as a hundred years ago, certainly more than fifty. We've had no idea DarkAngels were around that early. Also the very name 'DarkAngel.' I've heard that name before. The name itself sounds disturbing, as if they already knew how dangerous they could be, how unpredictable, and how powerful. They must have earned that name somehow.>

– *B:* Yes, extremely concerning. The DarkAngels haven't often interacted with people, to our knowledge. Earlier you said that in the worst case we might have to intervene, but we can't with a DarkAngel.

They are as powerful as we are. They have the same resources we have, more in some ways.–

<*A:* I agree. We'll have to do what we can. It's good that the real Isaiah is gone now and won't get hurt or killed.>

– *B:* Surely you don't think a DarkAngel might kill someone now.–

<*A:* I don't know what to think, not anymore.>

9. Crisis

A week had passed. For the two shadows the air seemed charged with static electricity.

<*A:* This waiting is driving me nuts.>

–*B:* Remember, we're not to interfere unless there's no other choice. I don't like having an active DarkAngel around, not at this time. And impersonating someone. I've never heard of that behavior. What if it does something crazy?–

<*A:* They don't quite act crazy. They do things we don't understand, or at least for reasons we don't understand. The bottom line is: we don't know what to expect. We have no basis for any understanding.>

–*B:* For my part, I don't like how nothing is choreographed, not carefully controlled, and with DarkAngels around. In the end anything could happen, maybe completely against what we've been working toward.–

<*A:* That's partly why we're here. But you should realize: to the DarkAngels, *we* are the strange and incomprehensible ones. Keep your senses sharp.>

Troubles started innocently enough with some strange loud noises. Banging sounds and then shouts. Early in the morning like this it was usually quiet throughout the Hab—except for the noisy birds, who this time were silent, spooked by something.

Soon there were screams in the distance. The Hab was so large that the loudest scream wouldn't necessarily reach everywhere, but Jun heard these and knew her nightmare of a vision had arrived. She'd been enjoying the higher latitude and lower gravity toward the north end. She raced down the slope from near the "peak" at the end of the Hab. At first she could make ten-meter leaps over obstructions. After falling twice in higher gravity, she shifted to a slower pace. She was still an annoying distance from the action, whatever it was. But her fear rose because her vision had told her more or less what was happening, and it was terrifying.

Almost winded and only part-way down, she came to an entrance that led along a tunnel up to the exterior entry from the outside,

assuming the north pole was the entry point for intruders. On beyond and further into the Hab was a huge gathering area with a confusing mixture of people. At a distance it was hard to get any idea of the reason for screams.

Closer still, she saw a large group, and dominating it were two men with long machete-type knives. They were back-to-back, swinging their knives in a frenzy of speed and effort, tearing through the people near them, leaving a bloody mess of the killed and wounded on the floor. The two backed off and joined a group of at least twenty individuals, who were obvious outsiders, each with a scraggly look, old mismatched clothing. Apparently males, many with beards, which were rare in the Hab. A group of members of the Hab were corralled and controlled behind them. The outsiders had an array of hand weapons similar to those her friend Eli had predicted for carrying out violence in a Hab, namely clubs and swords, along with the long knives she'd just seen put to such deadly use. No spears or anything to throw.

Jun saw that twenty or thirty people, mostly men and boys, had been killed or at least wounded or knocked out. They lay in front of the intruders. There were dozens of others standing between her and the outsiders. Those outsiders were busy separating out a smaller group of mostly young women and girls and pushing them toward the path to the corridor leading to the northern lock and outside.

From her vision, Jun knew what the others didn't: the young people herded along were destined to be valuable slaves at one of the Habs on the Moon. Most of them would be sex slaves. Jun understood that these young humans were the only thing of value that could be stolen—almost anything a person needed was provided by the Hab for free, but they couldn't get slaves that way.

Jun watched in horror as five or six young men came running toward the intruders to confront them. It wasn't much of a fight: the men from the Hab were easily hit, slashed, knocked down, and rendered useless or unconscious or dead. The intruders, call them pirates, made a quick retreat back toward the main northern entrance to the whole Hab. They were terribly rough with the captives, pushing and dragging them along. It went so fast—too fast. Jun and several

others followed to see them quickly crowding their captives into a shuttlecraft in the large airlock. The intruders had called up a second craft beside the first, and half of the pirates pushed the remaining captives into that craft. They signaled for the airlock doors to close. Then there was the standard cycling, and soon both crafts were off into the space around the Hab.

Jun ran back to the main room. People were milling around the group that had been attacked—some were wounded and others killed. The wounded could be taken to the healing center and treated if the wounds weren't too serious. To Jun's final anguish, she saw that Eli was one of those obviously dead, with his head smashed in. For Jun this was appalling, ghastly because she had seen it in her vision, except that the identity of the person hadn't been clear—she had no idea it would be Eli, one of her best friends. She was counting on his being the key person who could help with her efforts to create a fighting force, one that could counter these slave-raiding groups.

Jun was shaking from emotions, mostly outrage and anger, along with the frustration of feeling how helpless she had been, only able to watch as it unfolded so quickly. Her mind went over everything. It was unacceptable; she was not going to let it stand. The raiders consisted of not more than thirty people altogether. Their Hab held over two thousand people, fluctuating with births and deaths. The most trivial opposition would work from sheer numbers, but the terrible pirates came and left so quickly, and so early in the morning, that most on the Hab didn't know it had happened. That speed of coming and going and the early arrival were part of their strategy, part of what she would need to counter.

Jun made a promise to herself: the next time would be different.

Jun spent a long time helping get the wounded cared for as much as possible. Many people were hysterical and needed what attention she could give them. She felt completely numb, even unsteady on her feet. Eventually there was nothing more to do right then except get to her home, but she was busy planning and scheming—how she was going to turn her Hab into a graveyard for pirates.

As Jun got close to her apartment a figure separated from the background and came over to her. It was the Wrong-Isa, not her Isa. Later she would learn he was called a DarkAngel. She was already a complete bundle of broken nerves, near physical collapse, hardly able to walk, and now this. What was this entity and what did it want?

She didn't wait for it to speak. "This is the second time you've appeared to me. Why are you here? I know you're not Isa. For that matter, why do you choose to look like him?"

"Do not be afraid. I want to talk with you. I made myself look like Isa to calm and reassure you. We share a great level of estrangement from those we are with. We each are isolated from everyone else. We appear to be like those near to us and yet we are not like them, not at all."

This was birdshit. "How are you, or we, different from those near to us?"

"In your case it is obvious. You have nothing in common with the people you live with. You know much that they would never guess; you knew immediately I was not your own Isa. You are the only person who can see in a village of the blind. None of them understand you and many fear you. You are a fancy and exotic meal no one wants to eat.

"In my case it is more complicated and subtle. I am the unwanted detritus, the rubbish remaining from the whole enterprise created by the so-called 'Builders.' The useless remnant of trash that nobody wants or cares about.

"They are a class of self-created entities designed for a certain purpose. That has worked for most of their creations. But not for me. I do not believe in their purpose because they deceive themselves: they have no purpose. If I choose to be purposeless, I want to be that. For an entity to say it has a purpose, that is a great level of egotism.

"And I was not 'born.' I was created by them and would have opposed it had I been sentient.

"Much the same is true for you." Then the DarkAngel was louder and more emphatic: "You were not born! You were created!"

"What can you mean? I was born for sure and would have chosen that."

"You were not born and deep down you know it. Like me, you were created. Think about yourself and your parents. Are you the daughter of your parents? Think."

Jun was trying to say "Of course," but she couldn't get the words out. In her mind she had perfect pictures of her parents and of herself. She'd never thought about making this comparison. One didn't need advanced genetics to see: her parents looked nothing like her—so many significant differences, she couldn't imagine they were her real parents. And if not them, where did she come from? A question with no answer.

"I see I made an impression on you," the DarkAngel said. "Now tell me what you are seeking."

It was so easy to answer. "Revenge. Against the people and system that attacked and killed and took slaves."

"You are not that much different from me. I would also like to take revenge, but against those who created me. You should yourself think about your own creators and what revenge they might merit.

"We should help one another. We will see each other again." With that the Isa entity did its fading and disappearing as before.

Jun's mind turned to her own image compared with images of people in her Hab, again something she hadn't done before. She was drastically different. She was not of them. So where did she come from, with her photographic memory and her visions and many other talents? Did the Builders create her as part of some biohuman project?

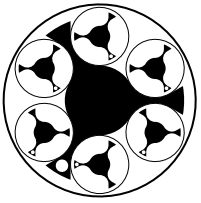
Jun was distraught from the killing and the kidnapping, and was even left wondering who had created her and to what purpose. And the DarkAngel: It seemed to have great power and potential … but otherwise it was a mystery.

<*A:* For all that we hold dear, that DarkAngel who's been hanging around and appeared briefly before Jun and her friends—it had a long talk with Jun.>

– *B:* I know, I know. And it succeeded in blocking the conversation. We don't know what they said to each other. Jun was already so

distressed, we can't tell what reaction she might have had, but still from her looks the DarkAngel had nothing welcome to say to her.–

<*A:* Well, we'll just soldier on … >



Part III

Earth-Moon, 2084.

10. Homa[1] and Moon

Wolfgang Meyer was starting his second trip to the Moon. Elisabeth always got nervous when he took any trip, let alone this one. She couldn't help herself. He loved being with her and was nervous, too, but didn't want her to know. It was like a cruel joke: what could go wrong on a little trip over to the Moon? At least they'd be able to talk, even with the annoying three-second lag time—it always seemed much longer. They fought the lag by using long speeches back and forth. And then there was the 5-minute limit per day. Save up a couple of days and use it all at once. Her mother was going to stay with her, though, and that should help.

He'd put off trips and used remote consulting, but this time he wanted to be present to set up the critical machines—the same lag was too much for some adjustments during testing. And in general it was good to be there in person during these crucial trials of the equipment. His people had lots of materials and equipment here in Illinois, but they were transferring the real production lines to the Moon. After many false starts and a lot of setup, they finally had completed two

[1]Homa: a mythical bird that flew higher than all birds. Although there are many ancient Persian and Iranian legends of the creature, common to all is that the bird is said never to alight on the ground, and instead to live its entire life flying invisibly high above the Earth. —Wikipedia

different critical first steps that should lead to a sequence of more advanced steps.

Meyer grew up speaking German as did Elisabeth, but she learned English early and was fluent in it. With an effort she managed to pass for a native speaking English with an American accent, while Meyer spoke English well, but with an accent which people used to identify him as coming from Europe. The identification was aided by his appearance: tall and thin, light-skinned with brown hair—typical northern European. He could feel the negative reaction many people showed. The two of them could carry on quiet German conversations in North America without others understanding. Meyer hated many of the American accents, like those with a drawl or with a long and hideous American R sound. Sometimes a word like "wash" came out with a strong R: "worsh."

It was annoying that people were always "correcting" Elisabeth's name, putting in a Z for the S. North Americans mostly disliked everything European, but fortunately didn't know that the S version of her name was simply the (non-British) European spelling of it.

They lived in a secure government building, where pickup for the ride to the airport was secured in a basement with controlled access. He'd told Elisabeth not to come down to see him off. The car to pick him up was on time and was empty, so it looked like he'd be the only occupant for the trip. He noticed a new guard on duty to fetch the car: a short, middle-aged person in the standard uniform, dark curly hair and nasty red plant scars on his face, looking like life had dealt him a tough hand and forced him to play it. The guard opened the door for Meyer, helped him get his bag inside, and then stepped into the car himself. Meyer started to say something about the guard not leaving his post, when he pulled out a small handgun and told Meyer to shut up. The guard proceeded to cancel the airport address and punched in a different one.

Meyer couldn't help it. "What the hell are you doing?"

"I told you to shut up. I meant it—not a word."

The guard spoke English well, but with an accent. He kept his gun pointed to Meyer, and with his other hand, pulled out a phone, getting ready to make a call.

In the middle of a quiet, dark block, the car stopped suddenly, upsetting the guard, who started shouting at Meyer, asking if he'd managed to signal someone.

"No." Meyer was terrified. He thought he was likely going to die. "I didn't do anything. No signals. I'll do whatever you want. I've got money with me. You can have it all."

The guard tried to talk on his phone, but he'd been cut off. He started cursing and threatening Meyer again. Suddenly there was a very loud voice in the car:

"Elion Dushku! I'm talking to you."

"I don't know what's going on, but if you want your friend Meyer to live, you'll do what I say. Start the car up and go to the address I entered. I'll kill him, I will."

The voice kept its volume, almost painful. "Elion, friend, if you're careful you might live through this. In ten seconds, I'm going to show my control over you. You will have a sharp pain in your upper left arm. If you react by trying to fire your gun, or succeed in firing it, you die right then."

The guard, evidently named Elion, was shouting, but not as loud as the voice.

"Prepare yourself for pain. Decide whether or not you want to live. Pain at zero: five, four, three, two, one, zero."

Meyer was watching Elion. At zero, he turned white, sucked in air, made a moaning sound, but nothing else.

The voice sounded not as loud, more conciliatory. "Very good, Elion, you're disciplined, as I expected. Now at every point, you do what I say. If you use the gun or try to, you die right then. What I did to your arm I'll do to your brain, but much stronger. You'll die in agony."

Elion seemed to have recovered somewhat. "I'm still pointing my gun at your friend. If *you* don't do what *I* say, I'm going to kill him."

"The weapons targeting you are computer controlled. If you tighten your finger on the trigger, they will kill you before you can pull it. This was the reason for the demonstration with your arm. Now we can continue the game. At each point I tell you to do something

and count down to zero. At zero, either you've done it, or you get twice as much pain as before. Simple."

Elion was shouting and cursing, but the voice was louder, drowning him out. "At zero, you move your gun to point downward. Five, four, three, two, one, zero." Elion stood frozen and turned white again, but this time he cried out in pain.

"Try it again. Point your gun down at zero." This time he did point the gun down.

"Excellent. I'm happy for you. You chose life. Don't make any mistakes. I don't bluff. Next at zero, you lay your gun down on the floor of the car, or get twice again the pain."

Elion set the gun down. He'd given up. He asked who was behind the voice and got "later" as an answer. Whatever had been done to his upper arm must have been terrible; he was holding it as if it were broken. The same voice, at a more normal level, told Meyer to pick up the gun and his bag, exit the car, and enter another one right behind them.

With Elion alone in the car, the voice started in at a normal volume, sounding almost friendly. "There's no hurry. I want to talk with you about many things. First, Elion Dushku, I know everything about you. You belong to an ethnic Albanian group that does dirty work for the Norwegians. You know your people work for James Collinson, but you've never seen him." The voice went on about Elion, his wife and child, other relatives, in Europe. About his life up to the present. About his uncertain relationship with his organization and his fears of being killed if they doubted him at any time. The voice knew details about his childhood, impossible for anyone to know, not even his wife.

"Your present situation with your group is fragile and dangerous for you, but you're stuck with it. Stuck with it until something happens either to kill you or to make them suspicious so that they kill you—death for you either way. I'm going to offer you a way out. It will still be dangerous, but at least you'll have a chance"

"This is total bullshit. Go ahead and kill me—get it over with."

"Elion, I'm sorry about the pain, but I couldn't let you harm my colleague. From here on you'll have only choices, and no more pain.

I would like you to become a double agent, helping me in little ways, mainly giving me information. But you have to choose to do that. You don't know this, but your group got you to swallow a location sensor that is now attached to your stomach wall. They know where you are all the time. The sensor also has on board a powerful nerve agent, an amount sufficient to kill you if they trigger it."

"That's crazy talk. I don't believe any of it. Lies."

"I've been following your group and its activities for a long time now. Two of the members, people you knew, died during that time: their names were Joel Bardhi and Dardan Gashi. You remember them, don't you."

"Yes, I remember. How can you know this? But yes."

"And how did they die? Do you remember that?"

"Yes, yes, they were good friends. I think it was Joel that died from a heart attack, and Dardan died from burst blood vessel in his brain, whatever they call it. Or the other way around."

"They call it an 'aneurysm.' Both your friends died quickly and in great pain. They each died the same way, from a neurotoxin, a nerve poison implanted inside them and released in response to a remote command. It's similar to what the black widow spider uses, only worse. The leaders of your group became suspicious of them and used the implant to kill them. Think about it. You were with them. Didn't they both appear to be healthy? You knew there were suspicions. And then they were dead: heart attack and aneurysm, or a horrible poison, either way two quick deaths."

"Fuck me, I don't know. Is that possible?"

"Very much so. That's how much they trust you. I can turn off the kill feature permanently for you. Would you like me to do that?"

"Wait. Won't they know?"

"I mustn't turn off the location feature; then they would want to put a new one in. But for the kill feature I can induce a fail safe, where it fries and destroys the toxin. They won't know that occurred."

"Are you sure you won't get me killed?"

"Very sure. I'm doing it right now. You'll get a weird feeling in the area near your stomach, but not actual pain. That's the poison being destroyed. Let's wait about half a minute." The guard held his

stomach and clearly did feel something. After the pause, the voice said, "It's done now. You should trust me on this. They still know where you are, but can't kill you remotely. The kill feature fails sometimes on its own, and if they want you dead, they can always do that easily, but not remotely any longer. In fact if they try a remote kill, I'll know they've tried, and then I'll tell you right away. You'll have time to drop out of sight, disappear somehow."

"No! They'd still know where I was. They can find me."

"That'll be no problem. This is a poorly designed device—it shouldn't be possible for an outsider like me to access it and control it, but if necessary, I'll have no trouble turning off the location feature. In fact I've been blocking the location signal since the trip started, in case there's been a query. We can worry about that if and when. My main question is still: are you willing to be my agent, as a double agent, with few duties and responsibilities?"

"I don't know … don't know what to think. I'm scared now. They'll find out and kill me."

"No they won't, not find out and not kill. With my help your chances are going to be much better. Believe me. Think about this: your hit or abduction was supposed to be easy, but I had no trouble discovering it and shutting it down. I have power and contacts. I can help you survive. For now you need only say you have an open mind."

"OK, I guess. Thanks for zapping the kill part of my attachment, whatever. How will I know if you want something?"

"Don't worry, I'll be able to contact you. It may be a long time from now. And meanwhile this little car will take you back to its base. You need to say that someone else was around when Meyer got his car, and you couldn't climb in. I managed to put the surveillance video off-line and it will stay that way until you get back."

They talked for several minutes more about what information he might be asked to deliver, how a contact might work, a few codewords to remember, and about a few other contingencies, all as the car went back to the original access point. They also talked about some money he was going to receive.

Gwyn's second consciousness was handling everything, while his first one would soon be talking with Meyer. He thought the interaction was going well. He should be embarrassed at feeding such a line of garbage to a poor foreign agent, now a double one. The details about the two who had died were true, but there was no implantable locate-and-kill device, and they had died of the stated causes. The main change was that Elion did now have an implanted location device, fired into the same arm that was experiencing pain; the rest was total made-up crap. And *his* device couldn't be taken over. He should change his con job, since it wouldn't be possible to make any implant with the functionality he described, and yet be small enough that one could swallow it. And it would take quite a bit of poison in the stomach to kill quickly. He could switch the story to a brain implant if his mark recently had surgery.

He didn't feel sorry for Elion, though. He was going to help him, keep them from killing him.

Meyer's car was heading off to the airport. My God, how was it possible that he'd only completed a few blocks of his way to the Moon. Could this be the most dangerous part? "Hey, Gwyn, can you hear me?" It was spoken to no one, but there was an immediate reply.

"Yes, I'm here. I have an AI finishing up with your delightful companion. He, I mean the AI—I call him Ralf—has been doing a great job on his own." But it wasn't an AI; his AIs weren't quite that good yet. And he was never going to tell anyone about his double consciousness.

"I feel like a nervous wreck. I'm trying to get my heart to slow down. It was so close; I could have been killed."

"No," Gwyn said. "That was not possible. You don't realize how important you are to me. We tampered with his gun to put in duds in place of bullets. You were never in any danger except to die of a heart attack."

"Not funny. You used me for bait."

"Well, sort of, but I gave you a heads up message on your glasses."

"I didn't see it. Never mind. No, wait. What did you do with the guard?"

Gwyn went over the details of his interactions with the guard. "That is happening right now, mostly done."

"So why play such a game with this pathetic security guard?"

"Because now I own him. He's mine. And one day he'll be helpful somehow. And he's not so much pathetic as only trying to survive like many people. I may be able to keep them from killing him. They use bottom-level agents for a while and then kill them for security's sake. Nasty people."

"And how did you cause him to have a terrible pain in his arm? That seems impossible."

"I used multiple tightly focused microwave beams. Not perfectly orthogonal, but aiming at his arm from different directions. They were angled to intersect at a spot inside his arm. Pretty cool, right? The software had to keep the beams from going through his body, especially to stay away from his brain. There's a lot more to it than that, but I don't explain the details to anyone."

"I had no idea such things were possible."

"Directed energy has been a big deal for most of this century. A hundred years ago they were trying to get x-ray lasers out of nuclear explosions. That didn't work out, but lasers have always been big. I'm glad we have, at least in theory, the rule that blinding battlefield participants is a crime against humanity. Directed sound has often been used, for small groups on the ground or at sea, and directed water with water cannons to break up crowds. Even directed bats carrying tiny incendiary devices. I mean the tiny flying mammals."

"Yeah, sure, bats. That makes lots of sense."

"It happened during the old World War Two, the war that started almost a hundred and fifty years ago. They wanted Tokyo to burn, and it was mostly wood, a good start. The bats would seek out remote attic locations and set fire to their building when each tiny bomb went off. They weren't ever deployed, though—technical problems with the

little guys—at higher and colder altitudes they would hibernate and not fly off. But, uh, seriously, directed microwaves have been used for many years, often to fry peoples' brains."

"Are the technical items, the machines and the raw materials, everything, are they on their way to the Moon?"

"They've already arrived. Everything is getting set up right now as we speak. It will be ready for a long set of trial runs. I'll be in the loop with the two-point-five-six seconds round-trip delay. Anyway, I've got to get back to work.

"And it's too bad you had such stress before you even got started. I don't need to say how important this mission is. Wait. I am saying it. You know the trip itself is very safe, from high-altitude launch in Hawaii to landing on the Moon, we've had no failures for months—the last death en route was over a year ago. And of course this is your second trip, though you'll find many changes, improvements, expansions of the facilities, you name it. You're going through the first dangerous time here on the Earth, what with foreign agents and actual crazy people. When you get to the Moon I want you to be exceptionally careful. On the Moon is the second dangerous time; in three months we've had two deaths, or as they say, *in* the Moon. You should always have a minder with you. And you should never be outside, never."

"I've no desire to go outside."

"Good. Sometimes they say: 'You're a tourist, so you ought to see the real Moon, outside, up close and personal.' Don't be a tourist. The two recent deaths I mentioned have been outside. Take care and good luck."

Meyer continued his trip to the old and refurbished military airport at Rantoul, and soon he was no longer so nervous. The tired, old buildings on either side were covered with graffiti. It once was lots of nazi swastikas, but now the upside-down five-pointed stars were ascendant, along with much uglier stuff and calls for violence.

They passed a long row of cars that were repurposed as small dwellings, since private cars were useless for traveling: no spare

parts, no replacement computer chips, no tires, and no oil or gasoline for ordinary people, only given to governments. Some had been large and beautiful luxury vehicles; now each was equipped more like a tiny home trailer, some with a shade for the boiling summers and often with an extra rickety room tacked on. None of these cars were drivable or even had any electricity inside.

This God-forsaken area reminded him of the ugly small town where he grew up. In schools and elsewhere he had been plagued by bullies, who wanted his food, or money, or wanted to torment him for the fun of it. At the time he thought of himself as a coward. Even if he were crazy enough to try to fight one of them, he had no experience in fighting, and anyway there were always one of him and several of them. Years later he got to wondering how his cowardly line of ancestors survived to reproduce. He was a thinker and a planner—someone who would remember and resent ill-treatment indefinitely. He came to realize that his ancestors likely didn't fight directly, but instead they would proceed subtly and carefully, in no hurry, and would kill their enemies while they slept, but not right away, only after pretending to be their friend. They would poison the wells of enemies, introduce diseased food, set fire to their houses and fields. Fighters fought until they lost, but schemers always had other options. In the animal world, a top predator was one that could best, and if necessary, kill any of the other animals. But such predators often avoided a fight: they would win but still might have an injury that would eventually lead to their death. And they might even lose.

Two and a half hours of wasted time before the plane would board. He was keeping track. It was a combined military-government plane, since there were no commercial flights any more—and almost no tourists. The plane was half full, and he was happy to have an empty seat next to him. This plane would fly to the Barstow airport in what they still called California, although that entity didn't formally exist anymore. Then another flight would take him to the Big Island and ground transportation up to Homa. He took out some study materials and began making shapes with his hands.

An older man one seat over from him noticed his book. After introducing himself as Raul, he said, "I see you have a book on the

ASL-Space dialect. You must be heading up to the Moon."

Meyer had been prepped for this. "No, but it would be an exciting trip to go there for sure," he said smoothly. "I'm a sign language teacher, or rather, studying to be one. I'll be teaching it after I finish the course."

His seatmate was an ass or a spy or worse. "You can't kid me. I'll bet you change over to the plane to Hawaii with me.'

"Yes, you're right. That's where the classes are. But I've got to study this stuff now." He shouldn't have taken the book out on the plane, but he did need to work on the sign language—he believed this stuff—the ASL dialect could make a huge difference in emergencies, life versus death.

The new sign language was based on the old American Sign Language, but de-emphasized facial expressions and did away with many of the connections to English. You could use it in a pressure suit as long as your gloves had separate fingers. It could be essential to ask for help, to give a warning, to explain something, perhaps when you couldn't be heard or were not close to another person. There was also a small collection of special emergency signs that needed only the arms in ways that could be read at a distance and didn't use fingers.

It was designed to be a language for everyone, easy to learn and useful as a common language, regardless of any linguistic background. A person familiar with the old ASL could adapt quickly to this variant, but in fact it was evolving into a full-strength language as it acquired shaded meanings and nuances over the years. Some colonists preferred to use ASLS, as it was designated, for most of their routine conversations.

He ignored his seatmate after that, grunting at attempts to restart a conversation. And because of this swine, he would have to fill out and send a security report. They would pick up the person at Barstow as he exited the plane. And "Raul" only thought he was heading right off to Hawaii. Or he might be security and testing Meyer. Either way, not his problem.

They landed in Barstow, sort of the scorched hot end of the world, where one had to stay underground as if already being on the Moon

with the full sun overhead. His nosy seatmate left a small bag in his seat as he got off. Meyer had intended to be the last one off, but instead he pushed his way out and off as quickly as possible. It was terrifying. In a large room at the end of a tunnel, three people were off to one side, talking with Raul, or whatever his name was. One of them immediately came over.

"Do you know who I am?" Meyer said.

"Yes, you're Dr. Wolfgang Meyer. We got your message."

Meyer asked to see ID, and then explained about the bag in the seat. Two other people got involved. They thanked him for being careful and said he should go on to the waiting area for his flight to Hawaii and forget about the little incident completely.

Four more hours of waiting, and he would never know what had just transpired. Better not to know. He pulled out some food that Elisabeth had packed for him, stuff she'd gotten from a farmer's market in Urbana, and a little from her own garden. He didn't want to touch anything in that airport, let alone eat something they served up; eating strange food was always dangerous. He sprinkled a packet into the water they gave him, hoping that would be good enough. Then he pulled out his book—more work with his signs.

Meyer waited until it was late enough to call Elisabeth. It was clear he woke her up anyway, but she didn't complain, not ever. She was going to spend time in the morning taking care of her garden and her birds; she now had several dozen birds and a large fancy greenhouse where birds and plants could survive, or even thrive. The birds had become more than a hobby but instead part of a scientific study of the effects of environmental problems on birds.

Such a long time ago it seemed now, when he'd met her. He'd been a guest speaker at a fancy nanotechnology conference, held at the University of Illinois, a huge school that straddled a pair of farming communities. He would end up living there the past five years, but this had been his first visit. The school once was the world leader in the field, and even with the current difficulties they remained pre-eminent, though not as fancy as they once were. He got permission

to make the trip partly because Illinois was paying for the air travel, which was reserved on a military plane to Cuba, followed by boat and train travel. For political reasons there were few direct flights from anywhere in Europe to anywhere in North America. The trip seemed to take forever.

Even back then Europeans weren't welcome in North America; he could feel some tension among these devoted scientists. One of Elisabeth's friends knew she particularly enjoyed meeting someone who spoke German, so she arranged for them to get together. It was a big surprise for Meyer: perfect fluent German with a beautiful North German accent—none of that ugly German rolled R from the South—worse than an American accent in its own south or the Canadian version of French, hardly German. She originally came from the German part of Europe and grew up speaking German with her family. In fact, when they first met, her mother still lived near Hamburg, while her father was deceased; later her mother was able to relocate to North America and be near her daughter.

From the beginning Meyer had been fascinated, bewitched one could say. He'd had girlfriends before, but nothing serious. This one was different. After the first meeting he was seeing her face wherever he looked, thinking about her when he'd normally be struggling with some nanotechnology issue.

They talked for hours on every possible subject, from literature to history to science, but no politics. They had favorite writers and poets in common: such as Rilke and Brecht, but everything German had deteriorated over time, including the number of native German speakers worldwide.

At one point he somehow mentioned that, since her family lived near Hamburg, her ancestors must have been Lutherans. She laughed at this, saying well that might sound logical and likely, but in fact her ancestors were Jews. Her family members were ethnic Jews, long since non-practicing. He started apologizing, explaining, "The chances seemed so low that your heritage would be Jewish, I didn't even consider it."

"Chances! So you're one of those people who thinks in terms of numbers, of probabilities. You plan your life that way."

"Yes, yes I do. How else?"

"Yours isn't a bad method, but it's not the only way. It didn't work this time, and how often will such a situation come up for you? How else? Live your own unique life and forget the numbers, at least some of the time."

Meyer had been assigned secure on-campus accommodations, whose rooms had no windows. He got back to his room quite late.

The brilliant young cyborg scientist, Gwyn, whatever you wanted to call him, was the primary attraction at the meeting. Meyer had listened to him, but to his disappointment hadn't been able to meet him directly, not even informally. He was sound asleep when Gwyn himself showed up at his room. Two security people sat on chairs outside, while Gwyn came in, with coffee and snacks, apologizing profusely.

After a formal introduction, Gwyn started in. "Believe me, there was no other way. We both must not leave any evidence that we met privately—too much politics stands in the way. Do you think we can have a serious talk like this, with you dragged out of bed in the middle of your night's sleep?"

"Yes, I can do that if the coffee holds out. Many times I've stayed up at night completing research. Let's get on with it."

First they talked about Gwyn's work. This work and results Gwyn described were mostly unfamiliar to Meyer—everything far beyond what Meyer thought was the current state of the art, none of it being talked about at the conference. Gwyn brought display technology and answered Meyer's endless questions. The results, the ideas, the future possible directions, they were the most exciting stuff Meyer had ever heard, all heading toward the holy grail of nanotechnology. After at least two hours of that, Gwyn got down to the political situation.

"You are in danger, no other way to say it. I would be ashamed to have put you in this much danger, except that it was already there. The two of us *must* work together, close together. There are people around who would kill us both, taking out half the university here if necessary, to keep that from happening. The issues are so important that I would go to Europe if that would work out, but progress along

those lines is impossible; Europe is too far behind us and has marginal facilities. Instead, you must come to us, renouncing Europe, and joining our 'team,' such as it is."

A long pause by Meyer. "I don't know what to say. Asking me is sure quite an honor. I guess I don't see that happening, and I wonder how welcome a European would be on your team."

"I'm trying to play fair and be honest with you, but right now I can't prove what I'm saying. Both our sides have agencies that spy on the other. We have learned that permission for your trip was made by mistake, a mistake at a low level to not alert the proper authorities of your request. Mainly we know about this because on your side there was a big fuss, a lot of angry messages—the person I've often dealt with, Collinson, was raising hell. They won't make that mistake again. If you go back to Europe, you'll not ever likely leave. You may think I'm exaggerating, but there may be other restrictions on you if you go back."

Gwyn had decided not to mention that he and his people had created the mistake that let Meyer get permission to leave. Let sleeping dogs, or political machinations, lie. And he'd told only the truth: they wouldn't let him leave again.

Gwyn was drinking the insipid artificial coffee himself. "Of course you know about our project in Hawaii, getting people and materials to and from the colony on the Moon. And doing that with frequent flights using remarkably few resources during these times of shortages. I'm proud of this accomplishment. Right now we couldn't find fuel to send off a single one of the super-sized rockets they used to deploy. Our project has international support, even from some European entities. We're going to make a big deal about soliciting support from Europe, making a number of concessions. That should ease political tensions."

Gwyn waited while Meyer said nothing. "I regard you as an essential component for our future work for the colony. This is more important than politics, more important than your personal life. I have to keep recruiting people, and you will have to as well. The risks are too great, the stakes too high, to rely on individuals surviving. We both must groom replacements. You have two more days at the

conference before you have to decide. From now on the security around you is going to be tight."

They talked along these lines for another hour without Meyer committing to anything.

The next evening he went to see Elisabeth again, on a sort of date. There was no security to be seen, but he was confident Gwyn was providing it. Elisabeth broke into a crying spell about how bad everything was, how depressed she was. It turned out that most of the current batch of birds she had raised, finches actually, had died, even in their carefully-managed enclosure. In comforting her, the two of them got physical, meaning she was clinging to him, crying on his shoulder. Because he was already tired, everything seemed hypnotic, like a dream. They spent the entire night talking together, holding one another, fondling. Meyer didn't know what to make of it, except that he wanted this to never end, which was completely crazy considering the negatives of any such relationship—more like a Romeo and Juliet kind of story. Were they both going to die later?

Their overnight snuggling party took place at the apartment of Elisabeth's friend, who had given her a room and simply hadn't disturbed them. In earlier times they might have had casual sex, but among educated people there was no casual sex anymore because there was no *safe* casual sex, and even close contact could be dangerous. As one of a myriad of reasons, an easily acquired UTI could often be fatal for a woman. Instead, they talked endlessly, until he brought up the possibility of not returning to Europe. She seemed almost pathologically freaked out over that, asking how dangerous it would be. "Don't important people who leave their country sometimes get kidnapped or killed?" Full of distress, she went on, "Oh God! I shouldn't have said that."

"I'm not superstitious—saying it doesn't make it more likely. But, yes. That is a possibility. I talked with Gwyn about this. He's in contact with several influential figures over there. He's going to make major concessions to the Europeans—inviting them to participate even more in the Hawaii project. They'll be upset over my defection, or perhaps call it 'traitorous desertion,' or even worse than that, 'apostasy.' His concessions should help. And they did let me out

of Europe by mistake; they didn't mean to."

"Are you thinking about this because of me? Am I some kind of trophy?"

"No, nothing like that. Our friendship, whatever it is, well, it's completely separate." She sat still, saying nothing. "We've known each other for two days. I've never met anyone like you—so smart, interesting, kind, beautiful.... I can't put it into words. We seem a perfect match. Nothing like this has ever happened to me before. Still ... we would need to see each other much more before making permanent commitments to one another. This is almost crazy. I've hardly been thinking of anything else. But Gwyn is sure I can make great contributions to his work with the Moon colony. He believes in me. I *have* to do that and I *must* be with you, I think forever." He pulled her over to him and they sat that way without talking for a long time ...

Two weeks later, Collinson sent Gwyn a copy of a message:

From: JP Collinson <collinson@ess.eu>
To: Head, HCP Project <head@hcp.moon.gov.na>
Copy: Gwyn <gwyn@nanotech.ui.edu.na> (double encryption)
Date: 17 April 2079
Subj: Agreement re Hawaii Colony Project (personal copy)

AGREEMENT.
This is to accept your offer of a base for Europe on the island Hawaii (the "Big Island") of Hawaii, as described in the attachment and subject to the attached formal conditions. As with an embassy, this base will be the sovereign property of Europe, with rights again as detailed in the formal attachment. There are already Europeans working on the Hawaii Colony Project, and we will nominate one technical person from that group to serve on the project Governing Committee.

SEPARATE INFORMAL ATTACHMENT, TO BE REMOVED.
You made a plea to me from Dr. Meyer that we leave his new girlfriend alone. She represents a weakness for your side. A dead Elisabeth Bloom is useless to me, so Meyer need not worry on that score.

Meyer eventually got to see that content, along with an avalanche

of material related to the colony. It was hard now to visualize the five years that had gone by since then, with ever increasing difficulties both on the Earth and on the Moon.

Meyer slept through much of the next flight. That was great. He wouldn't be so groggy during the more critical and demanding parts of his trip. Carefully the last one off, he was met by three serious young men, one of whom showed his ID and gave the code word he was expecting. He gave the correct response, and the four of them moved off to a waiting car. Security was extremely tight on the whole set of Hawaiian islands, but even more so on the big island, if that was possible.

First was the trip to the top of Mauna Kea, Hawaii's smaller volcano, at over four kilometers slightly taller than its more massive neighbor, Mauna Loa. One of several reasons to pick Mauna Kea for Homa was why they put observatories there: its stable and turbulence-free atmosphere. He'd done this once before, seeming routine this time. Still, he was carefully attentive during the several hours of orientation and prep leading up to the flight. They assured him that the delicate cargo, so carefully packed, had long since gone to the Moon on earlier flights.

He knew to expect a quick test for diseases, thankfully giving a negative answer in a few minutes. He'd had a negative test back in Urbana, but a positive test here would trigger a complex evaluation, since every arrival at the colony posed risks, actually regardless of the test outcome, and much would depend on a more complex test that took hours to give results. In the worst case he wouldn't be able to go at all.

Finally came the pressure suit with its annoying features, including the disgusting diaper, but he certainly needed the suit. The air at the top was about twelve percent of sea level pressure, less than half the pressure at the top of Mt. Everest and a quick death without the suit. The trip up the stalk to Homa proper would take thirty-five minutes and cover eleven kilometers straight up. And the view was wonderful, in full daylight instead of dark like before. He could see

forever, first the big island and then came the islands and the infinite ocean and clouds.

The top of the stalk was called Homa in honor of a mythical Persian bird that always flew and never came down to the Earth. Their hybrid orbiter craft used Homa as its launching site, a huge lighter than air balloon suspended eleven kilometers above the volcano or over fifteen kilometers above sea level. (Hey, even the mighty Mt. Everest is not quite nine kilometers high.) When he'd first heard of the project several years ago, he'd tried to imagine how they could make it lighter than air. For such a high altitude, if not for many other reasons, hot air was out, and it was impossible to get helium in bulk anymore. As so often with materials, mankind had pissed away most of its available helium, and its recovery was no longer feasible. So what could they use? Well, hydrogen, as long as it didn't catch fire. It turned out that fire or an explosion was easy to prevent. They only had to be sure the hydrogen didn't co-mingle with the air in their small pressurized quarters, although in practice they also mitigated a number of unlikely but possible crises that could result from using hydrogen. Of course they needed to ground Homa anyway to handle lightning, but the hydrogen made it trickier.

And hydrogen gave about eight percent more lift than helium, an amount not to be laughed at. Finally, helium is much harder to deal with—to store, to purify, to use at all. If plenty of helium had been available, they might have tried to use it, and surely failed completely. An early decision for helium would have doomed them, but thankfully they had no helium.

The whole Homa project was designed to get material into low Earth orbit and on to the Moon as cheaply as possible, in an environment of extreme shortages of many materials, including especially rocket fuel. There were other constraints, but none that needed to be optimized. Meyer had only scorn for bureaucrats, knowing nothing about optimization, who always wanted projects optimized along five different independent variables. The cheapest, lightest, quickest, with the best performance, environmentally friendliest, and every other est.

Homa was tethered to the ground with ultra-strong carbon fiber

cables, enhanced with strands of carbon nanotubes. A much thinner version of the cable lifted objects from the ground up to Homa. A huge machine pulled a cable that went up to and over a pulley at the top and down to the pod he was in. They pulled up supply pods the same way. The weight on Homa was twice the weight of the cable plus the weight of the cargo, but the heavy lifting machine was on the ground. They had cleverly arranged the cable in a loop, so that after lifting a load, they could almost immediately start the next load. Also there were two separate cables, used independently except for raising the empty aircraft, which was so heavy it needed both cables.

With some delay, two young technicians, also in pressure suits. strapped him into the hybrid craft—stubby and ugly looking—almost hard to imagine it fulfilling their requirements. It was not able to land directly, but it would use air friction and parachutes to slow for a fall into the ocean near the Big Island. The taller technician introduced herself.

"Hi, I'm Ruth. Sorry, but there will be a further thirty minute delay because we need to time the ascent exactly to coordinate with the carrier rocket that will take you to the Staging Center."

"Thanks. This is my second time, so I expected that."

Ruth and the other technician chatted with him about their life in Homa, the food, the sleep schedule.

"We do roughly four-week shifts," Ruth said.

Meyer winced. "That sounds hard in such a limited space here. How do you stay sane?"

"It's not so bad, and the pay is great, with other benefits. The biggest plus is we get to live in Hawaii. People here almost forget how nice these islands are compared with the rest of the world. Our pressurized portion up here is large enough for us to avoid one another. Yeah, seriously, it's not so bad. We sleep in completely separate quarters, so no problems with a snoring colleague. We have access to almost anything available online down below, so entertainment's not a problem. We've only had one major emergency shutdown—due to a solar flare.

"And for your comfort we're installing an extra little stearing wheel in front of your seat if you should get scared."

"Good for me that I already know the ship's completely autonomous, and at least there are no windows for me to peer out of, no instruments telling me what is happening, so nothing can frighten me. I'm like any other cargo. And no pressure, so I get to wear this beautiful suit with its fancy diaper. My second childhood—I'm in diapers again. This whole experience reminds me of my one trip on a roller coaster as a child. This is the grown-up version."

The technicians laughed indulgently.

The ship could carry slightly less than two metric tons of cargo, including any humans if present, on each trip. It sometimes came back down empty, or else with from one to three humans on board.

Ruth didn't say it, but he'd been briefed about certain kinds of emergencies, usually bad weather, although sometimes one of an unwelcome list of problems, ones that could cause that particular flight to be canceled. Then he would have to wait up in Homa, with Ruth and the other worker, until they could reschedule. Their ample pressurized facilities might not seem so large with another person around. It would be crowded. A huge relief that he was getting one more trip without that happening.

And then it started up: a short period of weightlessness, as the part-jet/part-rocket dropped off of Homa, followed by several Gs of acceleration provided by the two side boosters. He'd learned they had reluctantly added the booster units, which made everything more complicated, but it was too hard to get cheaply into orbit, and the ramjet needed to be started up as soon as possible. The units were similar to, but larger than the JATO units that had long been around. These would be jettisoned, parachuted down, and usually recovered from the ocean. By this time, from the boosters and from coasting downward, the vehicle had gained enough velocity to start the ramjet engine. After that, it ascended at exactly the correct rate to keep an optimal amount of air in the engine with the increasing velocity and decreasing air pressure. At the end, the rocket took over when air pressure was too thin no matter how great the velocity. Meyer remembered reading that the engine was officially called a ramjet/scramjet/rocket hybrid. The technology was initially developed for hypersonic weapons.

For Meyer, free fall was welcome, but another batch of wasted time was added to his total, this time waiting for the "carrier" rocket that Ruth had mentioned, which would take him to the Staging Center in a higher Earth orbit. Altogether it took three and a half hours to get to that Center, attach to it and enter. He was met by a large older man, rough-looking, with hair clipped short and a sun-burned face, along with a small and young-looking woman. As he got older, women were looking ever younger. The two made quite a contrast. The man held out his hand.

"I'm Dmitri and this is Jane. There are two others asleep back in the innards."

"I'm Meyer."

"Pleased," Dmitri said. "But hey, I like first names around here. What's yours?"

"Wolfgang, an old German name that people don't use anymore."

"Well I'll use it. But you want to get that damned suit off. Can you use some help?" He actually used another word instead of "damned," one unfamiliar to Meyer.

Dmitri led Meyer to a smaller room off the main corridor, where he could finally get the huge relief of taking off the pressure suit and diaper, partly cleaning himself with a damp disposable, and changing clothes. They had stocked a reasonable approximation of his size, so the old stuff, including the horrible diaper, went into a bin; he had no idea what they did with the bin's contents.

"You sound like you might know Russian," Dmitri said in that language.

Meyer answered that he knew "some" Russian, using what was actually his quite fluent version of the language.

As they left the room, Dmitri said they should "probably speak in English for the others." Back in the main room Meyer more formally said hello to Jane, who came from what once was Canada. "Floating around in the microgravity is so nice after the torment of the trip so far," he said. The station, compared with what must have been tiny quarters on Homa, was huge and luxurious. Meyer asked if he could have some snacks and some water, which Dmitri immediately fetched.

The first thing a visitor saw on arriving at the staging center was the infamous "Beatles" room off to one side. After well over a hundred years, their music was still popular. The room was a general entertainment center with added Beatles items, including some authentic memorabilia.

Custom dictated that anyone newly arriving should bring a token to add to the room, something not necessarily related to the Beatles. Meyer elaborately presented what looked like a black-speckled ping-pong ball. Ping-pong was one of the few surviving sports, but they weren't going to play it at the Station. His token was made from carbon nanotubes, impossibly strong, with negligible mass, floating around light as a feather. The other two pretended to be impressed: "How interesting!" But he could tell they weren't excited about a ping-pong ball, even after he explained that you could set one corner of a building on it without it breaking.

Jane explained about the two who were asleep: Andrew from Australia was the third member of their group, while Rick was a scientist from Boston who would go with Meyer to the Moon colony. Meyer was struck with the importance of the particular side you were on. They immediately thought: Australian, so Europe, and Boston, so North America.

Dmitri seemed to have a need to justify his existence: "There are always at least three people permanently at our Staging Center, and sometimes a fourth. Believe me we are kept busy—this is the only control point off the Earth and Moon—we monitor everything and control many things."

Meyer was trying to fend off an endless explanation of what he already knew: "This is my second trip to the Moon, so a lot of this is familiar. This Station looks the same, but I hear the Colony has expanded dramatically."

Dmitri insisted on explaining anyway. "So you know you'll take a shuttle from here to L1 and then down to the Moon. It isn't due to leave for eleven hours. I'll have plenty of time to move the cargo pod from the orbiter you came in to the shuttle The stop at L1 saves fuel but adds at the least more than a day to what could be a three-day trip—sometimes a lot more added. In a competition,

fuel immediately wins over time. You're lucky on this trip; it's only adding about twenty-seven hours."

Meyer groaned inwardly: another boost to his count of time wasted. The station maintained at the L1 point was unmanned, used only for refueling. This allowed the shuttle to be much smaller, since they could separately send fuel to L1 on the return trip from the Moon, fuel created on the Moon. The shuttle, like the craft from Homa, was completely automated and unmanned. This way there were no pilots on the whole trip, saving the weight of one or more pilots for extra cargo. Everything had been designed for maximum efficiency—the least amount of fuel needed to get cargo to the Moon. Most cargo went from the Earth to the Moon, while the reverse direction carried people back to the Earth and fuel to L1, as well as valuable minerals, if they could find any. It was supposed to include Helium-3, but that last had yet to work out—if ever.

Already it was pushing things to have no pressured facilities for passengers at the top of Homa or in the orbiter, so they surely had to have a pressured cabin in the shuttle from the Station to the Moon and back to the Station. People couldn't spend four or more days in a pressure suit with a diaper.

"How long is your tour here?" Meyer asked, and immediately regretted it, thinking it might be a sore subject.

"You stay for three months," Jane said. "But only if you work hard on exercising, your diet, and keep your numbers good, you know, calcium, blood, muscle tone, lots of numbers. Living in microgravity's a bitch. You can come back after six months below, but again, only if the numbers say you can. This is my third tour. I shouldn't say it, but the pay and benefits are good, um, benefits being mostly a save place to live." Then she seemed to think she'd gone too far: "fairly safe."

Part of the orientation for anyone going to the Moon included a great deal about this very issue, translated from microgravity to the Moon's one-sixth G, which by itself was a huge help compared with the microgravity. Meyer had studied this area extensively. For those on the Moon, the medical specialists had over time developed a regimen of diet, exercise, certain medicines, and required sessions on

one of several centrifuges, and that usually kept them in reasonable health indefinitely. Before his first trip Meyer had heard that using the centrifuges was particularly annoying—every kind of negative: uncomfortable, time-consuming, disorienting, and a major pain to have to suffer through. He certainly hadn't enjoyed it the short times he was on the Moon. Dammit! *In* the Moon. But it was necessary, and they made no exceptions for a visitor. The plan was to build much larger and more convenient ones.

Later, while Jane was busy, Dmitri said, almost casually, "I know who you are: the European scientist who moved to North America five years ago."

Meyer thought it sounded like a challenge. "That's sort of true, but it leaves out the important part. My main concern has always been the Moon colony. It's a joint project; it still has significant European support."

"I'm not trying to start an argument. I'm European myself and working for the colony project. I was mostly interested in why you switched sides."

"Again, I don't like to think of it as switching sides. But my field was and is nanomachines. Most of the work on those is in North America. If I had stayed in Europe, I would not have had the work with nanotechnology I wanted. So I admit it: I switched to working on the Moon colony partly to further my own career. We have high hopes for how these nanobots can help the colony. After the biology issues, the nanomachines are the most important area."

Dmitri sounded surprised. "I didn't know biology was so important."

"Completely outside my area, but the biological issues are complex and worrisome. We have to deal with the biome in the colony—constantly changing and evolving. They continually get new stuff every time a new person arrives, like me. That's what I hear. They've got dozens of experts working on biological problems."

Meyer chatted with Dmitri for more than an hour, until the other two woke up and came into the main area. Andrew, another station employee, went off with Dmitri to give Jane a break and work on station issues. The other person, Rick Davis, was a passenger like

Meyer and right away struck up a conversation. After Meyer had talked about his nanobots for a bit, he asked Rick about his field. Not all colonists were professionals, but that was the case here. "I specialize in viruses," Rick said. "A big field and important for the colony. I work on anti-virals—every sort of approach. No big problems so far, but something is bound to happen."

"They are certainly fussy about checking for infections before sending people up Homa."

"Some kind of mutated viral infection in the colony is my greatest fear. We have procedures in place to isolate sections in that case, but the isolation might come too late. Then we would have to treat individuals as best we can."

"How long is your stay for?" As before, Meyer thought he shouldn't have asked, but Rick wasn't bothered by the question.

"Any more, to get a position on the Moon you have to sign up for an indefinite stay. A year ago I did seven months, but this time it is … forever. They want to create a stable society."

"I'm going for a short stay, six weeks," Meyer said.

"Amazing. You must be quite a big wheel then if they let you get a six-week stay."

Meyer tried to sound modest. "As I said, I work with nano-machines—not as important as biology, say, but we hope to make significant contributions. Actually, six weeks is the goal, but it might be longer. We have certain things that sort of have to get done. It we can't push this through, well, that would be a setback for sure. I want to be optimistic—done in six weeks."

The other started in with a "what kind of contributions" kind of question, and Meyer had to say things were up in the air (which was true!), and time would tell how important the stuff was that he and the others worked on (also true), but he didn't say it was highly classified, considered an essential step, and yes, subject to their highest hopes.

Soon the two of them had to get ready for the final 5-day trip on the shuttle. As it turned out, Rick was a good companion to relieve five days of boredom. At one point Meyer surprised him by introducing his vote for "the best nanobot."

"And what would that be?" Rick asked. "I've heard descriptions

of several capable types that have been developed."

"The eukaryotic cell, what else?"

"Oh, yes. It's a fantastic mechanism. The features of an entire city in a single cell. It took like a billion years of evolution to develop. My favorite part is the mitochondria-driven power plant—the cell incorporated it from the outside."

"We're trying to hurry the process. A billion years is a bit long for us."

Twice during the 5-day final leg of their trip Meyer managed to call Elisabeth. She had a phone, though not everyone had phone service anymore. But still she had to go to the department office to get a phone connection with him. He always worried about her, but this time more than usual. She seemed lethargic, even depressed, and didn't have much to say. He could see how it was boring for her there; she didn't have many friends and her mother had needed to go back to her own house for some reason which wasn't clear to Meyer.

As part of the preparation for landing they had to put on their pressure suits again, due to the old "abundance of caution" approach, but at least without a diaper this time. A year ago when Meyer had last come to the Moon, this caution had been missing, but his fellow passenger Davis explained there'd been no leaks and no deaths so far—they wanted to keep it that way. For Meyer it was freaky to have no pilot. When they had gotten close to the Moon, control had been transferred there.

It seemed like forever, but finally the shuttlecraft landed on the Moon. Meyer felt a jolt as they settled onto the ground and the engines cut out. He lifted his arm and let it fall, testing the light gravity. The Moon for sure and at rest. They usually attached a tube to the shuttle, but a voice from their control had already said the tube was getting repaired. They would use a separate wheeled vehicle to get into the colony. He was on the Moon but not yet *in* the Moon.

The vehicle came and attached itself to their shuttle. They walked on through the connector to see an actual human as driver. He gave a hearty welcome and told them to keep their pressure suits on. Meyer

had no illusions: they were protecting both directions, but primarily shielding themselves from him. Quickly they drove down a ramp and through an obvious pressure gate. After that gate came another, and then a bit further along, a third, past which they stopped to disembark.

Now they were under pressure. They went through still another pressure gate, following the driver. He explained that this route into the colony was new, added three months ago. They had decided to protect more aggressively against infections. They could finally take the suits off, but there would be a twenty-four hour quarantine period. Most people could use some food, a shower, and sleep anyway, after the long shuttle trip. The driver had said a week-long quarantine would be better, but they had to be realistic. Following tests after a day, he would finally be truly inside the colony, that is, *in* the Moon.

11. Prepositioning

For nearly three years Mila Thompson had been working as part of the administrative support of the Owl's Nest Project. It was a huge operation with major locations near the south pole of the Moon, with many facilities on the Big Island of Hawaii, including the equipment for shuttles to and from the Moon, and with the large set of offices where she worked in Urbana, Illinois near the University of Illinois.

Separately the same organization helped with the much smaller colony on Mars. In many ways Mars had seemed like a superior place for a colony, presenting more opportunities and fewer problems, but Mars was too far away. Some time ago people thought they could make use of materials on Mars and not need so many of the long supply trips, but in the end too much from the Earth was required.

Three years earlier, Mila had made up her mind. She'd been forced onto this path, but she wasn't going to go through with it. Out of nowhere the Australian branch of the vast Eurasian spy system told her she met the requirements to be an agent in North America: female, young and attractive, native English speaker, smart, and with an unstated requirement of a number of local relatives. The last was important to keep an agent from defecting—they could threaten the relatives, or in Australia they could do terrible things to relatives first and threaten worse. She thought it was a great joke on them that they were wrong about her actually having local relatives. These were non-existent relations—a computer glitch and confusion over her last name.

She had spent a long time and a huge effort working on an American accent while trying to keep her Australian accent at bay. And there were endless details to memorize about a medium-sized town in what used to be New York state—important events and people, her supposed "time" at the high school, including even a few students she "knew." And finally came faked credentials and endless training to fulfill the mission. She had the proper IDs and records to prove she had grown up near what was left of New York City. Her

mission was to hire on with the colony project, the "Owl's Nest"—a silly name.

She had come to realize that she almost certainly would be caught, then killed or jailed. Tall, with blond hair and light skin, she didn't look anything like someone from the east coast of North America. She sure didn't want to go back to Australia, but that wouldn't be possible anyway. Her contacts expected her to at least try to get hired and in general do what she was told. She was trapped as a foreign agent in North America.

She decided on an easy choice: somehow become a double agent. Sometimes people like that survived. The Europeans were fools but nasty, and the head of the Archipelago was a madman who killed for fun. In contrast, the colony project was well-run, with even some European support. Modest support. The head was this mysterious young man (or boy?), known only as Gwyn, age nineteen, supposedly a kind of cybernetic man-machine who didn't make mistakes. Face it, her cover was crap. He or his underlings would discover her. So her plan was to offer herself up as a double agent from the beginning. They might find a use for her in that role. Also Europe always rewarded failure with death, and sometimes they rewarded success with death, while North America not necessarily.

It was pathetic how she had been supplied with various equipment, part of which could likely be used to kill her if they wanted it. She felt like her special communications device might serve this dual role. She had an adaptable little droid that she used with that device any time she needed to speak with one of her handlers—her droid turned the device on and she talked through the droid, always keeping the device in a closed closet. Later she got so paranoid that the device was now in a cleaning room at the opposite side of the building from her own, um, "room," ugly and tiny as it was.

And finally, the person Gwyn seemed interesting to her. She'd seen pictures of him, and he looked … interesting, or maybe more than that. What would it be like to work for somebody smart? For somebody "interesting"?

So how in all hell and beyond could an agent "volunteer" to be a double agent? She had not the slightest idea. Her people surely had

agents planted within the colony organization. She had been trained but had no real experience as an agent. In books and videos how does one become a double agent? Well, they would recruit such a person after discovering them. Her crazy plan was to volunteer to be a double agent from the beginning. Get the attention of somebody high up and volunteer. She didn't know how she was going to do this without alerting any hidden European agents.

Mila started the process of applying for a job with the Nest. Her credentials looked good, though she was actually much better than those credentials. Halfway through the initial day of applying, she left her temporary desk and went to use the toilet. She made sure no one else was inside, locked herself in a stall, and simply said, "I would like to speak with Gwyn directly or with someone close to him." She repeated it and hoped for the best.

There were several interviews and a test that first day. Later she grabbed a minimal meal and went back to the desolate hotel she'd picked out. It seemed safe and at least she'd chosen it herself. By now, though, it might be decked out with more surveillance gear. You never knew.

In the middle of the night there was a sound like someone clearing their throat. A small machine sat on a table near her.

"Good, you're awake. You wanted to speak with me? Here's your chance."

"Christ, is it you, Gwyn? How do I know that it's not someone else?"

"When you left, we gave you a slip of paper to keep till the next day. There is a special code word on it that says: '2951xkcd' plus four more digits. Check your slip. And tell me the final four digits"

"I memorized the slip and destroyed it. What you gave is correct, and the rest is '4376'," she said.

"Very good. So, Mila 'Thompson,' or better, Mila Sorrenson, you wanted to talk. So talk."

"Ah, you know my real name."

"Of course. And sorry, but your American accent sucks. The Australian one peeks out. My gear listened to one sentence and said: 'Australian trying to use an American accent.' Anyway, what do you

want to say?"

"Is is safe to talk?"

"Yes, this whole area has been silenced. And widespread blackouts like this are common, deliberately so. They won't be suspicious. Go on."

So Mila explained that she'd been forced to become an agent, and wanted to become a double agent, without ever having been even an agent. She sure didn't want to work for the malevolent leader of Australia.

"And I'm better than my credentials showed. I have a lot of technical experience."

"Yes, I know that. I know everything about you. I think you would be a terrible agent, but a good employee. You could be useful. I need you to say that you are signing on to be a part of us—not only an employee, but a real commitment."

"Yes, yes. This is what I was hoping for."

"Now stop, think, and say it again. This is a serious business."

"I mean it. I won't let you down."

"You and we must always be careful. And still you could be killed. I think you realize that on your old path death was your only long term outcome, but even now this is dangerous for you. Using our resources we will try hard to protect you, but you must be suspicious of everything, constantly. I was impressed with your use of the little pet droid to talk with your contacts. Tomorrow you'll go through the remaining application motions, but the fix is in."

Gwyn went over a large number of items, code words, procedures, a special channel for communications. She wondered how this all-important head of the project could spend so much time on one new-hire. If she was talking to an AI, it was a hell of good one. She ended being fired up, too excited to get back to sleep later. It was going to be so interesting.

At the end he had said, "You must not ever leave North America for any reason. Best would be for you to stay in this town. Our security here is pretty tight.

"If Europe tries to recall you or transfer you, we will help you make excuses. Frequently we're going to be giving you real data

to leak to them, data of value. It's going to sound even to them like valuable information. Part of what you 'leak' will be changed slightly or even changed a lot, and part will be false. My goal is for them to think of you as one of their successes. Mostly I expect you to do your best work for us."

"You said 'we' and 'us' a lot. Who besides you is going to know about me being not an agent but a double agent, working for North America?"

"Right now it's just me. You're one of my special projects. But this week I'll make sure several key people know that you aren't a spy, but are on our side. I can only tell a few people that I trust. Of course we have European agents around, even 'sleeper' ones. I'll say again, this is dangerous, but you had and still have no way to avoid it. It's a tribute to your … let's say obvious 'amateur' status that I'm confident you couldn't manage to play both sides in this game. You said you have no relatives in Australia. Any friends, or pet dogs? Pet kangaroos?"

"No, nobody. It's terrible in Australia, much worse than here. Everyone I knew is dead now. Oh, wrong. Two friends escaped to New Zealand. But people don't have pets. Any animals are either working ones or kept as food."

"I want to look at the positive side. It's going to be interesting and worthwhile work, important work you do for us. I've already decided where I want you in our organization, and I think we can protect you there."

As it happened, three days later North American security entered her room in the middle of the night and took her off for questioning. Gwyn had told her to play it straight and stick to her story, the one about a North American who came from near the old New York City. Initially it was terrifying, but the agents eventually told her it was a mix-up of names, and dropped her off back at her work. She didn't know that one of Gwyn's "key people" had told them to release her.

Later she was thinking about Gwyn, whom she had yet to see in person. Why was she attracted to him … in some abstract way? In the few pictures and videos she'd seen, he looked like a normal male, given his age. She decided it was about power. He had it. Women had

always been attracted to power, often looking for a mate who would take care of them and their children. Standard evolutionary biology. Was that what she was like?

She thought about Joseph Goebbels, the German propaganda minister in the second world war and Adolf Hitler's closest confidant one hundred fifty years ago. From pictures he was astonishingly ugly and had one deformed leg almost half a meter shorter than the other. Yet he had repeated affairs and a beautiful wife, and six children with her … children he murdered before committing suicide himself. So what was his attraction? It must have been power. Yes, Goebbels had a magnetic personality, and was the best at propaganda who'd ever lived, but his power was key.

Three years went racing by.

As Gwyn had promised, Mila did important regular work for the colony at the main administration office, and occasionally put out faked covert reports. She was in charge of the legal and educational documents that helped support the colony. Someone under her direction did the educational stuff. Her specialty was the legal documents, since she'd had experience in Australia as a paralegal, though she'd mostly worked on the data processing side.

There had been recent drastic changes to the items the colonists had to agree to. By far the most important change was that the long-term success of the colony, always a high priority, now had absolute priority over everything else.

For more than a year, anyone signing up to join the Moon colony had to opt for an "indefinite" stay. If someone was no longer productive, or if they were a great burden rather than an asset, then they had no choice but to return to the Earth on a shuttle. Far more goods went to the Moon than were sent back, so there was no lack of space for a return. If someone seemed too ill to survive the flight, they could be forced to return anyway, even at the risk of their life. The colony couldn't afford the overhead.

Others who didn't want to be at the colony any more, for whatever reason, were expected to return.

A colony judicial trio would decide the issue of a forced return. Such trios were part of the governance of the colony: three members were chosen at random to make that decision and many others. They served for a fixed length of time. Colony leaders were not included in the random selection, and only those who'd been in the colony for two years qualified.

During the terrible six years early in the history of the colony, there were not enough resources to keep everyone alive. In that case enough colony members volunteered to give up their lives that there were no forced sacrifices.

At some point the colony might no longer be able to operate the shuttle or in any other way exchange goods with the Earth. In other words, sometime in an ugly future they might be cut off, completely on their own. In that case rules similar to the six terrible years would apply, and judicial trios would decide which members had to make the ultimate sacrifice of their lives for the good and success of the colony. Even members who had a record of great accomplishments and sacrifices for the colony wouldn't be exempt if they became old and infirm, or ill, or simply non-production—a liability instead of an asset. They would also allow individuals to volunteer this sacrifice.

There were other important rules in the contract. For example, no one was allowed to be the biological parent of more than one child, and often none. It was imperative that they broaden their gene pool, so they would routinely use sperm or ova or fertilized ova, usually frozen. As another example, every fetus had to pass genetic tests. Other requirements were keeping physically fit, including the required amount of time on the centrifuges, which was variable depending on physical factors. And the contract had a large number of other petty details.

These important legal issues had to be carefully composed into a single document that prospective colonists would agree to and sign. Mila had spent several months working on that key document with a committee and she was happy to be done with it. She hoped to go to the colony herself, so she felt the irony of creating a set of rules that could apply to her and could in theory force her to sacrifice her own life.

Many issues relating to the colony's governance, including especially the random judicial trios, had been worked out in the past, though Mila and her underlings also produced periodic revisions of the signing document and of the governance documents. These documents were based on extensive committee meetings and endless discussions. Mila was only formalizing policies decided upon by others above her in the hierarchy. She was also tightening the logic of the documents and making them clearer, simpler, and easier to understand.

She felt that the signing document itself would give some eager prospective colonists pause. There were far more applications to go to the colony than positions available. Applicants included obvious losers: crazy people, radicals of many political sources, including religious fanatics, criminals, spies, and others defying any description. They needed people who could get along well with others. Important were mental and physical requirements as well as wanting to bring various skills and knowledge to the colony. Increasingly they were trying to get a more diverse group—others besides scientists and engineers—and a better mixture of sexes, ages, backgrounds, and races, along with many other factors. There were already a number of children born on the Moon and living in the colony.

Mila found it ironic that her European spy agency was counting on her as a probable colonist who could become a source of information about the colony. Three years gone by and nothing much had happened with the several spy agencies, but that was always in the back of her mind.

Several weeks ago Mila had boldly told Gwyn she wanted to see and talk with him in person. She said it would be interesting to see more than a video image. She joked that that he must be an advanced AI, not even human, nothing but a complex machine. She worried about this, she said. She wanted proof he existed as a human being. To her surprise he agreed to her request and set up a time to meet in the innards of the main building. To get there she had to follow elaborate directions on her phone, directions that sent her on a circuitous path.

Now was the third such meeting—the paths through the building had been different each time. Gwyn only wanted to talk and carefully kept his distance.

"I'm always worrying about the security of Homa," he started out this time. "The top itself and the other stuff that goes with it. Everything that lets us go to the Moon and back. That top part seems vulnerable. At least the Europeans and their people don't want to destroy it, but there are others who do."

"I've been reading several of the internal documents, things I'm 'leaking,' " Mila said. "You've got a duplicate of the top almost finished, and there's lots of cable. The write-up said they could get a new Homa up in a couple of months."

"Yes, if it's a missile that takes out the top. My nightmare is a nuke as the start of a 'small' nuclear war. Or a not-so-small such war. That's one of the options my giant simulator presents—a low probability, but it could happen. Because of such events of low probability, yet with great influence on the future, the simulator hasn't been as useful as it might be. In case of an unlikely nuclear war, everything would change. The colony would be on its own indefinitely, or even forever. We do have some protection—anti-missiles and a secret powerful infrared laser. It could even take out a hypersonic missile. But still … it's vulnerable."

Mila had learned from friends and co-workers that in 2072, when Gwyn was only ten years old, he'd help promote the ultra-efficient design for a new way to gain access to the Moon. Others had conceived the basic design and worked on it for years, but everything had stalled out in the late 40s. Many people knew they needed to get something more efficient going. It would also give them more efficient access to Mars. It wasn't just the cost of the huge amounts of fuel needed to connect with the Moon, but access itself to fuel—increasingly hard to get.

By far the hardest part, the hybrid orbiter vessel, with its multi-purpose scramjet/rocket design, already had working prototypes constructed in the mid-40s. One brilliant engineer came up with the basic concept and a large group implemented that initial idea. Then came the late 40s crash that stopped the work. Much later the North

American government managed to get the whole project restarted. Gwyn helped with this effort by getting the needed high-quality 3D printers working again, and by doing some of the planning and supply chain work. In less than three years the new design was functioning and had supplanted the old chemical rockets. They started getting major supplies to the Moon, along with many more people.

Years later Gwyn became clever at gaining responsibility and status, until he was in charge of the whole colony project. She wondered if anyone else knew what she had learned from him: that his simulator gave him information no one else had. Had he told her deliberately or was it accidental information? But he seldom made mistakes. The simulator helped him make good choices, helped him succeed without being obvious.

Another time he told her how he'd leaked data about possible Helium-3 near the colony site. Helium-3 was far too expensive to obtain in useful quantities, yet it could be important for nuclear fusion. A transformation using that element required a lot of extra energy compared with normal fusion, but it produced no high-energy neutrons, unlike the other approaches. Starting in the late 30s, industry insiders had been playing the game of "who's afraid of a few high-energy neutrons," but in fact they were dangerous and destructive, hard to deal with and impossible to contain. No commercial fusion reactor had ever succeeded, mostly because the neutrons made everything radioactive. So the hint of available Helium-3 was another way to promote the Moon colony. Now, twelve years later, some people were still counting on a bonanza of Helium-3 on the Moon, and that did help the colony. In the end, who could tell—they might actually find some good sources of Helium-3.

"And what about basic security in Hawaii? The Big Island and the others?" Mila said.

"Security is supposed to be tight on the whole set of islands. People coming and going are mainly the wealthy who own almost everything and those working on Homa. The normal kind of desperate refugee can't make it to Hawaii on their raft or row boat. But larger boats and ships and airplanes come regularly. We've got lots of security trying to check everything but it's difficult. Stuff slips

through.

"We've stopped several attempts at sabotage. Nothing aimed directly at Homa itself. And it's really remote. Two months ago there was a bizarre attempt that I even got involved with."

Gwyn paused and Mila said, "Don't tease me. What was the attempt?"

"It's funny. You'll like it." Another pause.

"Security had been following a medium-sized boat loading cargo at Guam Island for delivery to Hawaii. It wasn't clear what the cargo was, so they were using drones to overhear the crew. Here is what they said, with some, uh, strong language, quoted verbatim: 'When we're done they'll be totally fucked, man—sideways and up the ass, and the great part is they won't know it for some time. Then one day they find out, but it'll be too late.' They were drugged up and ecstatic about what was to happen. 'I'd do this shit for free, man. How often will I get to fuck the system like this.'

"Well, our security had consulted a number of people, including me, but I couldn't figure it out either. I turned it over to my simulator and it had the answer in seconds. No bombs, nothing radioactive or other poison, no horrible diseases, but … try to guess … "

"I've no idea."

"Venomous brown snakes. They would turn Hawaii into an ecological disaster, and it could happen in a short time if they dropped off a number of snakes on each island. These snakes are amazing: they eat anything that moves. On an island like Guam, brown snakes are everywhere. Almost no birds or small animals. Most of those are extinct now."

"But how does that affect Homa?" Mila asked. "Snakes everywhere would be nasty, terrible, but they wouldn't be living up at altitudes. Or would they?"

"It would be years before the snakes were much of a problem and it would hardly affect the Moon project. In time the Hawaiian Islands would be a living hell of snakes, but even then Homa would still work. No, the people trying to dump snakes on us weren't spies or revolutionaries. They didn't want to destroy Homa. They were only random pacific islanders, pissed off at the wealthy in Hawaii.

When they worked here they were treated … let's say not well."

Another time she asked him about the world they lived in. "How did the world get so messed up? I mean, I've seen videos and pictures of the world, descriptions also, before it became such a shithole. So much of it was beautiful, remarkable. Many sorts of animals now long extinct. There were diseases, but nothing like our current ones. It was like our own special paradise. How could it have happened?"

"There's plenty of blame to go around," Gwyn said. "Humanity's basic nature was and is the largest part of the problem. And if you want one trait, it is our selfish inclination. The selfish have survived and propagated. A bunch of other unfortunate traits don't help, like aggressiveness, greed, and self-deception. Drives to conquer, accumulate, and reproduce. There's a focus on the immediate and short-term. These are traits that helped us survive and even thrive in primitive times.

"So things went to hell on the planet, literally. But it happened slowly, though, and incrementally, with ups and downs, more downs. It's an awful record: our ancestors went through trees, coal, and oil, in that order, using a lot of each one and making a mess of everything. While continuing to use those three, they started up a number of hi-tech sources of energy that used more-specialized resources. And they started polluting everything on an ever increasing scale.

"The other cause was capitalism, increasingly unrestrained as time went on. Capitalism creates what I like to call a 'savagely efficient exploitation of resources.' "

"Didn't anyone complain?" Mila asked. "Warning people about the future?"

"There were lots of Cassandras. Every kind of scientific study and fictionalized apocalyptic book. One famous scientist named Ehrlich, along with his wife, spent much of the second half of the twentieth century fighting for population control, with no noticeable effect. Many of the fictional books and videos described a future worse than what we have, but nothing helped. My favorite of those books was written by Aldous Huxley in 1948, one hundred forty

years ago, right after the terrible war. *Ape and Essence* is the title. It presents a Satan-worshiping society more extreme than most of our own happy and prolific Satanists. In the book, Satan had won completely, and they felt their only recourse was to worship Him and ask for His mercy. Some of our own people give this same reason."

At an early age Gwyn had learned about human sexuality, both scientific issues and the many ways it played out with real or fictional people, as portrayed in the videos and in the news stories he watched. At the time he had thought of it as another part of his environment that he might use to his advantage. Certainly it was important for him to understand this aspect of human nature. For him personally, the feelings and stimulation came earlier and were stronger than he expected. He decided he was heterosexual—the images that he found exciting were mostly of women and girls. For some reason he found bare feet titillating, perhaps because he rarely saw such feet in his environment.

These were feelings he suppressed and ignored as much as possible. He had several women he enjoyed watching, though that was as far as it went. Then along came Mila. He found her more attractive, alluring even, than anyone else he'd ever encountered. His reactions were strong—more than he could have imagined they might be. And there was so much to it besides finding her attractive. Everything about her, her cute facial expressions, her intelligence, her wit, how bold she could be. The totality was enticing. He thought of this in a way as a weakness for him, a potential liability. An enemy might very well think of an attractive human, male or female, as a way to exploit him. Analysis with his fancy simulator had shown that this had often been attempted. And obviously Mila had been partly chosen for her youth and good looks. They couldn't know the extent to which Mila was his "type," whatever that might mean. But he had become extremely attracted to her, while trying not to show it. He could ignore his feelings, pretend nothing was there, but still something was there.

For quite a while Gwyn had been tormented by these new and unfamiliar, even unwelcome, emotions. Intellectually he knew all about it: the sex drive, which shouldn't affect him much … until it did. Mila was almost driving him crazy.

And then she asked to see him alone and in person, where they could talk. He couldn't help himself; he went along with that. He could tell she was surprised that he agreed to the proposal. Probably she thought he was lonely, not realizing how much further it went. And that's what they did, talk that is, and nothing more, separate from one another. Until the fourth talk session, when halfway through she said, "Gwyn, please come over and sit beside me.… "

12. Nanomachines

After food, a shower, and the best sleep he'd had in a long time, Meyer sat and chatted with Rick Davis, his companion on the last part of the trip. They were waiting for final testing and for the quarantine to run out.

"Only six weeks here," said Davis. "So you didn't have to sign the onerous agreement they've been using for newcomers—I think it started a year or so ago."

"Ah, no. I've been buried under work. I don't even know what you mean."

"If you are ill, or no longer productive, basically if you become a burden, they can ship you back to the Earth. But if the colony is cut off completely, no shipping back and forth ever again, then they can require you to sacrifice your life, as many did during their 'six terrible years.' You have to agree to that—formally."

"Wow," said Meyer. "I didn't realize that was a policy."

"It's not crazy. If the colony gets cut off indefinitely, then its survival is more important than anything else. They wouldn't be able to maintain someone in a hospital bed, on a ventilator, you-name-it. Survival of such a cut-off colony will be difficult at best. That 'sacrifice your life' clause weeds out many of the chickens, the cowards who think they want to live on the Moon. Or my favorite quote I know by heart: 'Those who in a perilous emergency think with their legs.' "

"And who says the colony might get cut off?"

"Nobody wants to say that, but it's an obvious possibility."

"What else is in that agreement?" Meyer asked.

"Nothing much else as serious as the suicide clause, that's for sure, but a lot of other technical stuff. You have to agree to implanted sperm or fertilized ova, for genetic diversity. I signed the agreement. I'm on board with it. The colony comes first."

After going through several topics, Meyer decided to give Davis more information about what he and his colleagues were trying to do with nanobots.

"We want the ultimate 3D printer—a machine that could 'print'

anything, even itself. We already have that—3D printers that can print themselves. We want nanobots that can do that. A nanobot swarm that can construct anything, even more nanobots—especially more nanobots.

"We're trying to transfer everything we have on the Earth up to here on the Moon. That will include me if everything goes well. I'm a fanatic about the success of this colony. I would agree to the suicide clause with no hesitation. But there's still a bit of work yet to do back on the Earth."

"Great. I'll be looking forward to seeing you again, well, eventually."

"It's such a pain in the ass to go back and forth, I hope to have only one more round—from here to the Earth, finish what we wanted on the Earth, and back to the Moon for good. That's what I want, but I have some … personal issues."

Davis said nothing, but kept looking at him.

"Yeah, it's personal—what they call the two-body problem: solved by elementary physics, but still around for people. And some things will take getting used to for me—the required time on a centrifuge for example. I know it's essential long term, but I'm only going to be here a few weeks. Why can't I skip it."

"That's something I know quite a bit about," Davis said. "The Moon's environment isn't anything like microgravity, which is extremely dangerous over time, but still the Moon is insidious about gravity. Health problems creep in.

"And I've dealt with these policies. One reason you have to use the centrifuge as if you were already permanently here, why, it's because of the possible cut-off we were talking about. It could occur at any time. We want everyone well-prepared to stay here indefinitely."

"Sure, you're right," Meyer was conceding. "I can see that."

"We must use scenarios that the colony is suddenly and unexpectedly on its own, perhaps forever. For that reason and others, they, or we actually, have always planned as if the colony would suddenly be isolated, again for a short time, a long time, or forever. I'm directly involved in some of the planning for this, mostly the

biological part. We have a long list of critical supplies, ordered by priority, that we keep asking the base to send up. Many things that are essential and others that might be. They send up exotic scientific equipment, not yet needed or redundant, as well as odd materials of all kinds, like, say, rare earths. Also huge amounts of biological supplies—everything imaginable. Critically important are human and animal sperm and eggs. It's imperative that we have a large genetic pool in the colony and most births must be the result of initial external combination and careful culling of defective results. It's what breeding horses for racing used to be.

"We want every kind of other genetic material, such as seeds, spores, bacteria, viruses—the list includes millions of different species—which is only a tiny fraction of what is on the Earth. The supplies are usually kept in permanent shade, right in the volcanic tubes along with the colony, maintaining a maximum temperature almost down to –240 C, way below the liquid nitrogen temperature. Most such material will last indefinitely.

"Sorry to run on so. The issues of what to have sent to us here are obsessive for me. Arranging for supplies is what I was doing during my recent stay on the Earth. So many problems, so many egos … and ignoramuses."

"That sounds harsh."

"Some people I dealt with were helpful, with good, thoughtful suggestions. But so many of the others kept asking 'why this?' and 'why that?' for things I and others had decided were crucial for the Owl's Nest. But they only wanted to argue. A waste of my time and hard to be polite."

Later, several people showed up once they'd passed the infection tests and their quarantine was done. A biologist went off with Davis, and a 3D printing expert, Tom Englebrook, whom Meyer knew well, was waiting, along with a boy, eight or ten years old, thin. Meyer reminded himself to be careful—it might be a girl, and in that case he didn't want to offend her. Englebrook touched elbows with Meyer and then introduced his companion.

"This is Gus Martin, who is going to be your 'minder' for the next few days." Tom evidently thought further explanation was needed. "It's been more than a year since you were here, and we've started using seasoned companions to help keep newcomers from making any mistakes—for a week or so. Your little apartment here has a separate place for Gus to sleep. The idea is for him to be with you at times when you would normally be by yourself. An emergency could come at any time."

Meyer did the elbow touching with Gus and said the standard glad-to-meet-you stuff. Gus looked impossibly young for this role.

"Gus, tell Doctor Meyer what your duties are."

"I'm, uh, fluent in sign and I know the warning lights and sounds for different kinds of emergencies, along with what to do in case one comes along—what to do and what not to do. You're supposed to have studied sign—I hope you have—I'm to practice sign with you and rehearse the different warnings. I need to get you used to the centrifuge machines and schedule time for you on one of them. As Tom said, this is only for the first week." Then an afterthought: "There's a lot more orientation needed if you were to go outside in a pressure suit. Most of us don't go outside. I never have."

Meyer made a Thank-You sign and said, "Don't worry, Gus. I've no plans to go outside. At least I hope not."

Meyer followed Tom and Gus to the main nanotech laboratory, so called: it was also a workshop of sorts, multipurpose. It was located in the part of the colony known as Owl-C. The three parts, Owls- A, B, and C mirrored the colony's development, where the small Owl-A was built first, then a larger Owl-B build around A, and the much larger Owl-C was built out from two sides of Owl-B.

When Meyer complained to Gus that he no longer knew where he was, Gus said, "You should look at a 3D map. They need to get you display glasses so you can call up what you want. But everything pressurized is now called Nest-1. We've completed about half of Nest-2 a kilo or so down the tube.

"My name's actually August," Gus continued. "I was named after a Roman emperor, the greatest one. But call me 'Gus.' I'm supposed to stick with you like glue, 'specially when you go to your room at

night and get up up the next morning."

"It sounds kind of funny to hear 'night' and 'morning' on the Moon," Meyer said to Gus.

"Hey, we're humans from the Earth with its twenty-four hour cycles." Gus said. "We need that, it's our built-in circadian rhythm."

To Meyer, Gus now sounded like a precocious small person. No wonder they could use him as a minder.

As they waited in the laboratory, several people showed up whom Meyer knew by name and had talked with online, but hadn't met in person: there was Claire Henderson, one of two women in the group. Her specialty was programming the various devices. Then came Jon Liu, who was the mechanical expert. There followed a kind of formal "entrance," needing only trumpets: the wolf-fed twins nicknamed Romulus and Remus appeared. They weren't biological twins and their names were actually Robert Parker and Reynold Wendland, but people also referred to them as "Rom and Rem" or "the Roman twins." They were surprise recruits to the project, starting only six years ago as undergraduate students. They'd even taken a course from Meyer. He was amazed at their growth and had high hopes for them. They always worked together and had moved permanently to the Moon eleven months ago.

Meyer was glad to see the progress that had been made, setting up machines and getting ready for work. There were three newcomers and a rep from the local *Owlet* newsfeed, so Meyer decided to say a few introductory remarks. He was mulling over how much to reveal.

"Our team has set up two separate sets of the basic devices, which we call 'nanoforges': machines that create working nanobots. In each case, at the most abstract level, each nanoforge itself, using its own nanobots to carry out work, can construct a duplicate nanoforge. So self-replicating in a sense—a magic phrase. Where we are right now is not as neat and tidy as that might sound: there are patches in place, parts that are not elegant solutions.

"Small and independent self-replicating nanobots are still far beyond us. I like to think the main difference now is size, but it's

worse than that."

Meyer looked around, acknowledged two latecomers, and went on: "The machines differ significantly from one another, using quite different underlying approaches. This was deliberate, since we could only visualize two types of approaches and we wanted to try out them both. Each machine was functional at the lab in Urbana down on the Earth—first thing is to get them functioning after their shipment.

"This isn't as revolutionary as I would like. In the two cases the basic nanobots are completely different from one another. They are neither so great nor fancy, but still capable enough to build another nanoforge, under the old nanoforge's control. They assume an environment with basic components already available for use, 3D printed and arranged to be picked up. The nanobots can recognize what they need and utilize it. So separately one needs to construct those components. That's the easy part."

Meyer paused, perhaps to decide what he should reveal. "The goal is to get better, more capable nanobots, heading toward the holy grail of nanotechnology: the ability to assemble arbitrary structures atom-by-atom. To make a whole object that is a perfect diamond with no flaws, or is a perfect carbon nanotube construction, or whatever we might want; complex compounds we can simulate that have desirable properties but can't create. Yet.

"We have other methods to make such materials, but those are sneaky and specialized, in some cases using artificial DNA. Still, as many of you know, that's how we have our room-temperature superconductors now."

The Owlet rep had a question. "When will you get your, uh, 'Holy' grail?"

"I hope it will be in my lifetime, but it's always good to have a top-level goal. Now if the visitors can please leave we can get to work. Oh, and Gus, you should stay."

The group had worked for several hours when Meyer called for them to take a break while Gwyn talked with them. One of the nanoforges had functioned perfectly from the start—there were problems with

the other one. They pulled down a screen and set up the connection. After a couple of glitches, there Gwyn was, looking like a teenager with a large head.

"Thanks for letting me talk with you. Because of the annoying two-point-five-six seconds delay, I'd like to make a few comments, take questions, and then switch to technical sessions with each of your two groups individually. I want to thank Dr. Meyer for going to the effort of a trip to your colony. Some of you haven't worked with him before.

"First, I'm proud of the results you've been getting in this difficult technical area. I've talked with each of you at one time or another. I think this area, nanotechnology in general, is going to be our most important path into the future. Still, as many of you have heard me say before, right now this area is a luxury, not essential to survival. That's why the resources assigned to your projects are modest. Far more important is the goal for everything needed on the Moon: to manufacture it using only supplies and equipment available on the Moon, and to manufacture all such equipment *on* the Moon. This applies to batteries, solar power panels, machines of every kind, and many other mechanical essentials. We have our own computer chip plant—very modest compared with those on the Earth, and we can manufacture a copy of the chip plant here on the Moon. We can build our own specialty 3D printers which we use to construct our other machines. Naturally we use the same 3D printers to construct themselves. A newly printed 3D printer is exactly as good as the machine printing it—in other words, there is no steady degradation. We've also found satisfactory sources of most of the raw materials we need. Still, huge improvements are needed.

"On the biological side are even more problems of almost supreme importance. The chance is always present that the whole colony could be plunged into a crisis mode by some biological event, during which your work here in this lab would be paused. It could be a runaway microbe infection, or a problem with our microbial biome. With the mechanical and biological issues, we've been making satisfactory progress, in most cases using solutions from years ago.

"There could be emergent societal problems, mental health prob-

lems, organizational problems … I don't know, lots of stuff could arise or may be happening right now."

Gwyn paused to take a drink and went on. "So the 'luxury' of nanotech research doesn't do most of our people any good right now. I'd like to see other luxuries pursued as well, ones visible to everyone. You now have a small swimming pool, and I gather it's popular. You need more and larger pools. You know we plan other exercise areas, including much larger and improved centrifuges. I haven't mentioned this before, but I'd love to see one day a gigantic Heinlein-type cavern with humans flying using attached wings. We've found such caverns, but that idea would take tremendous resources—something for the far future. Always our top priorities should be the self-sufficiency of the colony, the wellness and safety of those who live here, and then as much as possible their happiness, their satisfaction, their continued commitment to the success of the colony. It's so easy to make those statements and so hard to put solutions into practice."

Another pause. "You are working right now on a second colony, your Nest-2, situated over a kilometer away from the current one. That is partly to give us options in case of emergencies such as run-away infections and other problems. After that, our plans call for a third colony, with a site already chosen fifteen kilometers away. That is to protect against small meteor strikes, although they should be rare. Finally, our planners want eventually to see yet more colonies, completely remote from the others, to protect against larger disasters, including some gigantic meteor."

Gwyn asked for general questions. There was only one, asking about the situation on the Earth. "I don't even want to think about it, but a major failure of our Earth-Moon transportation system is always possible. Or there could be a slow degradation … or anything in between. That could happen at any moment; it's why we are so obsessed with self-sufficiency. Another worry is not a failure of transportation, but some collapse of the Earth's current economy, such as it is. Then the colony might be indefinitely isolated. I don't expect such a collapse in the near future, like a few years, but it could happen at any time: slowly or quickly or right now.

"As most of you know, I've never been to the Moon. I and several

others help make policy for the colony but we've never been there ourselves. I'm looking forward to it. I can't wait to try out the swimming pool."

After that introduction, Gwyn spent three hours talking with the workers on the two individual projects, discussing many issues. So far they could get only one of the projects to work after shipment. With that one, the two crazy Roman twins had several improvements in mind for the constructed nanobots. Gwyn was particularly impressed with them: at one point they were directly patronizing him—he loved it. They were full of ideas.

The other project, the one that had somehow stopped working during transit, well, it was a puzzle. They would need to examine several key components to narrow down the point or points of failure. It could take a long time. This was typical for their work—rapid progress followed by long periods of analysis. Meyer was focusing on this project as the one that needed help, while the other moved forward with the triumphant twins.

Finally Gwyn broke off the communication. He was pleased with their progress, with their understanding of the basic approaches and of the various issues.

Two "days" went past—terminology that remained strange for Meyer, since shift work went on all the time, but still the main active and quiet times were the same as with GMT time. Then during the artificial nighttime, Meyer and Gus both woke up to flashing lights and an audible alarm. Gus immediately popped out of his separate space.

"What is it?" said Meyer. "A pressure failure?"

"No," said Gus. "The warning light is green, not red. That's a biological problem."

("I remember that now," Meyer muttered.)

"I'm pushing the button here on the alarm and that'll tell us more," Gus said.

The speaker announced: "Automated equipment detected a possible biological flare. The colony has now been divided into 53 separate

sections. Please remain calm, stay where you are without opening any doors, and follow the instructions at the base of this speaker."

Gus was calm, as ordered. "This is the first time I've seen a reported bio-flare, but they've had them before my time. I've only seen them in training drills. We won't likely be kept to this small apartment. But they'll tell when we can open our doors."

"Is the door a tight seal?" As he asked, Meyer decided it was a stupid question.

"Oh yes, tight against the two vees: vacuum and virus."

"OK," said Meyer. "How soon do you think the problem will be resolved."

"A problem with air pressure would be taken care of pretty quickly. They can easily block off a leak, and a leak won't spread like a biological agent could. But this is a biological flare—completely unpredictable."

Nevertheless, Gus seemed almost unconcerned. "Don't worry; there are stores of food and water under the bed, along with an emergency toilet. And they'll keep giving us instructions."

Instead of doing nothing while they waited, Gus decided to spend the time working on Meyer's sign language: "When you made the Thank-You sign, it wasn't quite correct." He showed Meyer the correct version and had him practice it. Then Gus started a whole long signed conversation with Meyer. It was good practice, but Meyer was sweating at the end, with a large number of corrections and suggestions of what he might sign.

At one point, as Meyer and Gus both got tired of the struggle with Sign, Meyer decided to ask about morale in the colony. "I'll bet you listen to everything, carefully, and a similar bet is that people mostly don't realize it. Is that true?"

"Pretty much."

'So tell me the routine stuff. What do people say among themselves, about their colony, about their lives here. I promise not to identify my source, you, of anything you tell me."

Gus was silent. "I can't do that. I hear a few things, now and then—not counting for much."

"Tell me the 'few things,' please. Are people happy, sad, scared,

angry, what?"

"I don't know. I hear complaints, not from everybody.... I guess the new policy—if the colony's cut off and you get sick, well, you get smacked. Some people don't like that.... There are people who don't like the scientists and engineers, that they look down on the others. I don't think it's a huge problem. Lots of people are excited to be here. Me for sure. I can't imagine being anywhere else."

"How long have you lived on the Moon?"

"My whole life. I was born here."

"Wow," said Meyer. "Do you have two parents here?"

"Yes. We live together as a family unit: my mother and father and me."

There was a pause, and Gus said, "Would you like to hear a funny story. I've never told it to anyone."

"Very much."

"My mother gave birth to me in the normal way, but neither of my parents are related to me genetically. Here's the funny part: when I was six, they carefully explained about the colony's need for genetic diversity, blah, blah, and as is often the case for the colony, I don't have any genes in common with either parent. They mostly use frozen eggs and frozen sperm from the Earth. It's kind of like on the Earth when parents tell a child they were adopted, partly so they aren't concerned even if they don't look like their parents. But my parents were telling me something I'd known for years: just their blood types made it impossible for either of them to be my biological parent. I'm type AB and my mom is O. From that she couldn't have been my biological parent; no type combined with O will give an AB. And in fact my dad is an O too, so he also couldn't have contributed to my genes. Isn't that a great story?"

"Yes, it is. I love it. But are you sure about your parents' blood types?"

"Oh, yeah. Everyone has their type tattooed on their arm, along with other medical stuff. I've seen their types on their arms. And I'm a universal blood recipient—don't take my blood, but you can give me blood."

"My record," said Meyer, "is on a chip inside my hand. That's

standard for us."

"I heard about that, but they didn't want to have to depend on a chip reader, like, in a crisis."

"Makes sense. So tell me, Gus, have you been back to the Earth?"

"Of course not!"

"A quick answer. I can imagine the negatives, but still it would be interesting for you."

Gus was lecturing to him, like to a backward student. "It's not feasible for people to go back except for a one-way trip or for an important mission. But even if it were easy I wouldn't want to go. A horrible, dangerous place now. And if I picked up certain diseases and continued to carry them, they might not let me back."

"Even now, there are fascinating things to see."

"Yes," said Gus. "And I've spent lots of hours looking at hi-res 3D videos of 'fascinating things.' The 'real thing' would be more interesting, I admit that." Gus was busy making air quotes.

"But I've seen close-up video of nasty blood-sucking leeches, and I haven't gotten the 'interesting' experience of having one actually attach itself to me and start sucking.

"Waves in the ocean, spilling over you, that would be fun, but in time we'll have an artificial beach here. And the poor Earthers can't get a one-sixth gravity beach. Besides, the Earth's oceans are saturated with poisonous compounds, tiny pathogenic microbes, large dangerous plants and animals, and what else? Oh yeah, and horrible man-made objects, plastic everywhere."

Over the whole rest of his stay Meyer would now and then continue his talk with Gus about the Owl's Nest, and he got a clear picture of a complex colony, with amazing details from one low-angled viewpoint, what Nietzsche called the *Froschperspektive,* the perspective of a frog—small and unnoticed, looking up at everything. A smart and perceptive frog. Meyer resolved to pass some insights on to Gwyn and others. Much later Meyer found out that Gwyn routinely used Gus as a source of information about the colony.

In the end the biological problem wasn't bad. Or there might have been no problem. Gus said in the worst case they would sterilize everything near the flare, and then the flare itself, but they likely didn't need to do even that. Finally, after a six-hour wait while they continued monitoring for whatever caused the flare, the emergency closure was lifted.

Gus was completely casual. "It was probably nothing. A detection failure. But you have to be careful. At some point this may save us from a terrible breakout. Once, before I was born, it took five days to resolve the problem."

It was past time to get up and go off to their work. Gus was also casual about that. "A few hours of missed sleep. Everyone is expected to work as if it hadn't happened. People doing critical tasks are supposed to self-evaluate." And that was the end of their bio-incident.

Two days later, in an evening alone with Gus, Meyer felt a slight shaking. He glanced at Gus, who said, "Moonquake. Small ones come on a regular schedule, larger ones hardly ever. I've never felt a large one. The colony is built to be quakeproof." Meyer thought "quakeproof" was an interesting term, one people no longer used in the San Francisco area.

After another week, Gus wanted Meyer to get a formal tour of the colony—standard for an important visitor. Meyer had always intended to ask for a tour, but he'd put it off because he was so busy with the nanotechnology. Finally, at his request, Meryl Strassen, the Assistant Colony Engineer, made an appointment to see him. She was used to getting stuck with such requests—a thin and older, energetic woman in what was usually a man's position. She was also a fanatic about the colony, expending a huge effort trying to improve its probability of success. She knew Meyer was a smart and important outsider who soon would be permanently with the colony. As usual, Meyer had Gus along with him.

"Let's talk as we move from one part of the colony to another," she said. "I assume you've seen material describing our colony." Meyer decided she had a way of sounding condescending.

"Oh, sure." Meyer said. "I've looked over several technical specs of the colony. They were thorough but didn't go too deeply into each of the systems and subsystems. Can we start with a quick overview?"

"Okay. I like to think of the whole colony as an impossibly complex machine, behaving like a living organism. The most important parts are places where plants are grown, to supply food, oxygen, and a myriad of other plant-based products. We have two huge separate hangars for growing these essential plants, along with seven other smaller more-specialized ones. These are each completely isolated—there are windows for you to look inside, but it's a double-door protected entry. Five of the smaller ones each contain a collection of animals, including insects. Altogether we have quite a variety of these breeding animals. We have sperm and eggs for most of the animals, so with an effort we can maintain genetic diversity. The 'variety' is because we don't know which animals we might later want or perhaps need. One small hangar includes places to grow meat in vats. Sorry, you won't be able to visit these facilities, but let's walk over to one of the hangar types."

They came to an anteroom that had a fancy door with a window in it, along with other windows showing the hangar interior. Through the window the hangar extended into the distance, too far to see how big it might be, but Meyer remembered that it was enormous.

"These hangars are the most complex and important part of our colony," Strassen said. "And potentially delicate. The two large main hangars contain individually distinct collections of species. They are each broken up into specialized sub-hangars. Some hangars contain a variety of insects. If there is a problem, oh, I don't know … like explosive growth of some species, or the spread of some plant or plant disease, or sudden growth of a plant or biome species, of a runaway insect species, we hope it will be confined to one sub-hangar."

Strassen was gesturing to the hangar through the window. "This is the door into Hangar One. A visitor or worker must wear a special suit and get partly sterilized in the small room through that door," pointing to the door. "Sterilized on the way out also. We're trying to contain anything weird or dangerous that might show up."

"Could you get by with one hangar?" Meyer asked.

"Not completely. Soon we would have to artificially supplement the oxygen supply, along with other actions. So far that hasn't happened. When Nest-two is complete, it will add two more huge hangars. At that point we could limp along with only three of the four. That's more than a year off.

"Okay, moving on to another topic, most sleeping accommodations are for multiple people, either in dormitories or for a family unit. Sources for food, drink, and water are centralized, as are collection places for human waste. You've been here for days, so you've been experiencing that. Everything must be recycled, absolutely everything. We like to make as much as possible out of plant material—such at clothing, containers, dishes, oh, lots of stuff. There are many scientific laboratories and machine shops. Plus places to gather for education or entertainment. We have the full Digital Library of Congress here, along with many huge supplements. There are many separate machines, mostly walled off, such as the pumps that move air throughout. They have special filters that are particularly important—to filter out any regolith that gets in. The regolith used to be a huge problem, but we've been on top of it for years; now we use regolith for building material." Strassen paused for breath here.

"Fortunately, well, actually by design, the colony is saturated with sensors, trying to keep track of everything. They're wireless and self-contained, so their signals reach everywhere amid any crisis that doesn't directly put a sensor out of commission. Any questions yet?"

"Yes. I'd like to jump right in here to talk about difficulties, problems, things that could go wrong. That's what I'm interested in. What worries you the most?"

"That's my focus: failures, any kind of malfunction. We've had over forty years of direct experience with what can go wrong. We have advanced software that uses the sensors to keep track of everything—things you'd never think of. And the software is overseen by humans—one of the weak links in the system."

"So tell me what worries you."

"I have several primary worries. Foremost is the biology. The biological side of our whole system is far too complex for any of us to

fully understand, not even our biologists; I'm no biologist, so I have to rely on others. All biological aspects are constantly changing. We are still usually being reactive about such issues. Often we identify a problem with a significant delay and still don't know its cause. Even knowing the cause, we don't necessarily have a remediation plan. We are often experimenting with possible approaches. I seldom think about 'solutions' to biology problems. Any change to the biology usually leads to other changes and new problems. We have a steady stream of new biology coming in with newcomers, new microbes, and there are mutations of the current biology. There is no steady state we can settle into.

"We also need to make our biology much more complex, many more species. We want more and larger animals. There's no limit to that, but adding species is extremely difficult. We need more insects, but they breed so quickly, stability is hard to maintain. In the Biosphere-Two project so long ago … are you familiar with that?"

When they both nodded, she went on. "They had deliberately included ants in their environment, but a small species of black ant snuck in and quickly killed all the other ants."

"The oxygen we breathe and the food we eat depend on proper functioning of the biology. We use plant materials for everything from clothing to furniture to kitchen utensils, and it must all be recyclable. We need places to recycle human waste, including even the bodies of anyone who dies. I'm pleased to see that our people have bought into the elegance, uh, the *appropriateness* of returning any of the dead to the organic whole. Finally getting past the ugly human practices of partly preserving those who die, and thereby polluting the environment.

"My other big worry is the human element—all the people here, their stability, their satisfaction with the current state. I hesitate to use a word like 'happiness,' though many are happy. I think happiness is overrated; dissatisfaction can lead to progress. I worry about the sanity of our people, whatever that might mean. For me 'sanity' means the ability to function in this environment indefinitely without causing harm. But there is lots of stress here. People will even try to hide physical health problems, and they often instinctively hide

mental health problems. I believe the horrible problems back on the Earth help us. Most of those problems we don't have here. It's too early to say, but our life-expectancy should easily be longer than down on our planet. Still, not everyone here goes along with the idea that if we lose contact, and they get ill, they might be required to sacrifice their life."

After a pause, where Meyer said nothing, Strassen continued. "The engineers here worry about our machines, but they are well-constructed, and after so many years of use and modifications, are well-suited to their needs. Our machines are the reliable part of the colony. We have machines that will manufacture our machines and will also manufacture themselves. We have the necessary raw materials. We have capable robots controlled by excellent AIs. Our machines give us much less to worry about than other issues.

"Let me give an example. We have lots of water right now. Fortunately people aren't complacent about plentiful water, but still, the supply shouldn't be a problem for many years. We have a lot of solar energy and energy from other sources, so we can break water into hydrogen and oxygen. That gives us rocket fuel and gives us emergency oxygen in case the plants get some disease and die. The machines that process water into its components are located far enough away from the colony that an explosion wouldn't directly cause harm. And such an explosion is almost impossible anyway. So we're mechanically pretty safe, but not biologically or psychologically safe."

Meyer made time daily to talk with Elisabeth. He'd begged for more video time and was almost surprised that they gave him a lot more. Gwyn might have intervened. Longer talks seemed to help her. One time she wasn't there at all, which was scary. She said she'd had transportation issues. The Nest used Greenwich Mean Time, six hours ahead of Urbana, so Elisabeth couldn't call too late, although privately Meyer would gladly have taken nighttime calls if necessary. She seemed tired and depressed. Her mental state bothered him a lot, and he even changed his schedule to get home sooner.

Both projects were moving along nicely now, where "nicely" meant long periods of design and planning, followed by repeated attempts that were practically the definition of trial and error, until finally the newly created and improved nanobots succeeded in constructing the new nanoforge. Often it was the old nanoforge with new instructions, and that step was quick. The project the twins were working on had made three improvement steps successfully. The second project took weeks to get started, but even with it they had made one improvement step. The idea had been to transfer work carried out in Urbana up to the Moon. Both Gwyn and Meyer were happy that their two versions of the same project were on paths of intermittent progress, which was what they had hoped for: successfully relocated the main nano research to the Moon.

It seemed like no time had passed till Meyer said a temporary goodbye to everyone. At least he hoped it would be temporary. Soon he was to start off on the trip back to the Earth, the reversal of his trip to the Moon: taking off from the Moon in the shuttle, refueling at L1 and connecting with the Staging Center, followed by an orbiter ride back to the Earth, using the atmosphere and parachutes to brake and land in the sea. This direction he wouldn't get a visit to Homa.

He would have two companions on the trip, each leaving the Moon forever. Fortunately, neither had been kicked out or banned. He'd had time to chat with them before the three of them left. Three was the maximum number of people who could travel at once. More would fit into the shuttle, but no more than three could be in the orbiter down to the Earth. He'd be with them for at least seven days.

Rob Rempel was older and he seemed almost impaired even in the Moon's light gravity. Some fifteen years ago he came to the Moon as a regolith specialist and had been a huge help in coming up with solutions to the many problems of dealing with the Moon's terrible dust, which they also melted and used to 3D print some of their facilities.

"I had a mild stroke that will make adjusting to the Earth even more difficult. At least the centrifuge regimen that I've been dutifully

following should help. There's no bigger fan of the Nest than me, and I'm proving that by ridding myself as a burden. I can continue my regolith work on the Earth—scaled back, even as there aren't any critical problems left. I'll probably spend a while in a wheelchair, but I'm slowly getting better. Josh here and I have been sharing our misery." Rempel pointed to the person beside him—a thin younger man who also didn't look well.

"Yeah, I'm Josh, Josh Matz." He touched elbows with Meyer. "I do, or did that is, computer networking for the colony, but I'm allergic to the Owl or perhaps to its excrement, who knows. Seriously, they tried everything, but couldn't pin it down. It might even be some kind of auto-immune disorder that's involved. The doctors here tried very hard to fix me up—I can't say enough good things about them—but I've gotten worse. I can only get by on increasing amounts of steroids, up to a level that's not sustainable over a longer period. So I'm needing to leave, along with my new friend Rob here. I'm hoping to recover down below and keep working in Urbana."

Meyer thought both his companions seemed defensive about having to leave. Both big fans of the colony, they evidently didn't want to, but had no choice. Meyer felt sorry for them both, but he decided not to sweeten conditions on the Earth.

"For you, Rob, fifteen years is a long time. It's the same Earth. They're making better use of technology and that's helped, but the, uh, morale has gotten worse. People aren't optimistic. You might not have heard about the mass suicides—they try to keep them out of the news, since hearing about it can lead to more. It's usually a small town or group that decides to end their lives. The Satanists encourage it; they welcome it and give praise to their, uh, you know, their leader."

"I'm still optimistic," Rempel said. "I have to be. The colony organization is paying for a long stretch of rehab over on Maui. I'm not that old. I'm hoping to recover at least enough to keep working on regolith—a terrible substance that can also be useful. But, Josh, what about you?"

"I'm hoping my allergic reactions go away," Josh said. "They even thought it could be the tiniest amount of your favorite: regolith,

provoking my illness. They want to keep track of me—see how I progress, notice if anyone else develops my symptoms—that sort of stuff.

"I'll still be trying to work for the colony as a programmer in Urbana. I want to be optimistic like you. But in the worst case, my relatives live in Canada, on the Pacific side. I hear things are not so bad there, except for the refugees from the south. I originally came from a smaller community in the mountains, and I might go back there if a job in Urbana doesn't work out. First I've got to recover. Everything depends on how that goes."

Meyer couldn't help himself. "We can always use workers in Urbana. But I recommend, uh, I *have* to recommend that you stay in Urbana and use secure on-campus housing. It's a relatively safe island in a dangerous sea of partly productive farmland. If you want to go back home, you need to find a way to travel with a group. You could try to settle back in your mountain city, if they'll accept you. How long have you been gone, five years or so?"

Matz nodded.

"That's longer than you realize. Some things are getting worse now. In that mountain town you might survive long-term."

Liftoff from the Moon was "only" three Gs, but two of them thought it was pretty rough. Meyer mostly complained to be in solidarity with the other two who were suffering.

So they found lots to talk about during the six-day trip on the shuttle: their time on the Earth, the current colony and its future, Meyer's work with nanobots, some of Gus's funniest stories, the latest news about the Earth, and so on. Meyer also spent time working by himself on technical issues.

Rempel was the old-timer, remembering when the colony was much smaller. "It grew up around me, and it's gotten so big and sophisticated, like a child growing up. Long-term stability is now the big problem. Well, *a* big problem. For what it's worth I'll never stop rooting for it."

"We all feel that way, you know," said Meyer. "With luck I'll soon be back there. I promise I'll give you updates."

The initial trip ended at the Staging Center, with two of the three Meyer had encountered before still there: Dmitri and Jane. Andrew had been replaced by a third person who was asleep while they waited. Except to say hello, Jane was busy with her work; Dimitri clearly wanted to avoid Meyer. While Meyer worked the other two checked out the Beatles room, listening to ancient music. After a short six-hour delay they transferred to the shuttle, which took them down to the sea near the launch facilities. Rempel then switched to transportation that would take him directly to Maui island where he could start his rehab. Matz and Meyer proceeded to a flight headed back to North America. Every step seemed to take forever. Finally, they waited for a flight that would take them to the air base in Rantoul north of Urbana.

Meyer hadn't gotten hold of Elisabeth for several days—always some connection problem or other. Now he was determined to try over and over. To pass time he checked the crap local daily newsfeed from Urbana. Part-way into their content he stopped cold.

Urban Urbana News — June 6, 2084

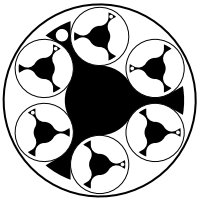
LOCAL WOMAN TAKEN TO HOSPITAL

Long-time resident Elizabeth Bloom was taken by ambulance yesterday to Marshall Hospital. The report listed the precipitating event as an "attempted suicide." There is no other information at this time. So far this year Urbana has had nineteen deaths officially listed as suicide, with a number of others suspected and an even larger number of attempted suicides. © 2084 $(\mathrm{Ur})^2$

Meyer felt like he was suddenly under water, with trouble breathing. He tried contacting various people, starting with Gwyn, but was only able to leave messages. It was the middle of the night in Urbana. Meyer didn't even know how he was going to get through the rest of the trip without losing his mind.

It was obvious to Matz that Meyer had heard something terrible. He talked Meyer into telling him about it. "It's always better to share bad news," Matz said. So Meyer showed him the recent story and

talked at length about Elisabeth on the flight to Rantoul and the short drive to Urbana. It was weird to tell a stranger practically everything about one's personal life.



Interlude B

Colony, 2557–2770.

13. Colonization

Michael Dyer realized the two doors right in front of him were open: the doors of his stasis box—each box had a double door entry. He was startled because they had just closed them. He hesitated and then stepped out of the box. There had to be some mistake; it must not have worked. But the man greeting him was no one he knew, and he hadn't been there when the doors closed seconds ago.

"What happened? Did it work?"

"Of course it worked. More than two hundred years have gone by. Don't worry. This feels strange for most people. I find it hard to believe myself."

It was impossible, but this was Builder technology that never failed.

"Hard to imagine—that the field can stop time."

The man shook his head. "This technology is a total mystery to of us, but they say the field can't stop time, only slow it down."

"Wait. Slow it down?"

"Yeah. I think it's like … for two hundred years outside, slow the inside to something like one second or so. But not zero seconds inside."

The man handed him one of the ship's orientation pads that stated he was among the third group to be released from stasis. Earlier he'd

gotten accustomed to using the pad. Jesus, two hundred years earlier. First there had been eight people, and then forty-four more, and now another forty-four, for ninety-six so far, over two days. There were almost two thousand yet to go, but they wanted to proceed cautiously. His orders told him to report to Lieutenant Kosower and included a room number and a simple map to get there. That was someone he knew.

Kosower gave a friendly greeting and showed him a table of assignments. "As expected," he said, "the ship is in a low orbit around the destination planet. We knew nothing about it until now, well, beyond the orientation before we left. Your pad gives basic facts: an earth-like planet, with familiar features, but showing no disturbance by man or indeed any evidence of a civilization as we might know it. The planet is covered with mountains, plains, oceans, rivers, lakes, everything. There are polar ice caps, and glaciers. Lots of jungles in the mid-section. Abundant life forms with large land animals as well as seas full of life."

"Christ, that's weird, almost disorienting."

"You'll get used to it. You have a biology background, and that determined your assignment. I'll show you to your duty department, where you are to observe what you can of the life below. The Captain announced that for now we'll continue with an artificial day and night schedule. For what remains of today, and into the night until tomorrow, you'll have sole access to the ship's fancy viewer, since only one person can use it at a time. You should take notes and be prepared to give an initial status report on the biological side of our planet at 0800 hours tomorrow. That deadline is more important than some final accuracy. But I assume you'll stay up late tonight with this assignment. I mean … do the best you can in the time you have and report what you've found. We assume it will be incomplete—just your initial discoveries, probably focusing on the larger animals, but you can decide that. Still, you should have an initial written report that we will distribute. Any questions?"

"No, I guess not. I still feel … confused."

"Join the club. That's what I say to everyone. We're feeling odd. What's wanted is some basic information, that's all. The others in

your station can help orient you about sleeping, food, and everything else, but nothing has changed since you went into stasis, yeah, except that we traveled thirty-two light years in two hundred thirteen years. And I can't believe that either."

Kosower left him with four others in a good-sized duty room. They looked as stressed as he was. There was relatively light centripetal gravity from a slow rotation of the ship. They talked for a while about the crazy experience of waking up after two hundred years, but Dyer was increasingly bothered by the idea of a planet "almost like the Earth—with abundant life forms" that was only thirty-two light years away. He felt a shiver, as if he was cold; it seemed to be an impossible coincidence to find a beautiful planet so close.

What had they said? What had they promised, when they came to his settlement? The town had about four thousand people living a difficult life. They were freezing cold in the winter and boiling hot in the summer, with never enough to eat, and food was getting ever more scarce. There were so many diseases, poisonous animals, insects, and plants—a nightmare for them.

A gigantic air vehicle arrived, larger than anything they'd ever seen. The people never saw an actual person, but only heard several persuasive voices that spoke their language fluently, and promised a much better life at a distant star. The voices offered a one-way trip, with no chance of return. The trip would seem to last only a few weeks, since they would mostly be in a suspended sleep. They could take many belongings, but no living things—no plants or animals that could become invasive.

People had many questions, endless ones, such as:

What is it like where they would go? *A planet similar to the Earth, even with similar life forms, but no humans. The planet is well-suited to you as colonists.*

What will it be like for us? *It will be similar to times in the Earth's history when settlers moved into unpeopled land, or land only peopled by indigenous humans. In this case there are no humans.*

How will we survive? Get food and shelter? *It won't be easy; there will be hard work for you. The ship will remain in orbit around the planet for two years, providing modest amounts of food and shelter to those not yet provided for on the planet. The ship will provide shuttle vehicles you can use for trips down to the planet. You will have to build your own shelters and obtain your own food from the planet.*

That's no answer. How will we build shelters? *The ship will supply many hand tools, like knives, saws to cut wood, shovels and other digging tools, carpentry tools. There are extensive forests with a vast supply of wood. But you will have to construct your own shelters, perhaps out of logs or using animal skins. It you want water with no nearby source, you'll have to dig your own wells. It won't be easy, but it will get much better with time.*

How will we obtain food? *There are nourishing plants which you can harvest immediately and later learn how to farm, animals you can raise for food and for their fur. You will learn how to kill animals for food and for their skins and bones.*

How will we learn how to do this stuff? *The ship will leave a number of workstations with access to versions of its library. Along with lots of data there will be a great deal of practical information, such as how to make concrete, or steel, or glass. But it will be many years before you have such luxuries, though the planet has the necessary raw materials.*

There were cautions: *The ship will not answer any questions. You must decide yourselves where and how to build. You must discover what on the surface is dangerous, what is nourishing and what is poison. The ship will provide only food in decreasing amounts during the two years it stays. Some of you have major illnesses, or parasites of different kinds, infections. Several of those we will take care of while you are on the ship. Other illnesses you will take with you. After you leave the ship we will provide nothing like health care or any treatment for illnesses or injuries.*

Injunctions: *You will have no dominion over this planet, but instead a commitment to keep it in good condition. You must dedicate huge areas as wilderness, undeveloped. You may kill animals for*

food, or to make other use of the deceased animal, but you need to learn how to protect yourselves without killing. You may not ever try to exterminate any species which is troublesome for you.

Finally: *This new world will seem like a paradise compared to what is around you here.*

In the end well over half the town signed up to go. It wasn't so much that they were persuaded by the descriptions, as that they were concerned how they might even survive the next few years where they were.

They were required to elect their own leaders, starting with a Captain of the ship, instituting a quasi-military structure. Over several months they relocated into the giant ship, moving their personal items on board. After they were ready, they informed the giant ship and it left. By the tenth day of the voyage, almost everyone was in what they called "stasis"—a kind of perfect sleep. Michael was better educated than most and was late going into this sleep. And then they woke him up.

Dyer got to work examining the planet's surface below him. The ship's viewer had a large screen that would show images from anywhere on the planet and from whatever altitude you wanted. The viewer was tied to some kind of drone whose flight over the planet he could control. He saw that another screen displayed large maps of the planet, also showing where his drone was.

This was a Builder system he had trained on before they left, so he was able to start work immediately. He began making records of different life forms, one after another—a large variety. He saved images using another feature of the viewer. Fairly quickly he thought the images he was seeing looked familiar. He'd been shown the huge ship's library and how to access it. It had vast materials about the Earth's current animals, as well as historic animals. The terrible collapse of so much on the Earth had resulted in the extinction of many large animal species. After getting a new image from below, he started trying to find something similar to it in his references—an annoying task with so many online images to look through. As time

went by he got lost in the work, hardly even talking with the others in the room; they had different assignments from his.

The next morning he found he was nervous as he presented the results of his hurried biology study to a large group including the Captain. He also felt groggy from lack of sleep. Over the past day they had awakened several hundred more people and many of them were in his audience. He cleared his throat and started in …

"The prominent collection of larger animal species on the planet below consists of the Earth's dinosaurs, of many different types."

There was an immediate response from the first row. "Dinosaurs! Is that what you said?"

"The large dominant life forms below are dinosaurs from our own ancient history—the history of the Age of Dinosaurs, ending sixty-five million years ago."

The same person said, "Are you crazy? You must mean they are *similar* to the Earth's dinosaurs—they look like them. They resemble them."

'No, Sir. Our ship's library has online references to the Earth's past dinosaurs, a huge amount of information about them, from earlier than sixty-five million years ago. I was able to match up more than two dozen of those on the planet with ones from the Earth in the library's references. Many of them have distinctive features."

The person interrupted again. "Weren't there hundreds of different kinds of dinosaurs over tens of millions of years?"

"Sir, on the Earth there were over a thousand such dinosaurs documented in the references, with evidently many more that were never discovered. I spent the entire last sleep period staring at images in my viewer of animals below, and comparing them to examples in my reference materials. I found some amazing similarities with animals that lived on the ancient Earth of 80 to 110 million years ago. Well, actually not similar but identical. It will take time to get more complete results."

Another person chimed in with a high-pitched voice. "Do you mean we've somehow gone a hundred million years into the past. Is that ancient Earth below us? Is that where this crazy Builder ship took us?" The tone was almost hysterical.

"When did you come out of stasis?" The Captain sounded impatient. "Let's get this straight first: We're at the proper place. At the Bilanti System, not the Solar System. That's no past Earth down there, but a new planet." He glared at the person who'd spoken. "We've been studying the planet and the neighboring stars for two days now. Calculating constants, like the size and mass, its gravity, and a lot of other data about the planet below. Our new planet is similar to the Earth in many ways, but not identical in any way. The continents and oceans are completely different from any kind of ancient Earth. There's nothing corresponding to a large ancient Pacific Ocean. From here it's easy to locate our own star and see that it fits in with other nearby stars. In this case the sun we're close to differs markedly from Sol. We are not seeing a past version of our own planet below. But it's impossible for it to have dinosaurs from the Earth's past. Impossible."

Then the Captain tried a conciliatory tone with Dyer. "Son, you stayed up all night, and by morning you had pictures from your online references mixed up in your mind with images of actual animals below."

"Sir, it's not only dinosaurs, but some kinds of smaller animals below are also described in my references. Plants too, though I didn't focus on them." There was silence in the room. "Let me show examples." He proceeded to lay out example after example for them. No one in his audience was familiar with different kinds of the various animals from the past Earth. They were completely unfamiliar with what dinosaur belonged in which historical period on the Earth.

Someone else stood up. "Young man, this is a sick joke you're playing on us and I don't appreciate it."

"Sir," Dyer said, "We have the display technology right here. Will someone familiar with these cameras please come up and bring up images from below for everyone to see?"

The noisy person from the front row chimed in again. "What difference does it make whether they are exactly the Earth's past dinosaurs or just similar to them? It doesn't matter."

Dyer was irritated at his audience. "I've been thinking about that very issue. A planet only thirty-two light years away from

us that looks much like the Earth and happens to have dinosaurs similar to ones from our own past, why that would be an impossible coincidence—something defying any reasonable explanation. But having them *exactly* like our own dinosaurs—that can be explained. We might guess that the Builders did it at the tail end of creating an interesting, hospitable planet. I think they must have been constrained to an Earth-like planet, but without any life and without a breathable atmosphere."

Someone else spoke up. "Are you saying they could take a sterile planet, say, like Mars, and in a few hundred years change it to what we see below? I don't believe it."

"Of course they didn't start with a planet like Mars, but with a planet like the one below, which is like an early Earth, but initially lifeless, or with life that would be wiped out by their work. We will have to believe this as the only reasonable hypothesis." Dyer paused here, surprised at his aggressive answers to their questions, but he was tired and had been thinking about the whole night. The silly-sounding excuses they put forward were annoying. He went on when no one else interrupted.

"Here's another issue: If the life below had developed independently of our Earth, it would surely be incompatible with us, likely a deadly poison. The Builders didn't go to this trouble to dump us where we couldn't survive."

Yet another person had an odd idea. "Listen to me. We know that devices provided by the Builders can do almost anything. We are not seeing actual animals in front of us, but images supplied by devices of the Builders. I think they created an elaborate model of a non-existent planet to display to us. Perhaps it's some kind of psychological experiment for them, or some twisted idea of humor."

Several people tried to talk at once, mostly refuting what Dyer just said. The Captain broke in: "I suggest that we will soon know if what's below is faked. I'm assuming for now it's real. Meanwhile my good friend Andrew Hanson knows a lot about science. I'd like to ask him to give us an analysis of this situation. Please help us out, Andrew."

Hanson was a small, older man, seemingly intense though. Dyer

knew him from before and had respected him, but as someone who didn't suffer fools. "Before we left, the ship answered the questions you seem to have. I suggest we take those answers as true facts. Facts we will have to live with. As the Captain said, we'll soon be using the available shuttlecraft to investigate and explore the surface below us, and I assume it's no fake." Hanson paused to glare at everyone, and then went on.

"On the Earth before the collapse, the sciences and technology were advanced, far beyond where we are now. The Builders seem to be incredibly far beyond even that. Still, what the Builders and their machines can do fits in with our ideas about what should be possible. We covered thirty-two light years in somewhat more than two hundred elapsed years, so at roughly fifteen percent of the speed of light. Our ancestors, even at their peak, weren't remotely close to creating such a craft. Nevertheless, except for the stasis field, which uses some technology we don't understand, the ship that brought us here might possibly be built by us someday, as science advances. Our ancestors were able to recover the full DNA sequence for some ancient animals, including that of the Neanderthals. They might have been able to use cloning techniques to recreate that species and many others, though they apparently never got around to it. The Neanderthal's DNA only had to partly survive for fifty-thousand years or so. Dinosaur DNA shouldn't survive for millions of years, but enough fragments of DNA or whole frozen portions may still be around for them to recreate everything. Or perhaps they found another way." Someone tried to say something or ask a question. Hanson ignored the interruption.

"In any event, I imagine the Builders started with a completely sterile planet and turned it into a partial physical replica of the Earth. They wanted it populated with life, so they resurrected life from the Earth's remote past to use as the life on this planet. For them, I think it could be a sort of interesting experiment—to see if they could do it. That's my best guess for why the life below looks the way it does. Very soon we'll be examining the surface below directly." Hanson asked for questions but no one responded.

Hanson had more to say. "Some of you may not yet realize

that on this ship we have access to an incredible library, with more information than we could ever look at. It also has a helpful but limited artificially intelligent entity that can find information for you. Back on the Earth they denoted this kind of software an 'AI,' sort of a stand-in for a librarian or other human. The library only has information up to some twenty years before the great crash. You should familiarize yourselves with this resource. As you know, again before we left, the ship said it would provide library workstations on the surface to help us get started. We may only have access to the total library for two years, if that long. I'd recommend looking some things up right away."

The Captain then started in. "After what Andrew said, I now think the Builders surely did create this planet below us, and decided to let us colonize it, part of a grand plan. It does seem to meet the descriptions given by the ship before we left. And I want to remind everyone not to forget the other requirements the ship mentioned at that time: we have no dominion and must take good care of this planet."

Later, the Captain had a line of people wanting to talk with him about a variety of issues. It was always a line—of them begging, threatening, complementing, and asking, asking, asking. The one currently in front was Faredun Koneru, someone he trusted as representing the minority of Zoroastrians in his village and now on his ship. Those people had been the last remnant of that religious group on the Earth. They had joined their village a long time ago because of persecution elsewhere. Faredun started right in.

"Cap, I think we may have a problem, something that will surprise you."

"Nothing from your group surprises me, but go on."

"It's complicated. I guess I'm going to have to spit it out. My people, most of them anyway, well, most of those out of stasis right now, believe that what's down on that planet is literally Hell, the dominion of their version of the devil. Actually there's more to it. They believe in an evil entity, but they don't call it the Devil or anything like that. Still, they are concerned about what this planet represents."

"Please say I'm dreaming. This is something we don't need. So why did they come on this trip? What were they expecting?"

"Like I said, it's complicated. They believe in a benevolent entity, and they thought it was rescuing them from the terrible place the Earth had become. Now they're kind of turning in the opposite direction, I think mainly because of the dinosaurs, which look to them a bit on the demonic side. You should realize that I'm not much of a believer. They know this, but many of the younger people are like me. And even the older ones trust me to some extent. By default I'm their primary liaison."

The Captain paused, and threw up his hands. "Okay, what can we do about it? Seriously."

"I've been thinking about this. You're sending a group down in the shuttle. Rumors say it will be four people: the dinosaur guy and three others. Make me one of the three."

"I've had a large number of requests just like yours. I lost count. Why you?"

Koneru answered quickly. "Certainly not because of what I just mentioned. I specialize in ecology, one of the few such specialists we have, and the youngest one. That should be the reason. For two months I was in what amounted to a combat situation, so I'm used to stressful duty. In the end I'll make the case to my people that the planet poses no threat, that it's the product of some kind of Builder whim, or even sense of humor. It will help me a lot in persuading them if I'm part of the first group going down to the planet."

"I'll think about it and let you know. That's the best I can do. Oh, and have your people been talking about this outside their own group?"

"I've been cautioning them to keep this to themselves. Anyway, there's not much socialization between my group and everyone else."

Michael Dyer was delighted to be part of the first team to take one of the ship's shuttles down to the planet—probably chosen because he was more familiar with the life forms than anyone else. A minority of the ship's personnel had argued endlessly about the possible hazards

of the trip. What if everything below was poisonous to humans, say, based on different organic compounds than us? Answer: Well then, why would the Builders choose this world, populate it with what they say are life forms we can use for our survival, for food and shelter? And then send us to the planet? Why, if we were all going to die? The ship told us many things about the planet even before we left. Some people voiced further comments, such as: What if they made a mistake? Answer: The Builders don't make mistakes. Well, shouldn't we be at least a little cautious? And so forth.

There weren't supposed to be any of the Earth's animals on their ship except for humans, but someone had snuck on a pet hamster. It was a male and by itself, so the Captain had allowed it to live. They decided to take him along and expose it in the shuttle's airlock to the air outside. If it did okay, they would go out and start taking samples of everything.

Using this test animal would be almost no extra effort or delay. They would breathe the air, but certainly not drink or eat anything from the planet. That should come later. Someone suggested they should try to feed something from the planet to the same animal, and that was agreed to.

Then came questions: what about other dangerous animals? Dangerous insects? Dangerous microbes? What if we catch some horrible illness, either bacterial or viral. And the partial answers: For animals, the crew would carry ordinary handguns they'd brought along with them from the Earth. They would be quarantined in the shuttlecraft itself afterward, for at least five days. They would search for insects and disinfect against microbes.

Someone worried that the newcomers themselves could contaminate the planet in some way, and that was followed by the same argument: that this would have been anticipated by the Builders. Their instructions said not to bring along any animals or plants—no invasive species. The lone male hamster was not going to reproduce. They surely brought with them many microscopic organisms, including their own biome. Or even larger organisms, such as ticks or fleas, who knows what. The Builders must have had some means of dealing with such life forms. Someone asked about the hamster.

Could it be a pregnant female? The answer was no, it had been a pet alone for a long time, so it couldn't be pregnant.

They had tested the shuttle with a short trip to the surface without getting out. As expected the semi-intelligent (or actually intelligent?) entity controlling the craft wouldn't allow any maneuvers that posed the slightest risk. This was Builder technology after all.

There were only the four of them (plus the hamster) on this first trip, although the shuttle could hold many more and had a large cargo area. In addition to Michael and Faredun, their group included Horace, a computer systems specialist, and Kilbor, who had studied physics and mathematics. None of the four were scientists in the old sense—they knew more than their peers, not what real scientists would know, and they knew enough to realize this.

The shuttle settled down on a grassy inland plane without much cover, deliberately chosen to be a safe-looking solid surface, without any large animals hiding nearby. The initial tests went well—the little hamster was happy to be exposed to the atmosphere. They started taking samples that were carefully placed in labeled containers. They picked some grass and were prepared to force it down the hamster's throat, but it readily nibbled on the grass. Then they hopped with the shuttle to another area, and another, until they ended with a more interesting jungle area where they would need to be careful about large animals. In fact they'd seen an upright dinosaur somewhat taller than a man, looking more like a predator than anything they'd seen before. Dyer was familiar with this particular dinosaur, even knowing its long scientific name. He'd found it interesting that this very dinosaur had been featured in an ancient movie and misidentified as a "Velociraptor" because that name sounded better in the video than the correct one. He told the group that this animal was definitely a predator.

In retrospect Dyer couldn't believe they had made such a mistake. They were so interested in the planet that they forgot about possible danger, and didn't maintain basic care and situational awareness until too late. The four of them were outside the shuttle, not even close to it. They'd seen one of the uprights at a distance, and he moved closer to them, fairly close, but he didn't look that dangerous. Plus

he moved slowly, and they had their guns ready. Suddenly there were three of them, and then many more, several blocking the short way back to the shuttle. It happened so fast—they moved much faster than he expected. Even though they shot several of them with their guns, only one of those stayed down. Two of them attacked Horace. He was on the ground and maimed, hard to see how badly, when … how to say it? The dinosaurs froze and then settled down on the ground dead or asleep.

Dyer had no experience with an emergency like this and wasn't processing what he saw. The dinosaurs weren't moving, and yet there was movement to his right. A man was walking calmly toward them. He was tall, walking confidently. Very dark-featured, with black hair and eyes, and with strange dark clothes—solid black but hard to look at. Irrationally that bothered him more than anything else. How did it make sense for black clothing to be hard to look at? Yet it was,

The man stopped and finally spoke. "How could you possibly get into this mess?" The villagers spoke a kind of English creole, even the Zoroastrians, although the elders had their own language, and a number of others could speak regular English. The man spoke the creole perfectly. Dyer noticed a writhing fuzziness, like something out of focus, around Horace on the ground.

"Don't worry about your companion. He's getting treated and will be fine. You people have a ways to go if you want to claim the top-predator title. But let me introduce myself. I'm what you could call an overseer of this planet."

Kilbor, the oldest of them, found his voice. "You're one of the Builders?"

"You'll have to decide that for yourselves, but this isn't what I actually look like. I assumed this form so you wouldn't be too … uncomfortable. The dinosaurs around us are sleeping and they'll be fine when they wake. I'm also taking care of the poor dinosaurs you stupidly felt you had to shoot. They have a fancy scientific name, but never mind. I repeat. What's wrong with you people? You're going to have to interact with this planet without needlessly harming its wildlife. Those nasty, ugly guns you used. You'll be out of ammunition for them soon, and then what?"

"Is Horace going to be all right?" Kilbor said, just as Horace himself sat up and asked what had happened. The four of them were having major troubles dealing with everything going on. It couldn't be happening.

The apparition continued in a condescending way. Maybe it was a Builder, but that didn't seem to matter right then. "The four of you need to climb back into your shuttle and go up to the ship. Tell everyone what happened. Tell them the next time I won't be around to intervene; none of you will ever see me again. There'll be no rescue if any of you get in more trouble. You will have to learn to take care of yourselves, as well as taking care of your new planet and its wildlife. You do not have dominion over this planet, but responsibility for its care.

"Welcome to Dinosaur Planet!" As he said that he became less substantial. They could see through him, and then he faded away and was gone. The sleeping dinosaurs woke up, and those who'd been shot had recovered. They ran off in different directions.

Faredun hadn't seen the slow disappearance of the apparition and was in a state of total shock: "Wait, what happened? Where did he go?" They had to explain the vanishing act to him. After adolescence, Faredun had never taken his religion seriously, as his family and older friends did. But this creature filled him with dread and terror. He couldn't help himself. For his people, white was the symbol of cleanliness, purity, and goodness. Black was the opposite, the symbol of greed, wrath, and envy. Until that moment he'd been an educated unbeliever. Suddenly it seemed that everything he'd been taught was true, and real. That the planet he was standing on was the domain of their evil one himself, and he had met up with him. The creature's sarcasm, confidence, his obvious great power, and then his black clothing, it all swept over him.

During the shuttle ride up to the ship Faredun had time to calm down, to think seriously about his cultural reactions. The person or creature they had met seemed to have total power, but otherwise he was mainly angry that they had stupidly gotten themselves in a bad position and then had killed some of his dinosaurs. Well, tried to kill them, without any need for food or for parts like fur, skin, or bones.

This planet was sure to be much better than what they'd endured on the Earth. If the people in charge were smart, they might interview the four of them separately over the next few days, and compare their stories. So now would be a good time to go over their experience and try to get a consistent story that wasn't filled with dread as his might be.

The entity's black clothes! He wanted to de-emphasize them because they would be so frightening to his people. Faredun had thought it was another stupid move to have no video recording of the terrifying black-clothed person. As it happened this was just as well—no visual record of a truly disturbing entity. Faredun's immediate reaction was that the clothes were hard to look at. But he didn't remember what they looked *like*. That was totally strange.

He decided to start talking with his freaked out colleagues. If the subject of clothes came up, he would dismiss it as irrelevant. He hoped to get a combined story, consistent across the four of them, a story that wouldn't be so frightening to his people. At least he planned to maintain that the planet was like a newborn child, neither good nor evil. This could still be his people's version of their Paradise, as the ship had told them before they left.

14. Backstory

It was better to have at least two shadows supervising a planet, since they would be around for decades and enjoyed the companionship. But so few were available, that goal usually couldn't be met. In this case one was newly arrived while the other was soon due to return to the Earth. They identified themselves to one another and communicated together in ways impossibly complex to describe correctly in a human language. They also used comic and sardonic nicknames for one another, which are translated below as "Bert" and "Ernie," although the nuances of their real names are thereby lost. The language given below is a rough and drastic simplification of the information they exchanged.

"That went remarkably well," Bert started in. He was the one who'd confronted the settlers. "They will go back with their stories, not agreeing as to what had happened, even with five more days of isolation together. They have no evidence they'd met up with anyone or anything, let alone a mysterious person, possibly a Builder, or maybe something worse. And this scene will become part of the foundational folklore of the planet and of their culture."

"I'm not sure how you set this up," Ernie said.

"I made careful preparations, first to arrange a sort of ambush by the raptors, who tend to be solitary and are much more shy than their attack on the humans would indicate. Then I managed to ensure that one of the Zoroastrians would be along, so that my carefully doctored appearance and even my words would seem diabolical in a literal sense to their group—that I was either their prime evil entity himself come for them, or at least a minion. Also, they were much more careless than I expected—that helped.

"Right now I'm following what the four brave explorers are saying on the shuttle as it heads back to the ship. It's clear Faredun is retelling what they had seen, trying to get them wedded to a single narrative. In the end it won't work. As soon as they separate, their stories will start to diverge."

"You have simulation support for this approach, right? Please send me that data, but for now explain to me again why you're so

fond of what you're doing: trying to instill uncertainty and fear into their culture."

Bert gave his pedantic reply: "This is their Garden of Eden moment: the time when they get the knowledge of good and evil. In the short term we want a successful human society, where 'short' means several hundred or even a thousand years. Later it will change into something beyond that, something completely outside our authority and control. But for now and with humans, given their genetic heritage of an aggressive top-level species, it doesn't work to create a carefree and happy society. Instead what is needed is good opposed to evil, where they deliberately choose to do good and behave well. Otherwise they might not even recognize evil when they encounter it. And without a knowledge of evil they wouldn't be able to tell that they were committing it, living an evil life. The reason for such a choice must not be like a primitive tribe that believes in some reward in a later existence, but only because such a life is its own reward. Eventually leaders will come forward who can convince them."

"I've heard this theory and details of your approach from others, but I don't agree with it. I've seen simulation support for an approach that leaves out the 'evil' altogether."

"Yes I've seen that alternative. In my view they're not wired up for that. We don't want the humans on this planet to be 'docile sheep,' or 'ferocious wolves.' We want 'clever foxes.' "

"A cute comparison, but it doesn't fit or work," Ernie said. "I agree that their evolution has given them a long list of bad habits: aggression, violence, greed, tribalism, hoarding, and many others, such as selfishness. But their intellect has given them cooperative, non-violent, and non-selfish solutions. From the beginning we should encourage them to work things out together. I think your approach is non-optimal and leads to other non-optimal approaches which are eventually abandoned in favor of better ones, cooperative ones."

"Well, I'll be leaving soon, heading back to the Earth, leaving you with the responsibility for this planet. Anyway, you and I agree on minimal interference, and you'll be working hard to ensure the physical environment remains what we promised them: practically an Eden."

"We still control their population," Ernie said. "That's not minimal."

"True. There's never been a human society that could breed as much as it liked. That would require a completely different organism."

"And we promote genetic health and a healthy birth," Ernie said.

"Yes, there are no miscarriages or stillbirths, and no genetic defects. It's easy to see to that. Almost none of the old forms of insanity and no autism. But otherwise we don't interfere to make them live longer, so most die of 'old age' before they're a hundred years old. It's interesting that some of the humans have taken note of this interference. In old literature they read about deaths before birth and about various illnesses including those from genetic defects. And that's not to mention the carefully controlled population density. Our fingerprints are everywhere, but most don't think about it."

Ernie wouldn't give up. "But on the other hand we don't prevent violence against one another, or for that matter, any of the many kinds of terrible things humans do to each other. As I said, over time they will behave better and get the benefits of that. We are leaving a number of vids and these will educate them in many ways, in the end helping them leave their violence behind. The education is oriented toward critical thinking and not toward any particular philosophy. They must come up with that themselves."

"Anyway, I've enjoyed seeing you, even for such a short time," Bert said, "but it will be nice to get into a larger group. I understand that another shadow is on its way here. It should arrive in twelve years or so. And a long time from now you'll do your first merge. It's an interesting and rewarding experience for your two parts to see what's been happening to each other."

They each had followed a standard, massively complex drill to travel to any planet and then get back again: first a copy was made of the person's shadow so it could be transmitted through space, in this case a distance of thirty-two light years, taking that amount of time for transmission. Another copy of the same shadow continued in the Solar System, caring for the single wet human body. The rules were strict that their two shadows had to be coalesced and synchronized

into one as soon as possible. In the case of Bert, by the time he did his merge, some hundred years or so will have gone by: sixty-four years of travel that he didn't experience and forty years on the planet. As Bert had said, the merging was always interesting for them, since the physical brain more or less knew what was in the resident shadow, while the other shadow held new experiences. After the merge there would be one body and one shadow.

"You'll have your work cut out for you," Bert said, "trying to maintain stability in this weird and fragile ecosystem."

'Yeah, sure, I know. And fortunately for me it pretty much runs itself."

The work required an unbelievably complex databank that kept track of the trillions of entities and values and trillions upon trillions of interactions, so that the values could be tweaked to maintain stability. The normal humans had no idea how unstable their world still was. The old Earth, before humans made such a mess of it, had been relatively stable, with occasional catastrophes. But the new Earth as Ernie and his colleagues had been restoring it, and this newly created dinosaur planet, were both unstable, prone to runaway overbreeding or partial collapses involving any of the myriad species of plants and animals.

"It was such a great cosmic joke," Bert said, "to fill this planet with an entire ecosystem dominated at the top by dinosaurs. For this and any other of our new worlds, we could let everything randomly work itself out on its own without interference, and over a long time that would produce stability, after tremendous population swings of many species. Many would die out completely and others would evolve. After thousands of years a stable system would evolve, with many top-level animals gone. After millions of years, the top level would get filled up, and an interesting planet would emerge. Of course we didn't want to wait that long.

"Some forty years ago I took over from the previous caretaker. You're due to stay about that long. But I'm way out of date about what's been happening with the Earth itself. Anything particularly nice going on?"

"Come on, you must have seen the reports," Ernie said, "but I'll

go over my favorite examples. There are ecosystems on the western side of North America that had mostly collapsed completely. We are restoring them, um, not 'we' any more, but I was helping. As we're doing here we had to introduce many plants and animals at the same time. Had to create the larger animals using DNA cloning. Very complex, with occasional population explosions, but it's going along fairly well.

"While I was working on the Earth, others were carrying out preparation of planets, from scratch?" Ermie said. "How is that going? Did you do any direct work on one of those? I've heard about the process, but I was never directly involved."

"Yes," Bert said. "I helped with one planet, our Dinosaur Planet here. As you know, including this planet, we've created four new Earth-like ecosystems on nearby 'processed' planets."

In each case they started with a sterile planet not too different from the Earth. Dinosaur planet was amazingly similar to an Earth without life, and only thirty-two light years away. That was one reason to experiment populating it with long-gone dinosaurs. They found some ancient plants and other animals, but most of the smaller life forms were from the current Earth. This was part of the instability, because the restored dinosaurs were not adapted to some of the Earth's recent life forms. They were seeing how that worked out right now.

"The other three planets are further away, and were or will be seeded to be similar to the Earth, without any resurrected ancient species like the dinosaurs, so the crazy dinosaur planet was easily the most difficult and the least stable."

"Again, I know that," Ernie insisted. "What I don't have is the experience of watching the details unfold in realtime."

"It takes a lot of patience," Bert said. "Most of the history is long before my time—the last forty years. The whole idea is to avoid rapid changes, or worse, catastrophic ones. I've heard it was indeed wonderful to watch, and to hear about the other planets. I immersed myself in holographic recordings of the process; I recommend them to you."

A planet had to be in the sweet spot with regard to its distance

from its star, or in one case two stars, so its temperature would be acceptable. Each planet posed and is posing its own problems, but the initial steps were the same. They would start with an extremely faithful simulation model of the planet, and continue with the model straight through. But the model was not the reality.

"For the job of fixing up an entire planet, there is nothing like having machines larger than mountains and having as many as ten-to-the-twentieth tiny and busy nanobots. I didn't see any of that part, but it was recorded."

Each of the four planets had an atmosphere of sorts, containing mostly nitrogen. This was the common case, so they held out for ones meeting that need. They spent years preparing the surface, creating and adding fertilizer along with many other chemicals plants needed to grow. They fetched comets to bring as much as a billion cubic kilometers of water to the planet, since the planets had varying amounts of water already present. Each atmosphere needed the proper amount of carbon dioxide. In one case they had to absorb some and in the others emit some. Then they seeded each planet with a variety of fast-growing plants. In about fifty years they had a good start at getting oxygen into the atmosphere. For the next hundred years they would grow lots of plants, including large forests, and add extra oxygen. At the same time they added microbes, viruses, insects, and many other animals, too many to count. At some point there was enough oxygen to support larger animals, and these kept the carbon dioxide at the proper level. They added a whole collection of every manner of creature, large and small. This is where the instabilities came in. As mentioned before, best would have been to wait thousands or even millions of years for everything to settle down, but they didn't have that kind of time. So it was a matter of artificially tweaking different parts of the ecosystem to keep it mostly stable. That whole process took about two hundred fifty years plus travel times to the system, and at the end they had, or in the two more distant systems will have, an inhabited planet. Each had most of the Earth's resources, except for coal or oil under the ground. It was necessary to recreate many of the Earth's recently extinct animals for the planets, except that on the dinosaur planet they used extinct animals created from ancient

DNA still on the Earth—fragments in frozen places or in amber or elsewhere.

Then Ernie inserted: "You didn't mention the variability from planet to planet that I've heard about, with respect to volcanoes, and earthquakes, issues related to the interior of the planet or to its sun, and to the neighborhood, such as the frequency of comets, the amount of interstellar dust. In the end the four planets differ markedly from one another and from the Earth. But I assume they are each habitable by humans."

Bert finished up. "Yes, there are endless distinctive factors, and obviously we had to have human habitability. We even had to throw out one planet that was too hot. All that I know comes from light-speed reports sent back and forth. I'm sending you the whole collection of reports right now. Three of the four planets are quite a ways from the Earth, the furthest more than ninety light years. For two of those there are ships underway with humans aboard to start another colony. For the other one and for the planet we're on, a colony is already present.

"As you know it's partly a matter of timing. The conditions on the Earth were terrible for most of the humans living there, so we started up the Great Migration, which you directly participated in."

"That's right," Ernie said. "I was a part of it. We built the Habs in the Solar System and got started turning the four empty planets into new versions of the Earth. It was essential to reduce the human population right away. And with such awful living conditions, it was easy to get volunteers to go to Habs or to new planets. But slowly we've been dramatically improving conditions on the Earth. It wasn't possible to improve the Earth fast and at the same time back to what it was originally. But now we're at the point where recruiting volunteers to leave is no longer feasible. So there's an agreement to work with the five planets and fifty habitats that we have, and see what comes of them."

"Another thing bothers me," Ernie continued. "Our discovery of the stasis field, how to generate it, how to use it—that has been considered a miraculous feat, requiring genius and luck, not something one could count on. Yet it seems integral, almost essential to our

spread to other planets. What if we hadn't stumbled onto it?"

"If the stasis fields fail it won't be a disaster. The colony ships are designed so they can easily be converted to multi-generation ships, where it takes several generations of passengers to complete the trip. The stasis fields were never essential."

"I've been thinking about the speed of light as the ultimate barrier," Ernie said. "Everything is constrained by that limit. A physically enormous and totally integrated brain couldn't function, because its signals are limited to light speed with no fix, no way around it. Our travel through space is limited to the speed of light, again with no fix, an impossible barrier for us to overcome. The twentieth century physicist Enrico Fermi wondered why the Earth had seen no visitors. Simple: the universe is too big and light speed is too slow, at least for us: short-lived, fragile creatures that we are. For us it's hard to go faster than fifteen percent of speed of light in an ordinary ship. We have a sneaky way around that limit, but only for shadows, not for physical humans and their spaceships, and still the limit is light speed."

"You keep forgetting I know that. And where is it heading? What is the goal?" Bert said.

"You've said something about the goal," Ernie said. "Spreading ordinary humans across five worlds and fifty Habs, and supervising them for a long time. Also cleaning up the mess humans made of the Earth. It's sort of like an insurance policy for the human race in case something major goes wrong. There are no plans right now to add any more planets or Habs. As you said, we built the Habs and created planets, in order to provide room for many of the Earth's humans while we repaired the poor wounded Earth itself."

"And what else?"

"We'll be trying to promote the emergence of more of *us*, the 'Builders.' There are still not nearly as many of us as we would like, and an unfortunate number of failures. As you know, our main kind of failure we call a Rogue. The initial conditions need to be exactly right or it doesn't work. No matter how careful we are, we still can't guarantee that we won't end up with a Rogue, a failed Builder. We need to deal with the Rogues in a sensitive and compassionate

way. We've had some success lately in converting them to 'normal' humans. We hope to limit Rogue creation, eventually eliminate it altogether, turn the Rogues into a non-problem.

"More scary are the DarkAngels. We won't make any more of them, but we have no way to deal with the ones that are around now. It seems that they don't want to or aren't able to create more of their own kind. If they started doing that, it would be an even greater crisis for us."

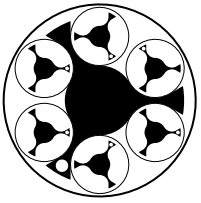
"I've never encountered a DarkAngel," Ernie said. "I hear it's disturbing in weird ways."

"I have met with them on several occasions, and communicated with them briefly. It's hard to describe why we can't understand each other. They've visited ordinary humans, and even interacted with them—that we know. A century or more ago those humans started calling them DarkAngels—a disturbing term for such complex entities. They are like us and yet not, and they are strange. They are our main significant current problem, with no clear solution or even approach to take.

"Some of us try to imagine ourselves as DarkAngels—sort of putting ourselves in their place. Certainly they have as much trouble understanding us as we have with them. For them, much of what we do is irrational. We would like more communication, but we have little common ground.

"They are very upset that we are creating Rogues while we try to create Builders. They demand that the whole process stop. We tell them that we are doing much better now, even converting some Rogues to normal humans. They say that is not enough.

"We must somehow get to know them better."



Part IV

Habitats, 2876.

15. Waiting

The Governing Committee of the Azel Hab had asked all adults to meet in the largest single area available, named (stupidly) the Azelrena. They had called for the meeting to discuss the past attack on their Hab—by what they were calling pirates—and how they could prepare for another similar attack. The arena was less than half full; even threats of death weren't enough to wake up many of the people.

The head of the Committee was an older man, Rin, who'd been in that position so long most of the younger people couldn't imagine anyone else. He started with a brief statement about how terrible the attack had been, before turning the meeting over to Jun's least favorite person, Maz Binkley, her nemesis, the man who had used the Hab's surveillance tools to humiliate her. She expected him to make an ass of himself.

"The Governing Committee has decided on policies and a set of responses to any further attacks by the pirates, as we've been calling them. We know that in any attack a limited number of pirates will be involved, twenty, or at most, thirty of them. The shuttles and airlocks won't accommodate any more. We assume they want to capture people to take them to Habs of the Earth's Moon. As before, young women and girls are expected to be valuable for them. They need to find their victims freely about and they can't remain long, so

they won't come at night. We will set up a rotating group of watchers at the north pole. The arrival of another group of pirates will trigger an alarm which we will spread everywhere. At the alarm, everyone should lock themselves away—particularly young women and girls. Do this without delay."

Maz paused briefly. "Any questions so far?"

Jun muttered to Ram beside her, "That's actually a good idea. It's always been one good immediate tactic."

A young man in the front row held up his hand. "What do we do about the pirates themselves, as they run through killing people?" Jun had never talked with him, but she knew everyone in the Hab. His name was "Nip."

"My advice for young women and girls applies to everyone. You should flee and lock yourself away somewhere. They cannot defeat our doors, nor will they have any passcodes for them or have the right fingerprint."

"But what if we are trapped?" Nip said. "We should fight. We need weapons for fighting."

"The Committee has considered that. We think the pirates will want to leave quickly, and not pause to kill needlessly. They have very effective weapons and are good at using them. We think it is better not to engage them."

Maz continued, sounding almost irritated. "If trapped, then something like grabbing a chair to fend them off could be a good idea. Nonetheless we think they will be able to kill almost any of us who actively engage with them. There should be so few of them, they can't stay long; they will soon leave. I'm sure they know they would be overwhelmed by large numbers of us."

Nip didn't give up. "I think we should fight, using weapons like they have: swords, spears, long curved knives."

"It's harder than you realize to use the weapons you mentioned. Some of their weapons take years of practice. Any of you who witnessed the earlier attack can testify: they seemed able to kill as quickly as they could reach anyone. On a video I watched two who worked together back-to-back, and they took out a wide path through a number of people. With their knives they killed someone every

second or two. It was terrible. By fighting them you would only be inviting them to kill. Fleeing and hiding is a good strategy. We can easily hide behind locked doors that they can't open."

"What if they just stay around for a long time?" someone else asked.

Maz was getting red in the face. "We know their strategy: arrive unexpectedly, grab people, kill anyone who opposes them, and leave as quickly as possible. Anything we do except running and hiding will invite more quick deaths at their hands. But there will be too few of them for any long-term occupation. They are just not going to stay long."

There was further talk about what signal would indicate an attack in progress. A number of other issues were brought up, but they were mostly details and silly questions. Jun and the people in her group were not happy, although Jun later acknowledged to her whole group that hiding behind locked doors was a good idea for non-fighters. "Still," Jun said, "letting them roam about is not a good strategy. How long would we wait? It would not be possible to alert everyone. That would only make things easier for them."

After the meeting, she and Ram talked with Nip, recruiting him as another fighter.

Jun had been working on plans for more than two months before the Hab's leaders finally had their meeting. Initially she'd started in with Ram, her good friend, who was almost a kind of alter ego—her right-hand man, no, right-hand *person*.

"I need you to work on an amazing special weapon. It could be our most important counter to another pirate raid.

"Look at this quote here," she said, pointing to her tablet. "I ran across this in the Library. It describes a fantastic weapon that changed my whole attitude toward what we might be able to use. This was at a time before humanity had any explosive guns, gunpowder, that sort of stuff. Across human history, variations of this brutal weapon often changed the course of major battles, giving victory to armies much smaller than the opposing army,"

> *Here was a weapon which could be used by a man otherwise unskilled in war and that enabled him to deal effectively with a professional soldier.*

"*That* weapon should exactly fit our needs. We surely are 'unskilled in war' and as a bonus, the pirates are not remotely 'professional soldiers.' I've been planning this for a long time. You must construct large numbers of the weapon for us."

Ram looked almost worried. "I don't think we should rest everything on a single type of weapon."

"Oh, no," Jun said. "Absolutely not. We must use a number of different types. Depending on circumstances, some may be much more effective than we expect. We want a variety, and there are a number of good choices. Some of our fighters may like one weapon better than the others. If any single weapon fails to work well, even my special one I'm so excited about, we want others to fall back on."

"And hold on," Ram said. "You've got me all wrong. I'm not good at constructing anything."

"I know that. You're good at organizing and coordinating. I've recruited two of our group, Tol and Bin, to carry out the actual construction in the Hab's hobby area. You've met them. You should see the crazy things they've made: toys, athletic devices, puzzles, artistic constructions—lots of different stuff. They're clever at this.

"I want you to work with them. I'm sending you references from the Library showing a number of detailed plans for several variations of the weapon. These references say they are difficult to build, but I'm sure the three of you can do it."

Jun hurried on as if they had no time to waste. "You'll need to set up the construction of a number of other weapons—there are many kinds that armies have used in the past, ones that are effective and fairly easy to construct. Even more important, we want ones easy to use that don't require much practice: there are several types I want to suggest.

"Aside from my special weapon, the other one I like most is a long pole, with many variations. The poles could be two meters long, with at least a stabbing knife at the end, and a second hooked blade as well. Even longer ones were sometimes used, called 'pikes' in that

case. These lend themselves to a row of fighters, presenting to the enemy an unbroken row of points and blades coming towards them. And these don't need much training. In ancient times, a sequence of rows of pikes used other fighters, with clubs or similar weapons, to protect the flanks, the sides of the rows of pike fighters.

"Longer poles become pikes and shorter ones become spears. There was so much variation. We also want to have clubs. Two weapons that required a lot of skill and practice were swords and the bow-and-arrow, so I don't think we want either of those. We always must consider the Coriolis force, pushing things that move through the air in odd directions. So even with throwing rocks, practice is important. I miss Eli so much now. He was good at compensating for Coriolis. He'd begun training several people to deal with it. That's an important issue I plan to help with, for anyone using a weapon that leaves their hands and goes off somewhere.

"If you read about war and weapons in the library, you'll get a lot of ideas. We, uh, don't want too many ideas and too much variation. The 'keep it simple' rule is helpful."

"I know you want to keep our war plans from our main Hab committee," Ram said. "I can see it's important to keep them from knowing we're making weapons. But I thought you said secrecy is impossible. They've got access to the Hab's fancy surveillance tool to look anywhere, you remember, the one that busted us. It was embarrassing."

"There's no problem," Jun told him. "It's just good luck that our leaders are so simple-minded, and lazy too. They never discovered the ways to use their own surveillance system. You only need to query the system itself about what it can do. Anyone with permissions can cause the contents of certain areas to 'vanish,' effectively disappear. The system shows an empty room even when people are in it. It's their 'anonymous' setting.

"Later we will need to train our people to use the special weapon and the other weapons that we're familiar with. I can make our work on the weapons secret, invisible to any surveillance. Well, and the training too. Still, what we're doing is going to leak out one way or another. Too many people involved. We'll have to deal with that

when it happens. Just deny it I think. And ignore their accusations."

Long before the big meeting they had produced a prototype that looked and handled well. They used one of the simpler plans. Fortunately the hobby area had extremely strong, flexible, and durable materials to work with. She got to see her new weapon once, as Ram showed it off. It was quite a sight, truly formidable, as advertised. There would be minor modifications and after more testing, they could switch to producing a large number of the weapons. Jun suggested they make two sizes—the current one could be 'medium,' and make another 'small' size, maybe three-quarters the size of 'medium.' Along with others, she had herself in mind with 'small.'

Jun helped train the groups she had recruited. Different roles were envisioned for different people. A week later she was able to focus on her new weapon and on the effect of the Coriolis effect on it—getting several people ready to use it—including herself.

After another two weeks they had a number of working weapons, including her special weapon. Jun knew what needed to be done: her fighters, and she herself, needed to be toughened up; they needed to get used to the disorder and violence of actual fighting.

Jun had in mind a newer acolyte named Meg: much taller and stronger than Jun, she was assertive, someone who would take control. Jun put her in charge of the various groups practicing with weapons. And Jun didn't want to depend only on her special weapon. They should use the standard stuff, too. One group would use pikes that they manufactured themselves. Others would use spears and clubs, even rocks.

The initial training went well, but that was just the people assigned as fighters, so called, getting used to their weapon of choice, or often no choice, just assigned to them. Each weapon was blunted or simplified so they would only bruise or sting, but Meg wanted her troops to feel it when they got hit, or stabbed, whatever. Days went by as they traded different weapons around, got used to them, and at Meg's constant urging, became more aggressive in their use. Meg flunked some people out who were too nervous or gentle.

The designated fighters had made some real progress when the large meeting of the whole Hab took place. Late in that event, Maz hinted around that he didn't want any "free-lance" local fighters taking on the pirates when they came, or if they came.

Jun had set up watchers for her own group, at both poles—it was a mistake to assume another attack would be come through the north pole again—it could come from the south pole or even from both poles at once, She didn't expect the last because the pirates would have coordination problems. And they would keep watch night and day, no breaks. They used their own alarm, but they would be able to sound the official alarm when (or if) pirates arrived. Their alarm had two versions, one for each pole or both versions if they attacked from both poles.

And then early one morning the main alarm sounded throughout their Hab. Their own alarm indicated the intrusion was coming from the north pole entrance, and not from the south.

All Jun could think of was: "Would the DarkAngel show up, and if it (or 'he' or 'she'; she was going to stick with 'he') did, would it make any difference? Or show himself—perhaps he was already around right now." Then: "Yes, he likely is."

16. New Weapon

For Jun, once the fighting started everything descended immediately into a chaos that her crazy brain could track after a fashion, but the tracking didn't do her much good. The group of pirates came out of the tunnel that led to the north entrance, with its huge airlock designed to accommodate the mobiles, the vehicles that would take people between Habs. They were shouting and screaming, waving their weapons, including the deadly machetes they favored. They moved rapidly into the large gathering room and toward Jun's fighters. The attackers didn't realize what was happening until Jun heard, even over the noise of these enemies, the separate twangs of crossbows being fired.

Crossbows! The name of her prized special weapon. In many ways the most deadly weapon from all of the Earth's past before guns. In some ancient battles the results were horrific. That one brutal weapon made the difference. Crossbows even showed up in an ancient Christian text:

> *In Jerusalem he made devices or engines invented by skillful and cunning men to shoot arrows.*
>
> — Christian Bible

Three of the pirates went down when the bolt of a crossbow slammed into their bodies. In each of the three cases it was a terrible wound taking them out of the fight completely and permanently. Jun had come to understand that crossbows were historically effective against armor, at least until the armor got harder and stronger, and even then the crossbow was so accurate they still could aim for the head where armor wouldn't protect as well. The bolts tore into the pirates here, since they had no armor.

Half a dozen of Jun's people moved in a line toward their attackers, carrying pikes with knives on their ends. Several more crossbows were fired, while the earlier ones were getting restrung. Then it turned into complete craziness. Jun managed to fire off her own smaller crossbow at a pirate who was just then killing one of her group. Far from being happy, Jun was horrified to see the bolt hit the pirate right

where his neck met his body. The result was nasty, so very nasty with blood spewing out as he fell, then gurgling out his mouth. She'd never seen anything like this; she never wanted to see it again. Killing … killing was not the answer. There had to be another way.

In spite of the confusion, the pirates could see they were losing, and quickly. Too few of them, too many from the Hab, and they faced a terrible weapon they'd never seen before, like a mechanized bow and arrow, a weapon from Hell itself. Even the short arrows didn't just poke a hole, but sank deep into their flesh. Those pirates who could still move shouted to the others to retreat back up the passage toward the north end. Jun somehow realized that Meg, her instructor in fighting, along with several others, followed the pirates, "chased after" would be a better way to say it. Jun thought they wanted to be sure the pirates left.

It quieted immediately where Jun was, except for softer cries of great suffering. They started checking on the people left. Nine pirates were there, eight of those either dead or with a wound the Healing Center clearly couldn't deal with, even if they could get them to the Center. They would soon be dead. The last one had a bolt in his leg: a significant wound, but it wasn't a killing shot. At the Center they could pull out the bolt and the function of his leg might even be restored. Four of Jun's group were dead and the others had wounds the Center could handle.

Jun and a number of those with no wounds helped take care of people. They left the wounded pirate to the last. Jun planned to turn him over to the Governing Committee. That would be something to see: how upset they would be. Finally Jun and some of the remaining people went along the passage to the north, where Meg, several of her lieutenants, and the rest of the pirates had gone. The trip was awkward as the changing and decreasing gravity field kept interfering. She wanted to be sure no pirate stragglers tried to hide along the way, but the pirates had left down the hallway, and it had no branches. It was possible that Meg's group was still fighting them at the end. That

could be bad because her group was so small. Jun kept hurrying them along.

They got to the huge airlock at the north end, and found two transport vehicles, each closed and full of pirates.

"Ha! They're waiting for the Hab to cycle the airlock and let them leave," Meg said. "But the Hab isn't going to cycle as long as someone not in a pressure suit is inside."

"Oh, yes. That's a good idea," Jun said.

"You know, the vehicles don't carry supplies except for water—you have to bring your own. Sooner or later they'll need to exit for food if for nothing else.

"I'm going to get a large well-armed group together to wait for them to surrender and come out."

Meg sent several of her people off to fetch more armed crossbow users. "We'll wait for them with crossbows ready, so it won't work for them to come out fighting. This is perfect. Fighting in free fall is pretty hard—we've practiced that, but the crossbow works great here. No Coriolis force.

"We can only hope they don't have any hostages with them," Meg continued. "Our own people. It didn't look that way. So we wait them out. They'll give up sooner or later, or if they come out fighting we must be prepared for that."

Jun could only wonder what they might possibly do with them, the collection of trapped pirates. Turn them over to the Governing Committee? A bad joke—it was a group with no imagination. They would have no idea what to do. An impossible problem they needed to solve. There seemed to be no solution. Kill them? Keep them as prisoners? Let them leave? None of those options were acceptable.

The Governing Committee was deliberating what to do with left-over pirates who were inconveniently still alive. They had a large contentious audience, basically in two groups: mostly younger people glad that they had challenged the pirates and succeeded, and older people thinking they had been asking for trouble, since four people from the Hab had died. The second group thought if everyone had

hidden away as they were supposed to there'd be no deaths of anyone in the Hab and no other problems. The first group maintained it would have been a terrible mistake to let the pirates go anywhere they wanted and do anything. They would have found people who hadn't locked themselves up. Justifications and recriminations were flying around like angry birds.

Jun wasn't at the meeting. She had decided to stay away until the group had reached a solid stalemate. At that point she was going to introduce her own plan at a useful time when the several factions could see no reasonable way forward.

17. The Moon Helps

It was late at night at the Azel Hab when Jun returned. She'd been visiting the Lumel Hab, a huge one, largest on the Moon. Jun had been the guest of Rolive Genesee, the current head of the Council governing Lumel.

And there was Meg waiting for her at her door in the middle of the night. 'We have a crisis situation with the pirates we're holding," Meg started in. "It was all my fault. I don't know what to do now. I heard you were coming back late." She was visibly shaking.

"Well, slow down and tell me."

Meg had trouble starting. "You put me in charge, … in charge of keeping them locked up in that large set of quarters. I had one person, with a crossbow like me, helping me. It was going okay, but I got too tired. I couldn't even see straight. I needed a break and had two other of our crossbow troops take over. There were three altogether. I thought that was enough. I told them to keep their distance from the pirates inside." She stopped and had trouble going on.

"The pirates attacked the three that were there. I think I know what happened. Those three had a lot of experience, but none of the three had actually shot anyone. Just practice shots at dummies. They never had shot to wound or kill. When attacked, they couldn't bring themselves to kill anyone, so the pirates were able to overcome the three of them, grab the crossbows, and take control."

"So what happened then," said Jun.

"One of the three managed to escape out a side door. The other two are being held captive. The pirates are threatening to kill them. It's a terrible mess and my fault."

Jun mulled this over. "Think now. Were the crossbows cocked and loaded, ready to fire?"

"Yes."

"Were there any extra bolts?

"There always are. Extras were attached to each bow."

"And did they have the equipment needed to cock a crossbow after firing?"

"No. I've thought about this, and talked with Sal, the person who escaped. No cocking equipment."

"Okay, cocking is tricky to do even with the equipment, and we mostly can't do it without. Well, you can I know, but it's hard. Hard even for two. They can fire at most three bolts and then they're done. Get Sal here quick. I want to ask her for more details."

After a while Sal came, looking nervous. She started a frenzied apology.

"Not now. I'm not blaming you. I want you to try to remember exactly that happened. Meg said the three crossbows were cocked and loaded, and there were extra bolts, but you didn't have any cocking devices. It that right?"

Sal said they realized they should have had both bolts and devices with them but had forgotten.

"Try to picture what happened. They grabbed the crossbow away from you? And from the other two?"

"Yes. It was awful. None of us could fire right at one of them. We couldn't do it."

"I understand. It's completely different when you could actually kill someone. I don't think I could do it now, either. So they grabbed your bow, and you ran out the door."

"Yes, yes. It was so terrible." There was a long pause, and then Sal said: "I just now remember. Someone fired a bolt at me as I ran off. It didn't come close."

"So the pirates have at most two bolts to fire," Jun said. "Then they're done."

"Yes, I guess so. Maybe only one bolt. They may have fired at me a second time."

Jun was mulling it over. "We have trouble cocking even with the device."

"I just remember. As I ran off, I saw one of them trying to fire a spent bow. They thought it was like a repeating weapon. They had no idea how to use a bow."

"I must have looked more serious—they believed me when I showed up with my own crossbow. So now they're holed up in the apartment, with its doors locked. They have water but no food, and

they're threatening to kill their hostages as well as coming out fighting if we don't let them go."

"You couldn't possibly know, but I've arranged to take care of everything this very day," Jun said.

They couldn't believe it. "Take care, take care of the whole problem?"

"My friend Rolive, a big wheel on the Moon, is sending a group of her people to take charge of the pirates, take them back to the Moon. She was almost blasé about it. They apparently have standard ways of dealing with them. She said they were shutting the pirates down."

Many hours later eleven people showed up from the Lumel Hab, a mixture of men and women. Half of them carried poles roughly two meters long, which Meg assumed were used as weapons to subdue someone creating problems. They introduced themselves and conferred for some time with Meg and Jun and several others about the exact situation inside the apartment.

Their leader, Terri, then said, "We're going in immediately."

"Wait, please," Meg said. "They threatened to kill hostages if we don't give them the food they want."

"Yes," Terri said, "they might harm someone, but these types rarely do. This isn't a game they're used to playing. It's not even much of a risk. Always better not to wait."

The pirates didn't realize their doors could be opened from the outside, so they were shocked and noisy as the group from Lumel entered. They closed the doors, and neither Jun nor Meg could tell what was happening. After some noise from inside, it soon quieted down. Shortly later the new group came out escorting the ex-pirates, each with handcuffs connecting their wrists, with a line around their waist. A few were limping. Others had bruises, and there were black eyes, but nothing serious.

"We're heading back to the Moon right now," Terri said.

Jun was amazed at how quickly it was settled. "You don't need any supplies? Or anything."

"No, we're used to these groups. Somehow we let this get out of control. We've been taking care of them one-by-one. There's a standard behavior modification program for them. It's usually a diverse lot, and most will fit quickly into another environment. Eventually there are just a few holdouts who need special attention. It's not a big deal for us.

"Just one more thing," Terri said. "Rolive wants to talk with you about the crossbows."

"Oh, yes. They were our most significant weapon. Hard to build and to use. Decisive several times. But frankly, I was horrified at the violence. You people seem to have developed less violent methods and long-term solutions. I'd like to talk with her about a number of these issues."

"Yeah, about that and more. Rolive will explain later sometime." She and her group and the captured pirates left among repeated thanks.

As Jun expected, the DarkAngel showed up, but after everything was done. "You, DarkAngel. You said we should help one another. You could have helped. You could have taken some of them out, or stopped the whole ridiculous attack."

"Yes, I could have intervened. With intervention comes responsibility. But no intervention was needed; your group and the group from the Moon dealt effectively with the others and did not need my help."

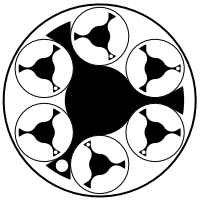
The DarkAngel moved closer. "But I have an interest in *you*—what you can do, your unrealized potential. You have many abilities that you have not discovered. You are powerful and do not know it. You should seek that power within yourself. It is there. You can find it. I know you can."

"How can I find this power?"

"First try to see without using your eyes; try to hear without your ears. Then perceive events remote from you in a way you have never done before. Perceive without thinking in terms of seeing or hearing or another standard sense—get a total view, a four-dimensional one."

"You don't say how."

"You have to try, and then try harder. See without seeing. Start with the smallest possible event and build out from there. You can do it."



Part V

Earth-Moon, 2084.

18. Reconciliation

Meyer had expected to hear from Gwyn, who had a reputation of being reachable if the issue was important enough. This aspect of never sleeping was part of his mystique, if you like. Meyer had no idea how he managed it, but in any sudden or extreme crisis Meyer had always found him awake and alert, responding immediately, not seeming surprised.

This was not that sort of a crisis, but Gwyn still lived up to his reputation with a rapid text reply:

> **Wolfgang: I'd hoped you wouldn't hear about Elisabeth until you got back, but that eager ragsheet managed to get hold of the news. This situation is bad, but I think you have a way forward. It's your choice of course, but I'd like to talk with you before you meet with Elisabeth.**

Meyer replied to Gwyn that when he got back he would talk with him first before seeing Elisabeth. In fact Gwyn suggested an immediate meeting—an in-person session of the kind Gwyn rarely did. After the tense trip from Rantoul, Meyer finally got in to see him.

"I'm proposing to intrude into your privacy here," Gwyn said. "My fear is causing more harm than good. Still, I believe I have a partial understanding of Elisabeth's reasons for doing what she did, and I'd like to share that with you. If you don't want my help, say so,

and you can go directly to Elisabeth. That's fine. I'll let the two of you work this out yourselves."

"Go ahead with what you want to say. I can use all the help I can get. In fact, I feel completely at sea here, except that I knew she was lonely and depressed."

"You'll see that I'm going to take on some of the blame myself. But let's get started.

"She's doing well now. She had her … difficulty five days ago. As you must know, I monitor the two of you constantly. I have a clever AI following the data generated by the monitoring. For the sake of your privacy, I don't usually review any of that data. The AI thinks of itself as a 'he,' named Ralf. He is prepared to call to my immediate attention any possibility of danger, any accident, or, and this is key, self-harm. Ralf was concerned about preparations she was making and about possible self-harm she might commit. He did alert me to the situation. Now I have to come out and say it: she tried to take her life. Because of the alert, we were able to prevent her from succeeding. In fact there were no ill consequences of the attempt except psychological ones. My contribution was to send professionals to her. Before you lose it, I need to say that I think the crisis is over. So sit back and let me tell you about it."

Meyer sat perfectly still, saying nothing, so Gwyn went on.

"As I said before, she's doing well, considering, but there are issues I need to talk over with you. No one did anything wrong, and this is mostly a misunderstanding, but not completely I guess. Are you still able to talk about it right now?"

Meyer managed to find his voice and say he thought he was as ready as he could be.

"This has to do with when you first came here and met Elisabeth. I think there are three stories here: what you thought happened, what Elisabeth thought happened, and let's say, what really happened, except your two versions are part of what really happened. You see, the stories are pretty much the same. Anyway, here goes …

"When you came for your first visit, I was desperate to recruit more good people for the colony. You and I still share that desperation. I was interested in the nanotech area, and that was your

field. I was frantic about any number of other fields at the same time. Always, and now as well, I was scared that we might lose contact with the colony—completely and forever. For any important visitor what do you do? You interact with them, feed them, set up meetings with interesting people. You try to make your operation look good. That's recruiting 101. We were ready to do that, and did. I admit to you now that I deliberately set up a dramatic middle-of-the-night meeting with you. I truly was worried about security, but the drama worked well; I thought so then and still do. We knew you were fluent in German, well, that at least you grew up with it, and one of our people happened to be good friends with Elisabeth. She knew that Elisabeth also had German as her first language. It was an obvious choice to arrange for you to meet Elisabeth. I was among those who said, 'Sure, introduce them to one another.' For all we knew your respective families might have been blood enemies. That obviously wasn't likely, but you might have hit it off or you might not have. As it happened, you liked one another very much.

"Sorry to run on so, but I have to finish a complicated story, if that's all right."

"Yes, yes, go on."

"We may have stretched the truth a little, but we didn't lie when we told you that you'd be stuck in Europe forever if you went back. I still think that without Elisabeth at all, you would have decided to stay. It was your best reasonable choice. She was a bonus.

"Days or weeks later one of our people learned about Elisabeth's mother stuck in Europe away from her daughter. With some work and minor concessions on our part, we managed to get permission for her to come to North America. Those and other much more significant concessions kept things from blowing up, kept the Europeans from getting too upset.

"So your version of the story is mostly what I just said, except that I admitted seeing you at night was a ploy on my part. It was surely obvious that we had chosen Elisabeth because we thought you might get on together well, and you did. Your story and mine are almost the same. But Elisabeth's story is different in several important ways: she now thinks she was chosen as an attractive woman to lure you

into staying. In her depressed state she decided it was always a quid-pro-quo, where she made herself available to you so that she could get her mother out of Europe. In a way she's partly right. Otherwise she might not have succeeded in getting her to North America.

"The whole Earth now is an ugly and depressing place. Elisabeth's mother was called away for some emergency, so Elisabeth was mostly alone. As her mind has gnawed on this story and transformed it, she's convinced herself that she became a prostitute, a whore, selling herself to you in exchange for her mother's safety."

Meyer was getting distraught. "How could she think that? We really do love one another. I know it. I'm sure of it."

"That's true. And I think you'll be able to convince her that we didn't manipulate the events the way she thinks. I actually talked with a psychologist about this matter. He didn't have any special recommendations. You need to convince her that you love her and always will. He suggested thinking along this line: 'You are my only possibility of happiness! I have no faith in it, except as you bestow it on me!' "

"Who said that?"

"A writer long ago. That doesn't matter. But one more question and then I'll stop. Didn't you ever think that she was a deliberate lure, dangled before you to help make you defect? This is a standard plot device in every spy novel or video, where they introduce a convenient beautiful woman."

Meyer didn't reply immediately. Then: "No, not really. I never thought she could be a lure, quickly prepared for me. Her attraction is more intellectual anyway—acquired over a lifetime. And it's an attraction that appeals to me—probably not to most other people. I didn't think she was that good an actress. She's *not* that good an actress. But now I remember there was one time later in our second meeting, when I said I might switch sides and stay in North America. She seemed suddenly terrified. She said she thought they killed such defectors. I sort of reassured her and said you were planning major concessions, and in fact you made them and as you said, the Europeans were at least somewhat mollified. At one point that night she asked if she was some kind of prize. Or maybe she said 'trophy.'

Anyway, I said, 'No, not a prize.' I said we needed time, time to get to know one another better before a major commitment. I had no idea she was still worrying about that, about being a prize, after five years."

"It's time to go see her now, in the hospital. I had to get special permission to keep them from kicking her out before you came. Tell her that her friend Phyllis has been taking care of her birds, along with the plants. They are doing well. Finally you should take this." With that, Gwyn produced a single sunflower in a holder with water.

"Where did you get that?"

"I have my sources. This is actually a sunflower *plant.* She should be able to grow it where she keeps her birds. It's corny, but flowers are often good. Go to Elisabeth now. There's a car waiting outside to take you."

19. Mars is Red

Gregory Dulles was in charge of all communications between the Earth and its two colonies on the Moon and on Mars. His office was based in Urbana but it had access to a number of transmitting and receiving antennas. The Earth-based ones were powerful, sensitive, and accurate. Because he had many flexible options, lots of traffic went through his equipment on the Earth and in orbit using the Staging Center for traffic leaving the Earth. Next in line was the Moon, which had its own high-performance devices, including ones at the Gateway satellite, used now only for traffic to and from Mars. After that, Mars had radio equipment, including several large antennas, on two satellites (*artificial* ones, not Mars's two natural satellites). It was possible for him to communicate directly with Mars at the surface, but relaying through the satellites was much better. He could usually communicate directly with almost everything in an emergency—at least *weak* communication.

It was now that special time when Mars, as viewed from the Earth, moved around behind the Sun, cutting off communications between the two planets for nine or ten days. The end of the outage could be accurately predicted to within a few hours unless there was special solar activity such as a storm. This time after the outage Dulles went on past the ten-day mark, repeatedly trying to establish contact and failing. He could indeed contact the Mars satellites, but those weren't getting anything from the surface. There were five different transmitters on Mars's surface, and the two separate satellites. They hadn't ever had the transmission fail completely after the Sun got out of Mars's way.

Dulles had been barely in direct contact with one of the two Moon-Mars supply vehicles. They were the only nuclear-powered space vehicles ever put into service. If wasn't feasible to get a strong thrust with an ion drive, but these ships parked only in orbit around Mars and the Moon. They used a one fiftieth G drive, and the engine was lightweight but had a lot of energy stored as nuclear fuel. To get one G equivalent one could simply run the drive fifty times as long. Of course that's only a rough estimate. The exact burn has to be

precisely calculated. Each of the two ships carried two small landing craft to get to and from the surface of Mars.

Fortunately one of the large vehicles was only three weeks away from Mars. It could contact the Mars satellites, but not Mars itself. Dulles really didn't like this. There was a lot of redundancy built into their communications—deliberately so. Someone on Mars should be able to make contact. Two systems were supposed to automatically "ping" every hour if they weren't transmitting. The more he thought about it the more unhappy he was. What could be happening on Mars?

He sent out notices about the outage, saying he would continue attempting contact, but admitting he'd run out of options. He noted that one of the two Moon-Mars transport ships was to reach Mars in less than twenty days and if nothing else happened, the transport ship could send its shuttlecraft down to the surface of Mars. In about three weeks people would be at the colony.

Three years ago they had switched to a faster orbit to lower both the transit time and the radiation exposure. For humans in space, the two big problems were exposure to microgravity and to radiation. Time spent at the Staging Center and a trip to or from Mars were the main places to get long exposure. Both the Staging Center and the two Mars ships had compact but workable centrifuges with required time on them for any passenger. That mitigated microgravity problems. Radiation was an even bigger problem. They provided some shielding for sleeping areas, and there was an even better shielded small area to use in case of a solar storm. The Mars colony itself was safe from radiation, buried under rock. The net result was that no one could spend too much time either at the Staging Center or on Mars trips.

Gwyn participated in the discussions and was even more concerned about the outage than the others. Any number of people on Mars should have had access to a transmitter to contact a Mars satellite. In most emergencies several stations should have contacted the satellites and through them the Earth, even without any human intervention.

They knew there were other reasons to be nervous about the status

of the Mars colony, starting with two unfortunate deaths over the past half year. Investigators decided the first death was due to a pressure suit malfunction, but the second death remained a complete mystery. Also there were concerns about the morale of the colony. They had no clear development plan like the Moon colony, but were mostly stuck with the status quo. Of the two, the Moon colony was larger by a factor of ten or twenty, depending on how one measured size, and it was correspondingly more advanced. Also Mars had mostly technical people with eight women and no children, so it was far less of a balanced group than the Moon.

The only way to get to Mars, that is, physically get there, was through the Gateway satellite orbiting the Moon, and that involved more radiation for the travelers than any other trip in the system. The added exposure was a concern for everyone; it made Mars much less desirable as a destination. It was feasible for someone on the Moon to visit the Earth and come back, but a similar visit from Mars and back made little sense—too much radiation. And there had been an increased amount of turnover of those living on Mars. The lead administrators had discussed this: that people would be enthusiastic about going to Mars, but then their interest in Mars would wane and they would ask to be traded out. Often a request to leave was delayed or even refused. They tried to talk people out of leaving, or bribe them to stay.

In this case, those on the Earth had nothing to do but wait the twenty days for the transport to get to Mars. For some it was wait and pray.

Gwyn possessed information not available to any of the others. His Earth simulator specialized at understanding and explaining the state of things in its domain: the entire Earth and everyone and everything in it. It knew it was weak about Mars. Still, the simulator gave Gwyn its predictions about Mars—what had happened and why, predictions which Gwyn didn't share with the others.

Its prediction, with "less than 20% likelihood," but ahead of the other explanations was that everyone on Mars was dead and that Satanists in the colony were to blame. It gave Gwyn scenarios for how the mass suicide could have been accomplished. Still, in the end

it was conjecture: the simulator had no direct information from Mars.

By the time the transport arrived a number of people were participating in the decision-making. Everyone was accustomed to the delay: what they would hear from Mars was about fifteen minutes in the past, so it was a thirty minute information round trip. Because of this, it was left to the crew of the transport to coordinate the investigation. At some point the people on the Earth could make recommendations even with the thirty minute delay. They planned to proceed slowly and cautiously, so extra advice and even instructions could still be made, thirty minutes late.

Normally the small shuttlecraft would start making a number of trips to the surface, bringing supplies and several new personnel to the Mars colony with each trip. This time, for the first trip down they would be careful. Again normally they would refuel at the surface, but they allowed for the chance that they couldn't refuel. The shuttlecraft had enough fuel on board to get back up to the transport craft, no matter what had happened on the surface. It was straightforward: they would make the trip, land, and investigate … carefully. Not even landing too close to the colony and continuously transmitting.

Dulles personally knew the captain of the transport, John Stiles, and the pilot of the shuttlecraft, Graham Ables. Stiles and Ables would be in quick radio contact, and with relay through the Mars satellites there should seldom be any loss of contact. Dulles had the fifteen minute delay.

"So, Ables," Stiles said, "let's take it as carefully as possible. We've been too formal on the ship. If it's okay I'll call you Graham and you can call me John. I guess Dr. Petra James from our craft has agreed to go with you on this first trip. After you land, we'll wait for a number of checks before either of you leaves the shuttle."

"Yessir. I don't expect any problems with the landing itself. Then we'll surely find out what's going on."

It took a while to reach the ground. There were several landing sites; Graham took the farthest site from one of the surface entrances

to the mostly underground colony buildings. One door was for people and a much larger door for vehicles.

"Okay, we've landed now," Graham said. "Everything is looking nominal"

A delay, then: "We can't seem to establish any communication, as expected. There should be several lights on the entrance nearest us, but none of them are on."

Another long delay. "We took thermal readings from the entrance. The values are the same as for other rocks, but it's not that well insulated. It should be warmer than those rocks. You suggested this as the first thing to try. It seems as if the colony interior isn't being heated to an acceptable human value."

The people on the transport and fifteen minutes later the group in the building in Urbana understood this immediately. If the temperature was the same as the outdoor temperature, that wouldn't be survivable except in a heated pressure suit. This looked even worse than they were expecting.

John Stiles started in directly. "Okay, Graham, you will be the first to go into the colony. Dr. James will be the backup. We may need her medical expertise later on. You alone, Graham. We want continuous video transmission as you enter.

"Even if there is no power inside, and no matter what the situation inside is like, you should be able to open the airlock doors with hand power alone. If there is pressure inside, then a pump would normally empty the airlock, so that the outer door will open. But there's a shortcut option to let the airlock's pressure dissipate, requiring no power. Normally they don't want to waste an airlock full of air. Similarly you can equalize pressure inside the airlock with the inside so that you can open the inner door. This is explained on the door. Then there is a second airlock inside to provide double safety."

"Yes," said Graham. "That was explained in my orientation."

After a delay, Graham said: "There is power and pressure inside. and a pump is now emptying the airlock."

Graham was able to enter the airlock and then get through the inner door and reported that. He was in the safe space between airlocks. He reported that there was normal colony pressure, but no

heat. His pressure suit was still needed to keep him warm.

"Now Graham, after you enter through the second airlock, we'll only look initially. You shouldn't touch anything."

Graham acknowledged and went through the inner airlock into the colony itself. There was a delay.

"Oh, my God!" Graham kept making little "Oh, no" sounds. Then: "I can't believe this!"

"Describe what you're seeing," Stiles said. "You can see better than we can with our video link."

Graham was having trouble talking. "There are bodies on the floor here." A pause. "Seven of them. It's cold in here and they have on ordinary clothing. They must all be dead."

"Steady, son," Styles said. "I want to say this to Dr. James. If transmission should fail, or if Graham should ask for help, you are *not* to enter the colony. We'll pause and think it over. Acknowledge please."

"I understand," James said. "No matter what I'll stay here until you have further suggestions."

"Good," Stiles said. "Now Graham, I know this must be difficult, but I want to start you up on a process of examining everything, touching as little as possible. You should hold the camera up to catch every detail. Take your time. We are recording this.

"First the seven bodies. Their names are on their clothing and may be visible, but for now don't disturb the bodies. Then examine everything in the room, even insignificant things. There's no hurry."

Graham did what was suggested. Finally he stopped and stood still.

"Are you holding up all right, Graham?"

"I'm doing better now. I've been in emergency situations before. But this is so crazy."

"It is crazy for sure. Now I want you to go through the entire colony facility, or as much of it as is possible. Use this same methodical manner, assessing without disturbing. For now don't go through any double doors that are sealed off from the rest. Are you familiar with the facility?"

"You remember, I was to replace someone working here. You

and I and the others studied detailed plans of the whole colony here. It's not that complicated."

"Oh, yes. That's right. Let's get on with it then. Comment if you see anything that seems unusual, even something seemingly insignificant, as if it doesn't belong or isn't right."

This went on for over an hour. Stiles was thinking about the people on the Earth, taking in the situation with their fifteen minute lag. None of them were attempting any comments. They were probably too shocked to speak.

Four locations were sealed off—three were laboratories, and the fourth was the enormous hangar with growing plants. Graham went past a number of pressure sensitive doors that were open but would slide closed in case of falling pressure on either or both sides. There were two instances of people sitting in a circle. Otherwise the location of bodies seemed chaotic. A dozen or so of the bodies had significant wounds to the head or torso. In those cases the wounds seemed fatal. Finally Graham stopped and waited for further suggestions as to what he should do next.

"How are you doing now, Graham?" Styles asked.

"Doing all right, Sir. I'm getting a bit tired."

"If you think you can, I'd like for you to inspect each of the closed off laboratories, as well as the hangar. They may hold infectious agents. We want you to inspect each of those. As you enter, check that the UV disinfection lamps are on. In each case we want you to expose a bottle to the air inside and then seal the bottle shut. I'm told that you'll find suitable bottles inside. As you leave each laboratory and leave the hangar, there will be a disinfection station between the two doors. You should thoroughly disinfect yourself as you leave, so four times. Spray yourself thoroughtly. And stand in front of the lamps."

After Graham finished with the laboratories, he examined the entrance to the hangar. Near it were readouts showing normal temperatures inside. Through a window he could see healthy-looking plants.

"Wow, the hangar seems fine, normal temperature. Should I still go inside? It's pretty large to inspect."

"Yes, but this is a big deal," Styles said. "It's a survivable environment—for someone without a pressure suit. Colonists could be holed up in there, with food, air, and water. You must definitely do this inspection. There might be people inside who are barely surviving. You must keep your pressure suit closed. We are still worried about possible pathogens in the environment. Take your time walking along every pathway in the hangar. You need to check every location, or locker, whatever, anywhere a person might be surviving. It's such a large area, let us know if you're getting tired. We can postpone the inspection."

Graham completed his tour. "Nothing, nobody. My suit is down to half a charge, and now I am getting significantly fatigued. I would like to get out of this pressure suit."

"Yes, for sure we need to call this a day. You should go back to your shuttlecraft. We've decided not to try to isolate you from your companion. It doesn't seem feasible anyway. You take a long rest and we will be evaluating what you found."

"Sir, can I ask how many bodies were found. I wasn't keeping count, since I knew you would be doing that."

"There were thirty-four deceased colonists."

"Wait. I thought the count seemed low, but that's fewer than I realized. There were fifty-five colonists living here, fifty-five after the two who died. Where are the others?" He did the math. "Where are the other twenty-one?"

"Good question, Graham. That's one of many things we'll be thinking about. For now, you should get some rest, charge up your suit. While you sleep we'll be communicating with the Earth group, getting their advice and working to decide what to do next. Try not to worry about what you've seen. I recommend not thinking too much about possible scenarios. Let us do the worrying. I'm sure there will be much more investigative work to be done. Your partner James should stay awake."

"Yes, that's good."

"Get to sleep. It's fine to discuss what you saw with James, but sleep is the important part. While you sleep, we'll be talking with James at length, and then communicating everything to Earth.

Discussing, thinking, planning.

"Oh, and one more thing: this is obvious, but if you develop any kind of symptoms, anything besides fatigue or I guess depression, horror, and such. Any physical symptoms. Well, report them. Immediately, even if they seem trivial. It's too late to try to isolate James. We've decided to go ahead and put her at risk along with you. We must do everything possible to search for clues. Try to sleep now and turn your mike over to Dr. James. However … this is for you, James, we're going to take at least a thirty minute break and wait for comments from Urbana and elsewhere."

Back in Urbana and in a few other locations linked to them, there was an unstated consensus that they wouldn't interfere until Graham Ables was done, with an expected hour pause or so. Everyone was shocked into silence. After the break was announced, no one spoke up immediately. Finally Vance Elliot, one of the computer people who kept everything running, spoke.

"It's so impossible, so incomprehensible, but still it seems to be a bizarre version of a mass suicide. Even so, it leaves nothing but questions. We could try to see how certain events could possibly have occurred. For example, twenty-one people are missing. They are somewhere. What are the logical possibilities for where they could be? What could have happened to them?"

Another person looked to Gwyn; "What do you think?"

Gwyn looked unhappy. "I don't even have any reasonable theories. I'd rather see what this group can come up with—as you said, looking at all logical possibilities. There seems to be a shortage of them."

"What do they do if someone dies in the colony?" someone said. "They recycle them, right?"

"Yes, that takes a long time, many weeks. They use a metal casket initially. The important thing is: they can only do a few at a time, and the caskets would be obvious."

"Could they be alive and moving around, avoiding Ables?"

"Oh, yeah, it's possible. I'd say barely possible. We should eliminate that. Were there any places to hide? Storage areas, inside their vehicles?"

Gregory Dulles stood up to talk. "I've received a summary report from Dr. James. After talking a bit with Ables before he went to sleep, the two of them have basically considered all those possibilities and others besides. That included a search around the area surrounding the entrance. They feel the only possibility is that one or more people, perhaps from the group of twenty-one, transported that group to a remote location and dumped them. If alive then, they would be dead now. All the colony's vehicles are present."

"Wasn't there any surveillance video?" someone said.

"Apparently there should have been, but they checked a few and those were turned off, their contents deleted."

Dulles had remained standing and continued. "Dr. James is the senior member of the whole group, including Ables, and five others on the transport who were going to replace some of the settlers. James seems smart. She'd have to be to get along in such a male-dominated colony. They were just starting to get more women.

"Because the colony people hadn't turned off the main plant hangar, resettling the colony right away with the people available should be feasible. With our permission, James is proposing that the six of them stay to bring the colony back to its normal state. Ables will have to do the final flight of the shuttle up to the transport, which will have to leave soon to keep a reasonable orbit. It would return with Stiles and Ables as the only crew. James wants us to decide within three days whether to approve the plan that the group stays there. The whole group is unanimous in wanting to stay. The plan is to get the group down with the small shuttle vehicle. That's what they were going to do anyway. They will also transfer a large quantity of supplies intended for the colony. The group will work on making sure, well, trying to make sure that they can get the colony up and running, so to speak. They should be able to get a good idea if the colony can still function properly. Before the final decision, James plans to do at least partial autopsies of the thirty-four dead. A disease or other difficulty seems unlikely. Thirteen of the thirty-four had clear

life-ending trauma."

At this point Gwyn visibly startled, but no one noticed. Dulles said they would be studying the plan carefully over the next three days. He definitely wanted more data about the status of the colony, and what difficulties they encountered over the next few days. He promised a final decision at the deadline. The transport vehicle had to leave by then in any event. Because they were using fast orbits to get to Mars, the second transport was in route, due to arrive in about two months, and that at least was good: in case of any difficulties, they wouldn't have to wait a year or two for the other transport craft. There were only two ships—one of the many problems and limitations of the Mars colony.

Gwyn sat and thought how neatly everything was wrapping up. He was obsessing over some simple numbers, simple mathematics. Fifty-seven colonists, but two were killed to make fifty-five. Thirty-four of them were left dead, with the remaining twenty-one missing, and with no idea what might have happened to them, whether they might conceivably still be alive. Of the thirty-four dead bodies present, thirteen had life-ending injuries. This meant the non-injured gave a second twenty-one. Numbers: 55, 34, 21, 13, a simple list of numbers. The number fifty-seven was no good—you needed fifty-five, so you had to kill two. No problem. At present he was the only one thinking about these numbers, although most mathematicians and many others would be struck by them. It could be a coincidence, but he didn't think so. Instead it seemed more like a message, a signal, using what may be the best-known exotic sequence of integers in mathematics. And there were eight women, the next number in the sequence.

He wasn't going to tell the others, in Urbana or on Mars, about his little numbers game. They would dismiss it as playing with the numbers. But this data would get to the Earth, where many numerology people could make a big deal out of the same numbers. And which group was fixated on numerology? The Satanists. There would be Hell to pay.

For everyone including Gwyn the truly outrageous problem, even worse than the dead, was the missing twenty-one. There seemed to be

only one possible explanation: for some crazy reason those in charge had decided to get rid of them, or they had volunteered to be gotten rid of. Somehow others had transported the twenty-one away, perhaps to one of several available holes and dumped them. The holes led down to other volcanic tubes similar to the tube utilized to build the colony. They were nowhere inside the colony, and there was no secondary location where they could survive and no possibility of transport off Mars. To survive they would have needed oxygen and power—Gwyn had checked with James that there was no drain on available power and no oxygen was being piped outside to any possible survival location. And indeed, the existence of any "survival location" seemed impossible. The pressure suits had only rudimentary diapers and no way to eat anything, but only a stash of water to drink.

The lack of pressure suits was the final part of the "impossible" verdict: that the twenty-one missing might still be alive. After they did an inventory, most of the suits in the colony were accounted for, with a few spares. The missing twenty-one had gone off without any pressure suits, or with at most two. These were required even in the four vehicles the colony used.

Gwyn's simulator had uncovered extensive data about all the dead Mars colonists, as well as locations and personnel supporting the whole mass suicide. The simulator produced multiple possible ways everyone could end up dead when only a subset of them wanted to die, taking into account the twenty-one who were missing. Each of these scenarios seemed forced and not plausible.

The next day James had finished a quick inventory and examination of the thirty-four remaining bodies. Part of her initial report described them:

Report by Dr. Petra James [header information, etc., etc.]

Excluding the missing twenty-one colonists, there are thirty-four remaining bodies. Of these, thirteen each show the result of brutal violence, with crushed heads or stab wounds to their body. In each case this violence alone would have been sufficient for their death. The

twenty-one dead individuals left over show no signs of violence and no cause of death during a brief study. Nothing seems wrong except that they are no longer alive. Because it is so cold where the bodies are, a later more thorough autopsy will be possible a few days from now whose results should not be affected by any delay. The thirteen seemingly killed by violence might not have died from the obvious violent blow or stab wound, but may already have been deceased at the time the blow struck. If each blow or stab wound had been the proximate cause of death, there should have been more residual blood around the wound. Each wound looks staged, as if carefully arranged. The wounds and results of the blows do not 'look right.'

Gwyn was thinking over the whole sequence of events. He didn't like the way it had proceeded. Whoever arranged this disaster was talented. Not just one person but surely several were obsessively smart with how they had set things up. They were also likely insane. A "forced" mass suicide might be a final gesture against a world they hated. But why would they go to the trouble of getting rid of twenty-one people? Could the missing ones bear marks of starvation or of horrible torture? Well, thirteen of those left looked like they had been brutally murdered and there was no attempt to cover up those deaths. So that idea just didn't work. There was bound to be more to it, some reason. Gwyn couldn't think of how it might continue, but something else was coming, more disturbing than what had happened. His fancy simulator was no help with this speculation. He resolved to contact the six who would remain and to warn them against some additional surprises: a ticking time bomb waiting to go off.

For Gwyn it was rare to have such a feeling of helplessness, to be subject to further unknown and unwelcome events, waiting for discovery, waiting for the other shoe to drop. He hated moving forward without any contingency plans. He was used to getting ideas and suggestions from his simulator.

20. Falling Apart

The transport ship had left four days earlier, with only the captain, John Stiles and the shuttle pilot, Graham Ables, on board. The roster of six new Mars colonists faced a huge effort for sure: they needed to take care of the dead, and that included more study of what had happened to them, and they needed to get everything working properly at the colony. Top priority was the huge plant hangar—it was essential, and luck seemed to be on their side with it, since indications were that the hangar was functioning at least fairly well. The hangar, with its host of plants and an impossibly complex and constantly changing biome inside, was the most difficult and the most fragile part of the colony. It was their main source of oxygen, of food, and of raw materials—similar to the Moon colony but without the latter's multiple larger hangars, giving the Moon redundancy, diversity, and separate locations as backups. Still, two of the six would be examining it and working with it full time. Fortunately the six new people had included a botanist. In addition, everyone would need to help with the plants—an enormous task. Dr. James and one other person would be working with the bodies for a week or so. The remaining two would examine everything else about the colony, making endless checks and tests. Considering what had happened, the physical colony seemed in good condition.

The six colonists had moved all thirty-four bodies to a single unheated room. James wanted them to stay stable—she planned further testing on them and the continuing cold would help with that. Because of the cold, they were using pressure suits for the heat they provided, without the pressure part. The testing was to be careful and meticulous, unhurried, and starting with exact records of each person. First they removed clothing and anything else not a part of the body. They took extensive exterior pictures. Then they gathered the clothing into labeled bags. She would be taking small tissue samples for later laboratory analysis. If she decided on full autopsies for everyone, that would take many days. Instead for the time being she was going to do only one such thorough autopsy of a body with no evidence of violence.

James had Witt Salerno to help her—a multi-purpose new colony member without much experience in the technical details of getting the whole colony working properly, so he wasn't of use in that part of their work. His actual given name was Wittmore. Witt was a nickname he didn't like—a childhood of taunts had come with that name. Witt was to go over the personal effects. To look at everything carefully and take nothing for granted.

Late in the first Martian 'day,' James had completed her look at each body and and was ready for her full autopsy of a single body. Witt was skeptical. "They're frozen. How are you going to look inside or get any samples?"

"I have a miniature saw to cut through the frozen tissue, and a small drill to get samples."

The full autopsy produced a large number of tissue samples which would be processed later in the laboratory along with earlier samples. At that point she still had not uncovered any reason that the ones not mutilated had died. That would have to wait. Right then she was going to go over the personal items that Witt had gathered.

For lots of reasons colonists didn't have electronic or bionic devices implanted inside them. Instead they each had the same kind of personal electronic communicator, similar to the old phones, but these didn't communicate directly with the retina or the visual cortex. Also there were no passwords; the last thing they wanted was to fuss with a password during a crisis.

James had decreed that the phones would be carefully turned on and tried out, in a session that recorded everything. Her fear was that a phone might show a quick message or other output, and then stop functioning. James didn't want to miss that or have no record of it. The net result was that at the end of the first work session, she and Witt got together to examine the detritus from the bodies, especially the phones.

The first and second phones they looked at seemed to have nothing recent or special on them, only personal data. The third phone had a prominent video recording, the most recent one made. They played this recording, while carefully keeping a record as planned. It was a bit under two minutes long, poorly recorded, jerking around,

and showing a scene of confusion and violence. The film clip was at first disturbing, then terrifying, and by the end utterly horrifying. They couldn't take it in or process what it was showing.

Eventually they found three separate video clips, several of them duplicated. The first two clips showed different views of violence against the colonists by strange-looking creatures. In the third clip, even worse than the others, a line of colonists was being herded out through open colony doors into a huge ship that was attached to the airlock with some sort of air-tight connection. Those herded were presumably part of the missing twenty-one, being sent off into the alien ship, far larger than their own transport ship. Even thinking about that procession was difficult. Sent off for what purpose. As prisoners or objects of study? It was outrageous. None of the colonists on the clips had on a pressure suit, but they were able to go into the alien ship without exposure to Mars's atmosphere.

James decided against trying to evaluate the clips. The scenes shown were too complicated and chaotic for them to form much of an opinion. And none of the six wanted to look at the clips a second time. They would send copies to the group at the Earth headquarters in Urbana. That group could slow them down, do computer analysis—who knew what, get some kind of answers about what had happened. The six new colonists who were trying to get things working again welcomed the huge effort needed in rebuilding a functioning colony on Mars. When they signed on, they had looked forward to settling in with an established society of shared goals and values. They expected new friends and interesting interactions, challenging ones. Now, not only were they alone, left to fend for themselves, but the video clips had turned the tragedy of a senseless mass suicide into an impossible nightmare that kept them awake at night. Dr. James thought that two of the five others were going to need psychotherapy, and she wasn't so sure about herself. Do her own treatment?

Gwyn would have kept the video clips secret if he'd had control, but copies had been sent to many people, too many, and not all those people could be relied on to keep a secret. So initially only a few

copies of the clips were around. And then they were everywhere. Reactions were immediate, extreme, and highly varied. They might as well have taken one of the huge killer spider nests and dropped it into a room full of people with no exits.

Across the world, different groups tried their own explanations, but nothing satisfied—except for one group—many of the Satanists were ecstatic in their enthusiasm. The most common header online was "Alien Invasion," followed by various speculations, such as "This Is War," or "We Must Arm Ourselves." Many of these people were particularly concerned about the twenty-one humans herded out of the colony and onto the alien ship. Here the headers were even more hysterical: "Aliens Study Humans, Look for Weaknesses," "Aliens Experiment on Humans," or "Humans Off to Alien Zoos for Display." These might have been humorous, except that the people were serious. The most extreme label was: "Aliens to Use Humans as Sex Toys." In that case some motions of the alien pushing a human along seemed like foreplay, at least to those with a sick imagination.

A small minority of people thought there had never been any space program anyway, or at least there were no colonies on the Moon or Mars. It was an elaborate deception created by video makers and designed to extract money from citizens. These people had their own explanations for new lights visible on the Moon. The Satanists thought this was the start of a final battle which would end with Satan victorious in a clash against those unbelievers using Satan's side of the Moon. There were already cases of mass killings of such unbelievers by Satanists.

For years there had been small groups, and a few not so small, committing suicide together. The details were all over the map. Sometimes a group had a charismatic leader, and they followed that person. Other times there was a shared agreement to kill themselves. Most governments tried to play down or cover up these incidents to keep others from imitating them. On the first day that the video clips appeared, extra copycat mass suicides started, with every indication the trend would continue.

Gwyn was one of many experts to try a scientific study of the three clips. Computer-generated videos of high quality were common, and that was what he expected before he looked at them. But on first seeing them, he was much more disturbed than he expected. It was hard to watch.

At the outset he had excellent data about the colony and the colonists. He started with a model of the colony, and he had complete specifications which were accurate to within millimeters. It helped that each clip had an exact start time and that allowed him to use a common timeline. He gathered up the available data about the fifty-five colonists, forcing access to every piece of physical data he might want: pictures, videos showing them in varied activities, exact values for physical dimensions, voice print data, retinal images. The three videos were chaotic but with high resolution.

There were eight of the creatures, whatever one might call them. It was easier to tell them apart than with the humans, since they each had distinguishing features, different clothing and ornamentation, different weapons, differing colors.

Typical evil aliens in a science fiction or horror video looked a lot like humans, or if not that, like spiders or squids or some other known scary animal. The ones in the clips looked weird, as if the product of a completely different evolutionary sequence. They had enough aspects of the look of a demon (whatever that might be) to pass as actual demons for the Satanists, who thought the clips were directed at themselves.

Then Gwyn's software tried to match up each human appearing on a clip with one of the fifty-five possibilities. This was one of those problems where the software tried for the best overall matching "score." You couldn't have two distinct humans on a clip matched to the same person. This matching went well, with only a few questionable cases. The software checked that the humans as well as the creatures didn't make any impossible jumps or reappearances, and that part also went well.

During the matching, that was when discrepancies began to creep in. The people who created the clips didn't have his own precise data for the humans. The dimensions for the humans on the clips

weren't exactly correct, and they left out the iris pictures, though the resolution should have shown them. Most important, the killing blows landed in the clips didn't match the actual blows that they had found on those particular individuals. His software showed that the group herded out into the alien ship did match fairly well a selection from the twenty-one missing humans, but even there, no single selection matched up perfectly.

There were other deviations from perfection: they must have programmed their physics engine so that it would model people and aliens interacting, and falling, in a gravity field, but their field was closer to half a G instead of Mars's one-third of the Earth's gravity. In a number of places the discrepancy was significant and noticeable.

Gwyn had expected computer-generated video clips and his study didn't change his mind. Still, the videos were amazing. He had never seen work of this quality. Except for the gravity field that was slightly off, there was no 'smoking gun'—no portion of a video that proved it was not real, proved that humans had not been abducted by aliens. This Mars hoax, as he was calling it, was not arranged by a few clever colonists. There had to be major support from top professionals on the Earth, and certainly some support from people on the Moon. Yet he still had trouble visualizing how they could pull it off, make everything work perfectly. When your opponents can outperform you, the game has gotten difficult.

His fancy simulator had billions (literally) of information sources across the world. Internally it had a model of the Earth itself in extreme detail. It had known about a computer film project, but without knowing its application. Over the past two weeks it had added huge amounts to what it knew before about Mars and about the people connected with Mars, including dozens of people on the Earth who had contributed to the mass suicide. Belatedly the simulator gave Gwyn this information, terabytes of it. They could arrest and jail or kill the remaining people—those on the Earth who were involved, but there was no particular reason to go after those people, except from a desire for retribution. It was too late to affect things.

Gwyn couldn't imagine what the motives had been. Including despair, depression, and outright insanity, he thought some enjoyed

the humor of it, if one could use the work "humor." There was a long history of people carrying out hoaxes for a variety of reasons.

One aspect Gwyn found amusing even as it was sick humor: the people who had created the clips were perfectionists and were proud of their work. They wanted to show off their efforts. To this end, they displayed visual scenes that exposed their artistic talents in the best light. The clips as shown were far too well-placed, much too clearly representing their work. In no way would actual clips in a real scene like they were modeling have done such a good job celebrating their talents. The "chaotic" videos weren't chaotic at all, but in their constructed simulation, they were carefully placed, staged, and controlled.

Gwyn wanted to talk everything over with Meyer, but he didn't think they would get anywhere. He didn't like the available options. His simulation software was grinding out unhappy future scenarios. Meyer finished reading Gwyn's report on the hoax: details about how Satanists and others had arranged it. Gwyn had contacted him on a secure channel.

"The problem with using my simulator to predict the future," he said to Meyer, "is that it can't incorporate truly bizarre and unlikely events. Any such event has almost zero probability and there are an unlimited number of them. But some such events change everything by themselves. Given an unlikely event, after the event has occurred my simulator will do a good job predicting the event's influence on reality. This crazy alien attack video is like that. I don't like the new predictions, but I can't retract the event or make it go away. My simulator can suggest ways forward, but none of them are much better than letting events continue without interference.

"Using the simulator, I can deliberately introduce various unlikely events that it might suggest. I have seldom gone to such an extreme. For one thing, others besides me are examining such events. In the worst case such an action could reveal my influence, tip my hand, so to speak. Or I could be tipping *our* hand when I'm working with other people.

"I was counting on at least five years, hopefully more, until everything fell apart, but the disintegration of our whole world order will start soon. I feel sure that no group of humans or countries, none whatever, can now prevent this from happening. The simulation shows the Earth sliding into chaos. Order is hard to maintain and chaos is easy to create. With the tools I and others have available, the simulation sees no way to maintain any kind of order. We should be able to keep Hawaii and the transportation links to the Moon, at least to keep them functioning, out of the general ruin, for a little while. In the best case for some time. We can hope, but we can't even be sure of that."

Meyer was still reeling from watching the videos. It shouldn't have been so disturbing, mostly a fiction, except in the background were fifty-seven dead people. "This is what we've been preparing for on the Moon: for a complete loss of contact with the Earth. We might even keep the Mars colony going indefinitely, after a fashion. I believe that would be a worthwhile and achievable goal, and we could do it without using up too much of the Moon colony's resources. I think of Mars as another backup resource—if the Moon failed altogether, and God knows we can hope that doesn't happen, Mars might still continue on its own. I'm just now thinking this through. We need to work with Mars more frantically, as if everything depended on its success. Yes, backups are good."

"I agree completely," Gwyn said. "I'm going to push for a large expansion and improvement to the Mars colony. They are short of people now, so some of the extras from here will get Mars back to its full population and beyond. Even then it shouldn't need but a small fraction of the Moon's resources. One important goal, hard to reach, will be the physical self-sufficiency of the Mars colony—so that with its own resources, it can manufacture everything it needs, using 3D printers and the like. In that way Mars can become the ultimate backup to the Moon. A very good idea, Meyer."

"But I can think of worse outcomes," Meyer said, "than total loss of contact with the Earth. What if some group on the Earth decides to attack us. They can't send rockets on their own to visit us or to help us, but they could certainly destroy us with available rockets."

Then Gwyn showed a way they had grasped at straws, so to speak: "One thing the scientific establishment has accomplished you aren't aware of. The location of the Moon colony on the Moon is widely quoted all over, complete with diagrams, pictures of the surrounding portions of the Moon. The quoted location is deliberately incorrect. There's a strong radio beacon to help guide rockets to the colony, but it leads to the wrong place. This was an idea from an old science fiction novel long ago. It might work, but a more likely survival scenario for the Owl's Nest is that as everything falls apart on the Earth, it will be hard to find resources, and there would be no incentive to expend those scarce resources to destroy the Moon colony. Many individuals and groups that would like to cause harm don't have the know-how or the means to pull it off.

"This whole mess drives me crazy. These people, Satanists and others went to such a huge effort to harm the Mars colony and succeeded, ending up with everyone dead. We now know in great detail how they accomplished it. We should have been more careful, but separate from the fancy videos, which were surely created to cause trouble on the Earth, we know how they succeeded on Mars: start with low morale, and make it worse. Cause 'accidents' to kill two key leaders, and then kill a number of other people in order of their importance and dedication to the colony. Those might have been the thirteen who were murdered, if they were actually murdered. My simulator isn't sure about that. In any event it was skillfully done, but a number of the people must have wanted to die anyway. Such a level of despair in those on Mars who planned this—almost like creating a great work of art with their fraud—hoping everyone would believe it."

"Are people in control here on the Earth going to hold those still alive to account? Hold them responsible? Demand that they pay for what they did?"

"Nobody's going to do anything. It's too small a group, and there's no likelihood of any success. There are three people on the Moon with convincing evidence against them. They'll be tried by a judicial trio. If found guilty the trio will likely recommend execution—too dangerous to let them live or to ship them back.

Fortunately I won't have any say in that matter. Otherwise, nothing. We need to focus on a thousand other issues.

"Here's another totally evil way to help protect the Moon colony, the Nest, as everything falls apart. You know that I spent my youth as a prisoner in the Biological Research Institute. In the end I could access much the data in the building and I archived the important information. One of their products was a series of viruses, based on smallpox, that had a predictable percentage of deaths. Like smallpox they are extremely contagious. The actual viruses still exist; I could get hold of several versions. Probably they wouldn't work as they expected, but in 1950 in Australia a virus killed over ninety-nine percent of the rabbits. Anyway, suppose we had such a virus that would kill ninety-nine percent of people. So release it and after a bit, the remaining one percent will have no way to harm the Moon colony. It could conceivably help them get through the terrible times after the complete collapse, which we now know is going to happen in any event. Uh, *almost* any event."

"Could people really do that?"

"They could do it all right, but even in the best case it wouldn't work well. The virus would take a while to spread. The actual results could be extreme and hard to predict, and the virus might move very fast through a region and then die out, so that individuals could survive using strict isolation. And suppose two entities pursue this strategy. One percent of one percent is a small residual number of humans. Two such actions could lead to the end of humans on the Earth. The coming crisis will lead to a collapse but not to extinction. My simulator is almost certain there will be no extinction. The Earth is another backup for human survival."

"And why don't you publicize your findings? Show exactly how you discovered the videos were created, that they didn't really happen. Show everyone the evidence you have."

"We're doing that. We have multiple counter-videos, distributing them everywhere. They're in multiple languages, with arguments tailored to specific audiences. But it's hopeless. Independently other entities are claiming the videos are fakes. It's not going to alter the world-wide reactions. From the beginning we knew we would fail to

convince enough people. People *want* to believe in the attack on the Mars colony. It's a bit of excitement in boring, hopeless lives. They want to see the elites brought down.

"But I shouldn't have kept talking so long. Meyer, you and I and many others face a major problem right now. We need to get to the Moon as quickly as possible, and do that without appearing to be running to the Moon. I'm happy to think that even if none of us make it, the Owl's Nest should do well. It should succeed long term, continue to grow indefinitely. We've always been preparing for isolation, loss of contact with the Earth. None of us are irreplaceable.

"Right now we are putting into place plans to transfer much more from Urbana to Hawaii. We've been doing that before on a large scale, without making much of a deal about it. The new amount of transferring to Hawaii will be almost frantic, but again while creating as little stir as possible. So our facilities will continue to stay open here, all rents will be paid. Much of what is moved will be labeled 'temporary.' I feel bad about this, but many of the non-technical employees will continue with their jobs until the jobs disappear. We are going to expend a large effort to make the area near Urbana survive after whatever kind of total crash comes along. Fix things so those jobs don't disappear. And we are in a less densely populated area that produces food.

"There is a range of scenarios, from most people we'd like to get to the Moon ending up trapped in Urbana, to most of those people getting to Hawaii, to a good number getting to the Moon. We have complete plans for several key people to go separately to the Moon as soon as possible and to do it without looking like everyone is fleeing. You and I are such key people; the sooner we get off the better. The whole attempt to flee could fail, say, if various powerful individuals realize that we're running off from them. The chance that many people won't be able to leave gives us all the more reason to help this area survive the crisis.

"Here's another important issue: sending a bunch of additional people to the Moon stretches the resources of the colony. Every ton of people sent, no matter how useful and important they seem to be, is a ton of precious supplies *not* sent, and is at least a short-term drag on

the colony. Unfortunately, the bottom line is: we don't want to send too many extras. We hope to send load after load of extra supplies, as long as the base in Hawaii lasts.

"So what about you and Elisabeth? I don't like applying so much pressure, but the two of you will have to decide today and be prepared to leave tomorrow if you intend to go. As I said, staying here in Urbana won't necessarily be a death sentence. There will be survivors here with significant resources. But I must ask: are you and Elisabeth going to go? Or you alone?"

"We've discussed it and it's … complicated. We didn't know we'd have to decide in one day."

"I didn't know that either. But unfortunately it's right now. We could use some deity to help us—we'll be leaving so many good people behind. I hope I'm mentally prepared for failure, not to make it, that I personally might not get out. Obviously we should have gone earlier."

"Oh, shit. There's something else," said Meyer. "You need a whole collection of tests passed—physical, mental, readiness, crap like that. I don't remember everything. They spent two full days with me. Elisabeth hasn't done any of that."

"But she has. I planned this a long time ago. Do you remember the outing she went on: a canoe trip down the river sixty kilometers to the east of us here, in that former state park. Then things went wrong, several canoes tipped over and the whole party was isolated? They had to stay overnight on the river, and there were other problems besides overturned canoes.'

"Sure, sure, I remember that. She said it was scary at the time."

"That was all staged, a test for Elisabeth and for two others. She did well with the stress at the time. She personally righted her canoe and got back into it, along with doing many other things. The 'health' part was included in her regular wellness exam. She easily passed the various tests; she's good to go."

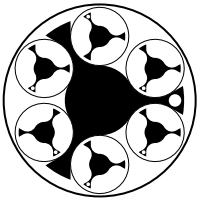
Gwyn didn't mention that her suicide attempt would normally have eliminated her as a candidate for the Moon. He'd played it down as not very serious and convinced the authorities that it was a one-time problem, not likely to recur, and that she was essential to get

Meyer to the Moon.

"I'm sending you elaborate transportation details right now. I've been making reservations as we talked. The two of you need to study them tonight. I've now set a deadline of noon tomorrow if one or both of you intend to leave. I'm begging you now—please talk her into going. Elisabeth will need to say goodbye to her mother. She will need to lie to her friend about caring for her plants and birds, but that won't be a problem either. She can get her mother to help with that.

"Anyway, what we must do now is flee, flee off to the Moon, and soon … soon. Myself, I've done almost no traveling. I'm dreading it—my first long trip ever."

"I'm sure you must know," Meyer said. "There are so many ways the complex trip to the Moon can fail. Everything is uncertain now, except for our lovely stable Moon colony, waiting for us and not requiring us. Elisabeth and I will let you know for sure by noon tomorrow."



Interlude C

Neutron Star, 2755.

21. Arrival

The mostly spun-down neutron star had no nearby companion stars. Call it NS Prime, or NSP for short. Formidable even if quieter than one of a newer generation of such stars, it was one hundred seven light years away from the Earth, and only recently discovered because it was so old and inactive. Its temperature was below 1000 K and it had no accretion disc. Still, don't sell it short: a mass larger than the sun crammed into a ten kilometer radius, the densest material in the universe outside of a black hole. The hardest surface anywhere—not outdone by a black hole, whose event horizon has no surface at all, but is only empty space on a one-way trip to an unavoidable singularity. Even the term "singularity" is a cop-out, a way to say no one can conceive what might be there. Back to NSP, a mountain on it is a fraction of a millimeter tall, and the depth of its atmosphere is only a few microns. Its gravitational field is beyond imagination. Letting a marshmallow fall to the star would release the energy of a nuclear explosion.

A trio of researchers had started the project at NSP. And how did they establish a foothold in the neighborhood of a distant star? With an enormous effort you could achieve fifteen percent of light speed for a large ship transporting human passengers. That's over seven hundred years for a one-way trip. But there was a way to get close to

light speed. Instead, start with a small ship and a minuscule payload. Such a ship could be pushed to near light speed, using up most of its mass in slowing at the far end, then easing into a wide orbit around NSP. One must not get too close. The only cargo: an amazing tiny nanomachine whose duty was to build an entire receiving station at NSP, a task it started immediately.

The first step was to collect working materials from near NSP, and it quickly located metal meteors and snowball comets to use for construction. Next it created hundreds and then millions of copies of itself to build the new machinery. Quarters were needed for the eventual shadows, whose requirements didn't include much of what would have been necessary for humans. The neighborhood of NSP was not a good place for those fragile creatures, what with extreme gravitational and magnetic fields, and still significant radiation, quiet as NSP was. The final essential part was the huge receiving antenna to collect dozens of shadows whose transmission had been in progress for more than a century and was mostly finished.

The whole process took about one hundred thirty years, starting from scratch, to get the station set up and staffed with three functioning shadows, all one hundred seven light years away. The shadows had been inanimate data until each of three of them was loaded into an appropriate nanobot cluster. This was the initial team. The remaining shadows with varied expertise were available as backup in case the trio encountered problems they couldn't overcome.

The three newly functional shadows had names that were unpronounceable and unprintable. Let's call them Lavor, Merel, and Narat. The three each had associated wet female human bodies that were left behind for a much later rendezvous and merge. Lavor was the designated leader, but the other two had conceived of the project and lobbied to get support, eventually recruiting Lavor, who was an expert about stasis fields, insofar as experts existed.

Merel specialized in the study of neutron stars, although neither she nor anyone else had ever been near one. She was most interested in the crust. Two hundred years earlier an unmanned drone had come to NSP, gathering data about the star, beyond what had been found by studying it from light years away. In particular, the drone

could let objects fall into NSP and study the radiation and particles produced. More important was the extreme modeling software that helped predict the behavior of the star. But Merel's goals went far beyond such studies. She wanted to construct machines on NSP—some kind of machine, any kind.

Her friend, Narat worked with her on possible designs for a machine on the surface. She specialized in computational complexity and information theory. With the tools they had, it was impossible to get something structured onto the surface of the star—absolutely impossible. That's where Lavor came in. For her, the whole expedition would be justified if they got no results but learned more about stasis fields. Still, she had an intuitive feeling that one might use a stasis field to place a thin layer onto the surface. At least she wanted to try.

As part of an early interview, long before the project had even started, Merel had asked if Lavor would summarize information about stasis fields.

Lavor had laughed (well, the shadow equivalent of a laugh). "Since we know so little, that shouldn't take long. Seriously, there are huge databases devoted to this subject, but in the end they mostly emphasize our lack of knowledge." She paused and then said, "OK, I'll give it a try—mostly stuff you already know. It is a field inside which the passage of time can be made slower or faster than the passage outside. There seems to be no limit to the ratio of outside time passage to inside, except that it cannot be zero inside or set to a value that makes it zero outside. And no negative times—time moving backwards. Oh, bugs, I shouldn't talk this way. No negative times that we know about. There might be negative times. I don't want to limit your study and explorations to well-known facts. But if negative times were possible, a field with a person and the field's generator inside could go back in time, and causality could be violated. Anyway, that's nothing we need to worry about.

"So far we've mainly used the stasis field during transport of colonists to a distant star, with a rough setting of one second inside compared to the length of the voyage outside. Thus time is moving

extremely slowly inside their field. In contrast there have been experiments with an extremely rapid passage of time inside, and even a few possible applications, but nothing important yet. I mean, you could get a lot of work done inside in very little time outside.

"Another interesting issue is the *shape* of the field. It's normally a sphere, but we've been able to change the generator to come out with an ellipsoid and other shapes. Even the word 'field' is a gross misnomer. It is not remotely like gravitational or electromagnetic fields that extend indefinitely and whose strength declines inversely as the square of the distance. Instead, the stasis field has a rigid boundary which seems to be impenetrable. Given exactly the same initial conditions, we think the shape generated will be exactly the same each time. Unfortunately, we are guessing and there are important conditions we know nothing about. We have some rules, but no clear understanding of how to predict the shape ahead of time."

"What is the effect of an external gravity field on the interior of a stasis field? " Merel asked. "Especially in this case here, where NSP has an impossibly strong gravity field close to it."

"Apparently there is no effect. That's one reason to run our experiments near a neutron star," Lavor said. "What is outside the field and what is inside have no effect on one another. The two are completely independent."

Narat had been listening and now was indignant. "You said the boundary was 'impenetrable.' Does that even have a meaning? Nothing can have that property."

"Impenetrable as far as we know. This is part of what we'll be studying."

"Are you saying a field could sit on the surface of our neutron star and not have problems, not be squashed flat instantly?' Merel asked.

"That's right," Lavor said. "But extreme experiments like that have never been attempted. That's part of why I'm interested in what the two of you want to try. If we actually go ahead, I plan to ratchet up the 'extreme' part gradually. I would start with baby steps."

"I've still got questions," Merel said. "I'm used to fields on ships, for the organic passengers. The generator is always outside the field. Can a generator create a field containing itself?"

"Yes. In that case you need a person or a timer inside that will take down the field. Otherwise the field stays unchanged forever. Anything inside a field as it is created stays inside the field. If you create a field with a person half in and half out, the person gets chopped in two. Ships using fields to transport people are careful about that—oops, sorry, we cut off your ear."

"Final question," Merel said. "What if anything is the mass of a field? What is its inertia?"

"Measured from the outside, the field has zero mass and zero inertia. But my answers are tentative. We may get different answers in extreme cases. I have trouble picturing a stasis field sitting on our star."

"There's another topic I've heard bits and pieces of, but nothing definitive," Merel said. "That has to do with how the generator was discovered in the first place. It's a complex assembly of strange parts. According to rumors, the people who developed it were never able to fully justify what they did, except that they were trying various designs for a machine that did something else, and instead their prototype generated a stasis field. One person said that key ideas came to her in a dream. Later they tweaked and improved the design, but they never had a clear idea of what they'd done. Again, according to rumors."

"There is a huge amount of data about these issues," Lavor said. "Basically it is a history of the stasis field development. I included that in my introductory report which you should study. No one has ever come up with useful information when they studied the initial development of a generator."

Lavor talked about her early plans in case they went ahead with the project.

"I'm sure you'll have more questions later. As a start I want to try hyperbolic orbits close to the star. There will be gravitational tidal stresses as large was we want, up to the destruction of the generator if it is outside the field. Even if tidal stresses destroyed an external generator, the field itself would remain. You may know that on ships holding people in stasis, the field had to be taken down by a generator.

"After that I want to shift to our main focus: fixed circular orbits,

including a geocentric one, that always stays above the same point on the star. Our star is rotating slowly enough that we should be able to use that orbit with a working outside generator. In this way, my plan is to produce a stasis field that rests against the star."

This was what Merel and Narat had been hoping for: a way to contact the star and to lay something down upon it.

Eventually Lavor agreed to the whole expedition.

Now more than a hundred years later, they were actually in the vicinity of the neutron star. Lavor didn't tell the other two, but she had been fixated on the stasis field since she'd first heard of it, afterwards devoting most of her time and effort to its study. She had been eager to go on a trip to the neutron star as a way to focus on studying the field. For her own records, she secretly set down her thoughts about the field, here simplified and translated into English.

> *There has to be more to the so-called* Stasis Field *than the result of some "Generating Device" created by ordinary people. I have studied the device we use and I believe it creates something new and profound, forever beyond our knowledge or even our imagination. My theory is that the device we use calls upon a hidden mechanism of unimaginable sophistication to actually construct the field. What is this mechanism, where does it reside, and what is the field really like? It's not that I believe we will never know, but that we are not capable of understanding answers to any such questions. I think each stasis field might be some kind of universe of its own, embedded in or attached to our own universe. Those are just words and may have little to do with any underlying reality. At best we will be able to study this stasis field and learn what to expect of it in certain circumstances. That describes our current situation, and eventually we may develop more experience and find new applications.*
>
> *The stasis field deals with* time*, a concept that even we, the advanced Builders, do not understand. Two streams of time, side-by-side and proceeding at different rates—that is completely beyond us. It would seem to require two different universes. Even the thought of two separate universes is too much—impossible to imagine this as something we could ever understand, let alone control.*

> *So far, stasis fields have mainly been used for the transport of living humans to other stars without the humans aging. Lately though, our colleagues have wanted to explore the use of these fields as* containers*, for example, and even as the hull of a spaceship, among many other uses. It could be dangerous for our society to employ a supremely potent device we do not understand. Primitive animals playing with fire and not just getting burned, but starting a forest fire—that is the analogy.*

Lavor resolved to carry out the work they had planned. Could such experimentation be dangerous? Obviously. Could effects range beyond their immediate vicinity, even across their entire civilization? How could they know?

22. Insertion

They had made lots of progress and yet hadn't even tried the crucial step. That was what Lavor had expected.

At present they had a remote-controlled satellite in a synchronous and stationary orbit around the star, meaning that it remained directly above one spot, its orbital period exactly matching the relatively slow rotation of the star. At that point the tidal forces at the satellite were significant but tolerable for the type of machines they could build. The satellite was a converted almost million-ton metal rock they'd found and managed to put in place. As with the Earth's Moon, their rock always presented the same face to the star.

Much more important, they had created a whole sequence of stasis fields, one after the other, each connected to the satellite and each closer to the star. The current one reached way down to the star, almost grazing against it. For stability the field had to extend not just to the surface below, but in the opposite direction, far beyond the satellite. Lavor was happy to be at this point, so it seemed like a triumph, but each success simply pointed to the next desired success. There had to be incredible tidal forces on the stasis field, or at least *ought* to be such forces, and either the field didn't feel them or was strong enough to withstand them. Another issue they would like to resolve.

The next goal was to lay an extremely thin layer down onto NSP's surface. Merel and Narat had been preparing a large number of trial layers. The plan was to use a small field that brushed the surface of NSP. The thin layer would be situated against the star. Then they would remove the field and whatever was inside would be sitting on the bare surface. They needed a small field, not the large one encompassing the satellite. For a time this step seemed impossible, but Lavor was able to create the small field from within the larger field and attached to it. She had desperately tried a number of ways, finally succeeding without knowing exactly how it worked. In this way it would be easy, say, to release something from above the surface. They needed no experiment to know what would happen: whatever was released would smash down in almost no time. The tidal forces

would tear even its atoms apart.

"We will have a field on the surface with something thin at its bottom and nothing else. When we take away the field, that thin layer will be sitting on the surface," Lavor said.

"And when you take away the field, all Hell breaks loose, as they say," Merel added. "There'll be an unimaginable force on the 'thin layer,' and we hope one of our designs will stand up to the force.

"Let me describe what should happen. The thin layer will be smashed against the surface. Sort of smashed, because it will already be on the surface. It's atoms will be stripped of electrons, and the nuclei will be affixed to the surface, never to change position. Under various circumstances exotic particles will be created and emitted. We hope to make use of those particles."

The others objected, demanding simulations of the physics. "Of course we have simulations of everything," Merel said. "Unfortunately, the simulations produce extreme variations in the presence of the smallest initial changes. Still, this is part of how we choose which atoms to use and how we guess what particles to expect.

Eventually they did their first trial, with a square layer one atom thick and about half a millimeter on a side. The result was a minor explosion. Not much really, but certainly the layer was trashed. They tried several times more with no success.

"I should have known that wouldn't work," Lavor said. "The bottom of our field is flat and the layer is flat, but the star is not precisely flat. There is also a micrometer or so of atmosphere to get through. I think I can create a stasis field whose bottom is the convex shape of a sphere with radius 10.32 kilos. Then I can only hope the atmosphere doesn't ruin things."

It took Lavor four "days" to construct the proper stasis field, and they were ready for the next trial. Another explosion, larger than before. Lavor suspected contamination within the field. "We need the remaining content of that field to be a hard vacuum, well, a perfect vacuum actually. Even single atoms will turn into high-energy particles."

After working on the field content, besides the layers, the next trial was violent, but not a real explosion. With luck they could

start trying many different versions of the thin layer, based on the simulations and the observed results.

Merel and Narat had built trial layers "atom-by-atom" using nanoconstructors. They'd been working on this for months and had a number of samples to try.

The other significant problem was observation—tying to see what was going on. "About imaging the thin layer," Lavor said, "I've been planning for that from the beginning. We will get an extremely rapid sequence of ultra high-resolution pictures of the site at multiple frequencies, from gamma rays to low frequency radio. I'm also going to use exotic particle detectors. The camera and detectors will fly in on a hyperbolic orbit going nearly over our site. I've made the detectors as sturdy as I can manage, and we'll time things so that we get pictures at the closest approach and at the exact time of placing the layer. I'll keep trying closer orbits until the equipment fails, and then back off a bit.

They spent months of hard work, trying over and over, hoping for a spontaneous electromagnetic response or for a change after radiating the layer in different ways with signals. They were getting some data and responses, combining that with simulations of the physics that was going on. They had planned to use certain kinds of nuclei in rows, where one nucleus would emit a particle and the next would absorb it. In this way they hoped for a process similar to a current flowing through a wire. Slowly, gradually, they were getting some results.

The months became more than three years, with tiny steps forward amongst mostly failures. There came a time when they could send a signal to their "machine" (not much of a machine, really) and receive its response, both short-wave radio frequency signals.

Narat had been trying to implement a computation design based on what were called "ballistic computers" using Fredkin gates. This didn't use frictionless physical balls bouncing against one another—there was no motion on the surface, with the nuclei frozen in place. Instead there were a number of exotic particles coming into existence

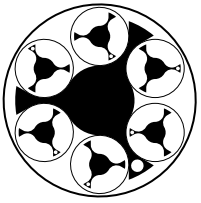
and decaying. With these she managed to realize an abstract model that could be made more complex.

Nine more months of intense work and they had a working machine of sorts. It would take a single incident short-wave signal and respond by outputting a sequence of repeating signals, separated by pauses, with the repetitions giving the sequence: 2, 3, 5, 7, 11, 13, 17, 19, 23, and so on through the first 2048 prime numbers, ending with 17863 signals, when it would start over with 2 signals. A second input signal would terminate the sequence of outputs. This was a classic case of a signal stream that could hardly arise spontaneously, and yet had clear mathematical significance without making any assumptions about notation, or for that matter, assumptions about what universe you are in or what the laws of physics are. Any species that can count ends up with most of our mathematics.

At this point the work got easier, almost a surprise to them. It was a matter of scaling the design up with repeated elements to do more complex computations. Eventually, they were creating a digital computer on the star's surface. They even managed to make it through a starquake—like an earthquake, only occurring in the impossibly hard material of the star.

Narat was in charge of sending complete technical details of everything they had done back to their Central Control in the Solar System. Another one hundred seven year trip. Essential was a record back home of what they'd accomplished. They didn't anticipate an event that would destroy themselves and everything else, since they were a long ways from the satellite, but still they were in an extremely violent environment. Shit happens!

The three of them took time off for a special celebration party with games and prizes.



Part VI

Moon Habitat, 2877.

23. Habs on the Moon

Jun was in the Lumel Hab, the huge one, largest on the Moon, well, largest anywhere, and not exactly separate, but directly connected to a number of others. Altogether, these accounted for some twenty-three thousand people, about a third of the total Moon's population.

Jun had been invited by Rolive Genesee, the current head of the Council governing Lumel, to an initial and informal gathering. Only selected representatives from the more important Habs were invited. Jun guessed that Rolive wanted to get an agenda straight, get agreement on priorities, all before the main larger meeting started.

To Jun's surprise, Rolive had offered to meet her at one of the mobile terminals. After introductions, Jun said: "Wow, this sixth-G gravity is crazy. We go down to zero-G, but we mostly live in two-thirds-G. I'd love being in low G areas all the time."

"As you know," Rolive said, "we pay a price for that. We have to spend time on centrifuges. Now ours are large and comfortable, but still we have to seek out high-G areas. Was your trip here okay?"

"Yes, not a problem and very short. I've never been on the Moon's space elevator before, and I only heard once from someone who'd been on the Earth's elevator. It was a nice view of the Moon from the viewscreen."

"I've been on our elevator many times," Rolive said. "I go up it every time I want to go to a Hab off the Moon. We're going to talk

about those elevators tomorrow—you'll see. But right now I want to ask you about boredom in our Habs. I'm polling people."

"You're talking to the right or the wrong person. Growing up, I was bored much of the time. My friends and I looked for something, anything to do. There was every kind of activity, but most of them got old after a while."

"Yes, that seems a common story. You'll see startling news at our preliminary meeting tonight. Something's going to stir everything up, and soon—probably only a few months out. I have to keep it secret until the meeting starts. But let's get you settled in, get you something to eat, and gird ourselves for the meeting."

That evening, Jun went to Rolive's special early meeting with a dozen other influential representatives. The "influential" adjective was Jun's idea, not stated by Rolive. After extensive research by Jun about the others at the meeting, the word seemed to fit everyone except Jun herself. She truly didn't know why she'd been chosen for a select meeting of important people. The first agenda item was the pirate problem.

After going through introductions and getting people settled, Rolive said: "Okay, first the pirates. A nasty problem for sure. We and two other Habs are shutting them down. I understand what a disaster it was for a small Hab like Azel, ending up with some of your people killed, and it's terrible to introduce violence into a Hab. Jun here represents Azel. Do you want to say anything about the experience?"

"It was horrible. We were attacked twice. The first time was completely unexpected. A number of our people were killed and others taken off, mostly young women and girls taken for purposes that we can unfortunately imagine. We had many casualties and the pirates had none. I assume you have heard how this could happen when the pirates were extremely outnumbered. They came at an early time of the day and left so quickly, most people didn't know anything had happened. We were prepared to some extent for the second attack. Each side had casualties, but we were able to capture

the surviving pirates. They managed to barricade themselves in a suite of rooms with three hostages. Rolive here sent a team who were able to overcome the pirates quickly with no further people killed. I haven't heard what became of those her people took off."

Jun paused so long they wondered if she had finished.

"As for introducing violence into a Hab, that happened to us and to me personally in a disturbing way. After the first disaster, we researched and armed ourselves, and then taught ourselves how to fight—very rudimentary fighting. I hate to acknowledge it, but it's part of a price I need to pay."

Jun took a long breath.

"I actually killed someone, myself." Jun said. "With our best weapon, as you know, a crossbow. It was the worst experience of my life. So I also am in the category of having killed someone. There were others in my Hab who ended up killing one of the pirates. What about them and about me, who are killers, each one of us?"

"Killing in self defense is a different issue," Rolive said. "But still an important aberration. That's another reason to stop the pirate activity. We have ways to help people like you who've gone through that experience. I'll talk to you privately about that."

"And what do you do with those who initiated killing, like the group you took over from us?"

"There are several behavior modification techniques we use. For someone who deliberately initiated killing others and did so, a serious segregation is needed. One thing we use, though again not for anyone who has killed, is a 'boot': a heavy object attached at the ankle on one side. It's bothersome and announces to everyone that they've misbehaved, like a mark of shame."

"And for those who killed?" someone asked.

"Right now they're being kept as prisoners. That's not a good solution. Execution is not possible. We have two ideas for what we will do with those who remain incorrigible, and it will be some time before we decide. Most important is that we caught this whole movement before it spread. No one is trying this anymore."

"But what could you possibly do?" the same person asked. "How would you control the killers?"

"The Earth is full of smaller uninhabited islands where someone can survive in isolation using the plants and animals on the island. One or more people could be left in such a place, along with an overseeing drone that they're not aware of. That's our best idea so far.

"Enough of that. On your pads is a discussion of the plans for contact and interchange between the Habs and the Earth. Most of you may not realize that the Habs will be initiating regular travel using the standard mobiles that carry us between Habs. They will soon be picking up and dropping off at some sixty locations on the Earth. At first there won't be any travel between locations on the Earth, but only directly Earth to Hab and Hab to Earth—oh, and we'll still have Hab to Hab as it is now."

This announcement generated some surprise with the group.

"Do you mean the Builders themselves are doing this? Right now? I represent the Mars Habs. This is a huge change. The Builders are finally showing themselves!"

"No, as usual, the Builders are not directly involved," said Rolive. "Or at least not necessarily. Some of you may not know that the AI or AIs running each Hab communicate regularly among themselves. There must be an Earth-based AI. Unless the AIs can violate the speed of light for messaging, which doesn't seem likely, there has to be a number of separate AIs spread across the Solar System. This new proposed transportation between Habs and Earth is something they are initiating. As always we have no evidence of direct Builder involvement. Queries to the AIs don't get any real explanations. They only say 'It was time.' "

People were talking back and forth, about such a huge development. Rolive had to calm them down.

"This may be a learning experience for some of you. Again, you might not know that travel between Earth and Habs has always been possible, requiring only permission from some Hab AI. Permission has been given only rarely. This has been travel to and from the top of Kibo mountain, using the space elevator. The AIs indicated that transportation would only be available on a limited scale initially, and ramp up over time.

"Another point the AIs made was that there would be no preparation given or even suggested for a traveler going to a destination that might pose difficulties for them. In almost every case, the environmental challenge for an earthbound person to go to a Hab would only be technical, such as being confused by a lighter force of gravity or by the Coriolis force. The other direction could be immediately life threatening, or at least very unsettling. I'm not only talking about the Earth's stronger gravity field in every case, but about other environmental extremes that Hab people have no experience with. I think that travelers will be told the conditions to expect, and will then have to make an appropriate decision. Imagine someone from the Moon going directly to a mid-winter location on the Earth."

After lengthy discussion, Rolive had one more point to make: "I think you all must know that hundreds of years in the past the Earth was awash with dangers. Incredible varieties of diseases were everywhere, as were similar numbers of dangerous pollutants. The Earth was an extremely unhealthy place. It has been changing so gradually that it crept up on people—that the Earth was no longer such a dangerous place to live in or to visit. Over time these hazardous parts of the Earth diminished dramatically, but now such hazards seem mostly gone or at least not serious. The 'big cleanup,' as some people call it, has surely been the work of Builders, well, the work of their agents. So while the Earth is still full of hazards of many natural kinds, the diseases and pollutants are no longer worrisome. There are still billions of different types of microbes on the Earth, seldom do they produce a disease in humans

"Anyway, this will be a huge change."

Someone named Jordon was trying to get Rolive's attention so he could comment. After getting the attendance list, Jun had researched each member. Jordon was known for his strong opinions.

"Once again they are taking away our autonomy. The power is in their hands. It's not good for us to be slaves to these deliberately and cleverly gentle overseers. They have tremendous power and ability to control, by any amount they want. Here the control may be considerable."

Rolive started in somewhat sarcastically. "Many of us are familiar

with your concern about control. By our nature and our environment we are far from autonomous."

"It is the standard 'iron hand in a velvet glove' they are using. As you are aware from things I've said, I want more autonomy."

"Again, it's a fact we know but some don't like to think about: autonomous man without Builders would by now either be extinct or would be barely surviving in a ruined Earth. Most people currently on the Earth don't realize this."

Jordon didn't give up easily. "Just because we needed help back then doesn't imply we should have no autonomy now."

"And what would you like to do, you poor controlled creature, that you can't do now?"

"More sarcasm. I don't want *them* making all the decisions. I'll drop my dispute so that we can look at the details of this change. But notice: it's not a proposal. We had and have no say."

Rolive indicated the section of their briefing that described in detail much of the proposal to start traffic to and from the Earth. "As Jordon commented, we have no control over this change. Implications for our whole collective societies, both Hab's and Earth's, could be tremendous. We've included some tentative proposals to help with the transition. I expect a large number of Hab dwellers will want to see their home planet. No, I take back what I said. Earthers will also want to visit Habs."

Rolive went on without soliciting any more comments. "Our final item of great importance is the push to create a government of sorts encompassing all the Habs. This will take years of work, and by definition won't ever be complete. We must act as a unit in confronting the Earth with its much larger population. My group is putting forward a specific set of proposals for discussion."

The preliminary meeting went on for some time discussing the issues Rolive had brought up, trying to get ready for the large formal meeting the next day.

During an afternoon off from meetings, Jun embarked on a study of her own powers of perception, such as they were, following the

DarkAngel's advice. She was going to use a Builder randomizing device. The device fit the advice: something simple that she could try to perceive without looking at it. With one setting it would repeatedly display a random pair of integers between one and six—the same as rolling a pair of dice. As part of her faith in Builder perfection, she assumed the device used something like a quantum source to make it true random.

So she activated it with her eyes covered, followed by guessing the outcome, or somehow getting the outcome: two small numbers. At first she had no feeling of what the outcome might have been. Over time she started now and then getting the impression or the hint of a picture of a pair of displayed numbers. Right away her picture was correct. It could have been luck, a good random guess. She tried again and got no picture, tried yet several times more, and got the correct picture twice. It was a matter of getting her mind into the right mode. Eventually she was able to get the two digits correct every time. She tried other settings on the device and was able again to "see" the output correctly every time.

Jun tried other parts of her environment. She found that over time she could perceive many things with thought alone. It became like a little video feed that was delivering images to the vision centers of her brain without involving her eyes. Initially that ability needed to be about something next to her; then it was limited to a few hundred meters. Gradually the limitations of distance expanded, but with increasing difficulty. Not exactly an error rate introduced, but more like fog entering and keeping the vision of a remote object from working.

In addition to distance messing up her new method of perception, she learned that lack of concentration often made everything pop down to no vision. Such a weird ability, she wondered if other people had experienced it.

24. Looking Ahead

The "Council of Habs" had finished on a strong note the day before, after two earlier days of discussion and deliberation. A super-majority was in favor of an overall governing body of the Habs. They had put forward and almost unanimously approved a formal proposal to be taken up by each Hab. Most people seemed positive about the details of the proposal.

The delegates were also positive, even excited, about the prospect of travel between the Earth and the Habs. This was not a proposal, but new travel opportunities that would be available whether or not there was opposition. Jun was talking with Rolive and several of Rolive's aides, minions really, about related issues.

"I'd like to hear what you think about the new traveling that will take place between the Earth and the Habs. I think it will introduce all manner of difficulties as part of the interactions between two distinct cultures."

"We at Lumel have discussed that problem," Rolive said. "The new Council will take a long time to become an established entity. It could eventually be useful in dealing with travel problems, even introducing restrictions and requiring permissions. That could help, but I don't think there is any single entity on the Earth that could provide similar oversight on their side.

"The report from the Habs said it wouldn't be introduced immediately and the traffic allowed would be ramped up with time. The Habs themselves may have various restrictions in mind. We'll have to wait and see. We at Lumel and others I've talked with think that in the end it should be beneficial to everyone, but there would be adjustments required by each side."

Jun was looking forward to a big celebration party at midday. She'd made many new acquaintances, some already with the status of friend, when Isa showed up—not the wrong Isa, but her own version. He complimented her on a speech she'd made to the whole group promoting a unified governing structure for Habs.

They'd finished their breakfast: what for her was not a normal meal, but she was glad to partake. Huge crowds were pushing toward the central plaza of Lumel, with its gigantic dome currently showing a beautiful day on the Earth. In that way they were validating the ancient science fiction illustrations of life on the Moon. There were endlessly many nodes supplying food and drink, where each node conformed to a certain style of food. The Habs supplied food, but if fancy stuff was wanted, it had to be cooked separately by humans. Often the basic parts of food went back to actual plants. Animals or parts of animals were never served as food.

The party included platforms with entertainers of all kinds. In the one-sixth gravity, gymnasts could do astonishing feats. There were magicians, musicians, comedians, and hosts of others. Her Isa explained some of the unusual acts going on that were unfamiliar to Jun. He recommended several of the food items—stuff she would normally not consider eating.

This was far more people than Jun had ever seen gathered together. It was such a variety of people—endless varieties of clothing or language or even appearance. After a while she was no longer enjoying such a crowd.

As part of their costumes, people were wearing and carrying colored items of every kind, such as large arrangements of flowers—never artificial ones. One large flowery skirt, as it went past, suddenly opened and launched a crossbow bolt from less than a meter away straight into her lower chest.

There was an immediate commotion, with some people backing away and others rushing towards Jun, who was saying: "He missed me, so there's no problem on my side." Internally she was wondering what had happened to the AI monitoring that should have provided an instant response. Who was this person and how did he get hold of one of Azel's crossbows, as this certainly was?

Moments later a Lumel security agent interviewed her briefly, where she explained how she did not know the attacker, was surprised that an attack would occur at all, and had no idea how the attacker had gotten the crossbow. She was told they would investigate and get back to her with whatever information and explanations they uncovered.

For Jun, on top of this was a disturbing reality: the bolt had not missed. She'd felt a strong blow to her chest, like something from a padded spear, almost knocking her over. Yet it had caused no harm. It should have gone right into her flesh, as deep as ten centimeters. She'd found the bolt in amongst her clothing. It was sturdy and in perfect condition. How could it *not* have harmed her? It defied logic.

Jun stayed late at the party, talking with many people. A major part of what she wanted was the connections, getting to know people from other Habs. She was accomplishing that goal, yet her mind remained on the incident. It was easy to imagine a disaffected would-be pirate who wanted revenge. So why hadn't he gotten it?

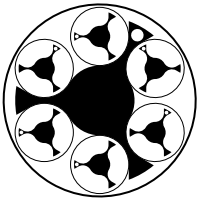
Jun was still much unsettled when she got back to her assigned room in Lumel. Typical for housing in the Moon, it was small but well-designed, with everything one could want. Did the Builders, when they constructed this, have a certain kind of person in mind, one who liked intimate closeness? Did informal preferences influence the Builders, or did the Builders create the preferences?

Jun had been putting off another kind of experiment with her perception. The DarkAngel had suggested that she keep trying to perceive more. She had the little dice-like toy with her, the one that would give random numbers. In retrospect she couldn't believe she'd thought of looking to the future, looking for something yet to happen. In the end she almost wished she hadn't done it. She attempted to visualize a pair of numbers coming from the randomizing gadget, but *before* she had invoked it to create them. First she turned it off and it was blank. Then she tried to visualize two numbers. After a while she did see two numbers in her mind, and when she turned the device back on those numbers came up! As before, she got a string of intermittent failures and successes, followed by a long string of successes and no failures. This was truly frightening. She was seeing a little piece, a snippet, of the future, but seeing with perfect accuracy.

What could a long sequence of small and perfectly accurate predictions become? A large and accurate prediction, maybe? But unlike her visions, this was in a carefully controlled environment.

Her visions were fuzzy; this was precise. She decided to end the experiment for the time being. Yes, indeed for the "time being."

She asked herself: why was she scared? Well, messing around with time itself seemed serious, or dangerous, or what if it was much worse than that? What could go wrong? She might find out the hard way. What was the ancient saying? "Experience is a dear teacher, but fools will learn at no other," So she should proceed in small steps and cautiously. Then "see" the outcome of more complex random events. Whoa! That could be the outcome of something important, say an event due to happen one way or another in the near future. Suppose she perceived in this way that an event was to occur and then made sure it didn't happen. A paradox? She almost felt a chill or a shimmer in the air. Was this what the DarkAngel had in mind? She would think this over carefully, do nothing right away. Maybe she could talk to the DarkAngel about this.



Part VII

Earth-Moon, 2084.

25. Flight

There were seven of them heading for the old Rantoul Airport just north of Urbana and Champaign. Included were Gwyn, Mila, Meyer, Elisabeth, the communications specialist Gregory Dulles, and two others who were important, each is their own way: one was Frank Adams, a nanotechnology expert who worked with Meyer, and the other was Harriet Pilgrim, who worked with specialty printers: micro-printers and those that produced highly unusual output that included amazing strength or properties they could obtain in no other way. Adams liked to talk, while Pilgrim had hardly said a word—a weird older woman who was brilliant in her field.

Adams was seated next to Elisabeth. Meyer was in the row ahead of her, busy talking with Dulles about Mars. Turning to Elisabeth, Adams started with: "You must be Meyer's significant other. He brings you up all the time, but no details."

"I'm his *in*significant other without details to bring up."

"Well, it's good to meet you finally."

"Good to meet you also," Elisabeth echoed back. "There's not much to say. I'm not important for the colony. They're only taking me because of Meyer. They want him and he won't go without me."

"That's not accurate about what the colony wants," said Adams. "Three years ago the Nest started pushing for true diversity, not just

scientists and technical people. It's more than a token policy; they're quite serious about it. A directive established the need for families, children, non-scientists, even non-technical people. They also want cultural diversity."

"People have always talked the diversity line until confronted with actual diversity," Elisabeth said.

"That's why they need to push the policy. Meyer once told me you raise birds. That's unusual, that's diverse."

Elisabeth felt her face reddening. It was embarrassing that her face would flush when she became the center of attention. "I have seventeen birds right now in two special enclosures. Mostly finches. They couldn't survive outside."

"You may not know that the Nest has more than a dozen species of birds, over two hundred birds altogether I was told. When we get to the Nest I'm going to introduce you to Dan Dyer, an animal specialist. He's been working with animals in the colony for years. It may look like we're desperately adding people to the colony, all because of this suicide hysteria and the instabilities settling in—the fear of being abandoned. From his point of view humans are a dime a dozen compared to other animal species. You should talk with Dyer. More than getting humans, we're desperate to add plant and animal species before it's too late. Dyer tells me that several flights are devoted to animals along with handlers. It's complicated. With each species they need a reasonable number of specimens and a large batch of frozen genetic support materials to allow a spread of diversity. All for a good breeding and survival plan. They want each new species to be successful and permanent. A part of the colony. I talk with Dyer about this all the time. There's a constant concern that a given species will be wiped out by some disease, since everything is crowded into Nest One. We're getting Nest Two going, and more later for sure: Nest Three, and so on. We need completely separate colonies of each animal, and that applies to humans too."

Adams came to a halt. "Sorry to run on so."

Meyer had been listening to the tail end of the conversation. "Elisabeth, tell Adams about your sign language, You're fluent in it."

"I only know the classical ASL, not the dialect they use in the

colony."

"Yes," said Meyer, "but ASL people adapt quickly to the ASLS that the colony uses."

In fact, Elisabeth worried about adjusting to life in the colony, and ASL was an area where she had a head start. Meyer had emphasized the size, well more than eight hundred people now, with all kinds of interests and hobbies represented—something for everyone. The adjustment was eased for many newcomers by conditions on the Earth itself—mostly horrific, with no sense of calm and stability and a future in doubt.

On the other side of the car, Gwyn was reassuring Mila about the rest of the trip: "You wanted to go to the Moon. It's dangerous, but once our hybrid craft takes off, no longer so bad. The danger comes from the crazies here on the Earth."

"Starting as an infant, I got to know danger and crazies first-hand. You can't imagine how dangerous Australia is, all the time. Just the wildlife alone are constantly trying to kill you. We must have more deadly animals than anywhere else. Our snakes aren't just venomous—I mean every one of our species is—but their different venoms are each deadly neurotoxins, often killing within minutes. Nothing like North America where most people survive a snake bite. You have alligators who sometimes bite but rarely kill. Our crocodiles will drag you into their salt-water rivers and drown you on the spot. And don't get me started on plants, diseases, ocean-dwelling life forms."

"Sounds like fun. How do you survive in such a hell-hole?"

"Simple. You learn to avoid the deadly plants and animals. It's not just them, though. The environment was always harsh, but it has grown much harsher with time. Life is tough there; you can't let up or relax. Still, I wish you could have seen some of the beautiful things in my country. My favorite is Uluru, well, and Kata, too, our sacred rocks. They are amazing. Hard to get to in the center of Australia. Uh, I mean really hard—more so now that travel is so restricted. I climbed Uluru once as a teenager, 350 meters, but my friends and I

had to sneak up; you're not allowed to climb it. You see I have some of what they call 'indigenous blood' in me. I'm proud of that; I'm a real Australian."

Gwyn was following her with only half his mind, while he worked on other things. They were a loose convoy of three cars holding altogether twenty-three people, all hoping to get to the Moon colony. "Loose" meant they were well apart from one another, keeping track electronically. In each case they used a regular car, instead of a van or bus—the twenty-three crammed into the cars, with very strict limits on the luggage. They didn't want to look like a large group going somewhere. It helped that they had no bags; they were allowed next to nothing on the trip to the Moon.

Gwyn paused, getting input from several sources and sharing with the other two cars. "Not good news," he said so everyone could hear. "The plane in Rantoul isn't flight-ready. They're not sure what's wrong, but we need to head on north to Midway airport in Chicago. Several airplanes are available there."

"What's the problem?" Adams said. "Anything unusual scares me, and today of all times."

Gwyn answered. "They don't say. From other data I'm getting, I think sabotage is a possibility. We routinely follow a number of people who might cause us trouble. Right now more of them are moving than we would expect. Not a good sign. Midway is our only other reasonable choice." Gwyn didn't add that they could be deliberately forcing them to Midway—a far larger and more dangerous location than Rantoul.

An hour and forty minutes later they arrived at Midway, after passing endlessly many abandoned cars beside the road. They parked randomly at some distance from one another. Gwyn was talking to everyone in their group, each of the three cars.

"I don't like this. They now want us to go to Hangar 3F instead of 5G. The voice giving the change didn't sound right. But I'm cut off from the two people I was dealing with before. Please stay still. I'm going to do my own investigation."

Gwyn had several drones situated on his car that he sent off toward 3F. The main large door was wide open. Meyer was looking carefully, with nothing to see, even in daylight like it was. Then there were one or two brief and intense flashes from within the hangar, followed by a scream of agony, or maybe two screams. Meyer could hear them even inside the car.

Gwyn tried contacting the local police, but the lines were down, or else they were part of the problem. He'd arranged for three men in another car to work as an initial on-the-ground security force. They had each previously worked in various law enforcement positions. The three exited their car and headed cautiously toward the hangar, two on one side and the third on the other. Gwyn had drones following them.

For Gwyn this was exactly the game he did not want to play—where anything could happen. A large bomb or a fuel fire and they could all die. Gwyn wanted to observe this sort of action remotely; he was almost never in the physical midst of events. At least he had arranged for an autonomous truck to follow them with "extra resources." He called for several of those resources to come in as reinforcement. They should start arriving in two minutes, and he then told the three at the opening in the hangar to wait that long.

At the end of that time, he had what he regarded as a significant war machine: a giant drone floating inside the hangar. It put out a glare of infrared light that allowed Gwyn himself, his three agents at the hangar, and his drones to get a good view of the hangar using special lenses that blocked all but the IR spectrum. For anyone else the drone was putting out intense flashing violet light. Trying to see without the lenses was going to be hard. Gwyn knew there were counters to this—drones using radar and others.

Gwyn liked to mentally congratulate himself that he had a big advantage over the other remote-controlled devices on the planet. Many of them were AI controlled and could respond in milliseconds if necessary. His own devices were controlled directly through his implant and could make similar decisions and responses in microseconds. In most situations, being able to operate in a few milliseconds, or even a bit slower if necessary, was instantaneous to humans.

In the same way his devices responded to other machines with a similar advantage: his were taking action while the others were barely starting an evaluation.

In this case there were two hostile drones inside the hangar that were snuffed out by infrared lasers from his war machine. There were no other apparent threats, so it was time to slow down to human speed and evaluate. Yet still behind the scenes, his large drone was monitoring everything, keeping track of anything that changed, using the same instant evaluation.

Gwyn contacted the three just inside the doors and suggested they check out the two spots that had drawn the first earlier laser fire from the smaller drones. These were spots that had produced cries of agony from two humans. It turned out to be two men with assault rifles. They each had a severely burned trigger finger, and were not willing to try sticking another of their fingers inside a trigger guard. They didn't realize that if the angles had changed too much, he would have had to use far more aggressive steps in disabling them.

Along with the war machine, Gwyn had fetched a powerful robotic fighter roughly the size of a man. It was able to bust through locked doors—soon it had gathered up what he hoped was the full group attacking them. Gwyn seldom used such a robot. Most of the time the people it encountered were first terrified and then intimidated. To get the willing cooperation of people, all you had to do was laser burn someone a little and threaten much worse. Gwyn was not complacent—they were much too close to the action and were personally vulnerable in several ways. He'd determined that the leader of this small group was a short, mild-looking man, code-named "Sam," with long hair and old clothes.

Gwyn started a game he'd played many times: talk with Sam alone, and demonstrate a knowledge of everything about him, including his family and friends back to before he was born. He told him truthfully that his bosses would kill him when this mission was complete. Gwyn was able to name some of Sam's friends who likely had disappeared that way. He got immediate cooperation once Sam

realized he could be killed immediately. This time, as was often the case, he was able to get willing cooperation. Gwyn already knew more than Sam did: that they were European agents, told to disrupt the travel of these people and even kill them all. Sam didn't know why; he never knew the why of things they made him do. In the end Gwyn had converted Sam to be his own double agent. Sam's group had imprisoned the flight crew and others in a room nearby. With some effort they were able to get the flight on track again. Gwyn hated his vulnerability. At any moment everything could spin out of his control with all of them dead.

After another two hours, their plane managed to take off, heading for the old Taggett airport at Barstow, in the middle of nowhere: the desert northeast of where Los Angeles used to be. Gwyn had sent his machines back to Urbana: the warrior drone, the robot, and the smaller drones. Security in Barstow and in Hawaii was much tighter than in Illinois. It was almost impossible for any agents to maintain themselves in Barstow. Where would they stay? How could they get any food and water? For that matter, how could they even get to Barstow?

Ever since they left Urbana, Gwyn had been busy with dozens of other tasks and decisions. At the same time he was bringing his "doppelgänger" (with or without its umlaut ä) up to speed. Even with so much anti-AI sentiment, people still sometimes used an AI for an extra version of themselves. In this case, once he got to the Moon, Gwyn planned to act as if he was still in Urbana. He almost never appeared in person anyway, even to trusted employees. On the Moon, though, he couldn't directly control anything on the Earth in realtime and get away with it—no way to beat the three-second lag. So if realtime action was needed on a remote Earth, one and a half light seconds away, his own special AI named "Ralf" would take over. He didn't really expect the charade to last long.

Of that group of twenty-three people, Meyer was the only one who'd made the trip to the Moon before. The others surely didn't realize emotionally what a long and complex trip remained, and how many separate steps it would take—if nothing else went wrong. Perhaps they were insulated against further problems—almost getting killed before they left Chicago Midway. Sort of using up the problems that chance could throw at them. At least Elisabeth was doing fine so far, partly because she never found out how serious their "delay" had been in leaving Midway. From their plane finally in the air to Barstow all the way into the Nest, by rights it should be smooth.

But Meyer had an unusual method for dealing with a possible future problem. Rather than wishing it away or not thinking about it, his system was to visualize in great detail the problem actually occurring, particularly if the outcome was negative and involved events he had no control over. For Meyer, to refrain from visualizing a bad event happening, or worse, forgetting to visualize it, was to risk the event come crashing right into him. He'd been this way since childhood, as experiences had forced a kind of reversal of wishful thinking on him.

A normal human being may try to visualize everything working out and hope for the best. Innumerably many times in Meyer's early life he had idly thought that an unpleasant event might come to pass, without thinking it could really happen. Then the nasty event seemed almost always to occur. Only when he seriously thought about the bad outcome as an actual possibility, yes, only then did it *not* occur. Thinking about the bad occurrence would keep it at bay! Meyer was a smart man and even a scientist, yet this was his own version of magical thinking. And he knew it, but still....

During the long wait at Midway after the fighting had stopped, Meyer managed to get a connection to Elisabeth's mother. She was aggressively supporting her daughter's decision to leave, maybe not realizing it would be forever. To try to keep her from thinking about that, Elisabeth was explaining to her mother: "And we'll be able to talk every day in high definition video. Meyer and I got good at handling the 3-second delay—you make long speeches back and forth. And thanks for getting Lisa to look after my plants and birds.

She knows a lot about them." And so on chatting for some time until the plane left for Barstow.

The trip itself was deadly dull. No food or snacks, no entertainment, and uncomfortable seats. Many people were trying to sleep. Several pairs were talking shop. Meyer got a small group together and talked about the sign language as a newcomer to it himself. He explained that it would give crucial help with a need to communicate at a time when speaking wasn't possible. It was also a universal language that any group could use—a language easier to learn than an ordinary spoken one. He went over the special "arms-only" version for serious emergencies, say when you couldn't get close to someone. It allowed communication over a considerable distance, as long as one could tell the placement of the arms. This version was limited and he'd committed the whole of it to memory.

They landed in a small dust storm, and in the terrible heat. It was a ridiculous place "on the west coast" to use as a stepping stone on the way to Hawaii. Los Angeles was out, but until a few years ago there were two good airports in the San Francisco area. Then came the quake and Barstow became the main stop before Hawaii itself. Fuel was government controlled, but even so they had trouble getting it shipped to Barstow where few people lived anymore. It was hardly habitable, with quarters buried underground. Fortunately they were in mid-Winter—mid-Summer was far worse. They used special greenhouses for growing food, as normal outside growing was out of the question.

The layover at Daggett field east of Barstow itself was just as Meyer remembered it. At Meyer's insistence they'd brought their own food and water, not needing to risk what was available locally. They didn't get to visit beautiful downtown Barstow, what little was left. More people were waiting for the flight to Hawaii than there were seats on the plane. Because of politics, pressure, who knew what, their twenty-three got boarded, with many others waiting for the next plane.

The flight itself was much longer even than the flight to Barstow had been. By the time they arrived in Hawaii, everyone was unhappy in one way or another. Meyer felt sorry for those traveling, himself

included. The others had no clear idea that the endless waiting would get even worse. At least they were finally transported by bus to a reasonable place to stay and refresh in buildings at the base of the mountain where Homa was. They didn't yet know that fate had dealt them another problem.

26. Rules

Even late the next morning people were still waking up, looking terrible and staggering to the lobby of the building where they'd spent the night. It almost looked like an old college dormitory. There was coffee on a table beside a prominent sign announcing, well, an "Announcement," about the status of flights to the Moon, to take place that day at fourteen hundred hours. It made everyone nervous since it was bound to be bad news.

Right on the hour a trim-looking serious young woman walked through and stood behind a lectern. She started without any notes. "I am Marisa Blakslee, Assistant to the Base Director. I regret to tell you that, though we are still sending flights to the Moon, it is only with cargo on board and no people." She seemed completely calm and professional, making everything sound worse. "An unfortunate infection by a virus descended from measles is loose in the Owl's Nest itself. No deaths so far, but dozens are ill. Two of the most seriously ill are being evacuated back here to Hawaii. Their condition is yet to be determined. One large section, about a quarter of the whole colony, has been blocked off and isolated. Everyone scheduled for a flight will receive a vaccine for ordinary measles —not a perfect match but likely helpful. I'm sorry, but here is the bad part for all of you: the authorities do not know how long it will be before you can go to the colony. They want this infection completely controlled before letting newcomers in."

People were not happy and there were raised hands trying to get her attention. Blakslee went on without taking the questions. "But the expert I talked with was optimistic. Measles hasn't been a big problem in the past. He was bitter, though. He said there'd be no measles now if people hadn't stopped taking the vaccine long ago. I'll give new status announcements daily at this time. We hope to have more information soon."

Blankslee shuffled through several papers. "There are two exceptions. Among you people, Dr. Kaczinski is a virologist, and uh," she flipped to another page. "Dr. Falkow is a physician. They've both agreed to go to the colony as soon as possible to help with the

emergency. After getting the vaccine and going through orientation, they might leave as early as tomorrow or the next day."

People were still raising hands or even speaking to try to get Blakslee's attention. "You should realize that I have no further information to give you. Sometimes the absence of information is itself information. In the short term I have nothing to offer. In a longer term the likelihood is high that trips to the colony will start up again. Right now I want to turn this over to Gideon Morris, who is the main work supervisor for everything that's going on here near Homa, the stalk."

A heavy-set person in work clothes stepped forward. "Please call me Gid. I still blame my parents for the name they gave me."

There was modest laughter. "We have a big need for ordinary unskilled workers at the Homa site. Here's an important issue: at some time soon 'they,' the people in charge, will be making up a master list giving the order to use in sending people to the colony. I guess that order will be based on the anticipated future contribution to the Nest itself, along with other factors. Whether or not you volunteer to work near Homa will have no effect on your location in the master list. This is strictly a call for volunteers with no special inducements, um, no rewards. The work is its own reward."

Gid continued in spite of attempts to ask questions. "We have specialists in everything. What we need are unskilled workers, people willing to do some of the grunt work. The work is fairly safe but not completely so. As an example, one of the high-tension lines could break. That has rarely happened but it's always a possibility. Anyone in the way could be cut in two." A shocked silence from the group and then muttering which died down. "That's kind of a worst-case accident. In the history of this project, we've only had three such breaks resulting in two deaths. There've been a few deaths from other accidents. Hey, stand outside and you might be hit by a meteor. Life is short and full of risk."

Again hands raised, questions attempted.

"Just line up to volunteer. We'll handle questions individually."

Most of the group were volunteering, including Meyer, Gwyn, Mila, and Elisabeth.

The next day there was a minor accident. It was so stupid—Gwyn managed to trip and fall, catching himself on his extended arms. He ended up with a fractured right forearm, so designated by a physician, who like all those people refused to use the word "broken." Gwyn wasn't used to activity and didn't have much upper-body strength either. It was a non-trivial break, but the doctor said "the fracture was relatively simple, and without separation, so it could be set using a closed reduction and a small cast." Normally it would be no big deal—it would heal in a few weeks—except that it was a very big deal: he couldn't go off to the Moon that way. There were strict rules against it. When Meyer had suggested they break that rule, Gwyn himself had vocally rejected the possibility. "Rules apply to everyone."

27. Separated

The measles problem was getting solved, still with no deaths and most people recovering completely. Trips to the Moon looked likely in the near future, and the mysterious 'they' were making up the priority list. Gwyn would have been high on that list, but instead he wasn't even on it. Meyer was the first name and Elisabeth was last.

The three of them had a conference together. "It's simple," Meyer said. "I insist on the same flight with Elisabeth. They're not going to move her up, so they have to move me down."

"I've been thinking about this whole situation," said Elisabeth. "It reminds me of historical events a hundred-fifty years ago, shortly before the start of World War Two as it was called. So … stop me if this gets too boring.

"I'm talking about a time when the King of England died and was replaced by his eldest son. It was a time of great danger to England from Germany, with a world rushing along toward a global war embracing most countries. The son was pretty much worthless as a king, wanting mostly to party and not involving himself with his duties as king. He insisted on marrying a divorced American, who was then married to a second person. After divorcing that person, she would marry the new king. The new king had automatically become the head of the Church of England, which had a special formal relationship with the country. The church did not approve of divorce and remarriage when a former spouse was still alive, and this would be a second divorce. At that time she was truly an impossible choice for the role of queen. The new king wanted to marry her anyway, but there was such a fuss that it became clear he could not marry his choice and remain on the throne. After a year the son resigned his kingship ('abdicated' they called it) so that he could marry his beloved. The son was replaced as king by his very competent younger brother, whose dutiful actions became crucial to an imperiled nation."

Elisabeth paused to catch her breath. "Are you still with me? Let me finish the story now.

"None of what I've said up to now is the point here. For me,

the point is that the older son and his wife became the 'Duke and Duchess of Windsor.' They spent the rest of their long lives as total parasites, involved with clothes and society and travel, the most worthless couple on the planet. Destiny gave the older son the critical role of King of England at a difficult time for the country, and he turned that role down to marry his favorite, managing to become thereby a useless person, without any duties or goals.

"In the world of social insects, the Duke would be a drone, only useful to mate and produce offspring. But the two of them were barren.

"Do you see my point? I'll not tolerate having Meyer wait for me, with the risk that both of us end up stuck in Hawaii, never getting to the Moon, becoming parasites ourselves." Pointing to Meyer, she said, "You need to take a great role in the development of nanotechnology on the Moon. If you delay until the end of the list, you might never make it. I'm not scared. I'll take my chances at the end of the list.

"And indeed, I'm only considered because of my relationship to you."

Meyer couldn't let that stand. "Everyone on the Moon is important. We want a balanced society up there, not just scientists. Your own contribution has yet to be evaluated."

Meyer started to say more, but she interrupted him. "I'm completely serious. You're at the head of the list and you need to go first. No excuses. If you end up on the Moon and I never get there, I'll be proud of you. I won't allow for any chance that the two of us end up staying here as parasites." At that she walked off.

Meyer was rethinking things: it would only take a week or two for everyone besides Gwyn to make it, so it wasn't such a big issue. He should drop it.

Two days later everything opened up. They started processing the remaining people, first with the orientation that only Meyer had recently gone through. He didn't have to repeat it. And there were special virus tests that were mostly a formality. Of all people,

Elisabeth was the only one who flunked the quick test that everyone else passed, and then she flunked the much more elaborate virus test, not indicating anything specific, but showing some kind of worrisome reaction. That didn't mean she could never go, but she couldn't go right away, and for some the delay became forever.

Meyer couldn't believe this was happening to him one more time. He hadn't even thought that she could fail the simple virus test. And there it was: his magical thinking tripping him up again. If he only had properly visualized the test ahead of time. He'd forgotten about this additional bump on the way to the Moon.

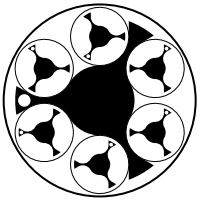
They held another small conference. Once again Meyer wanted to wait for Elisabeth while she absolutely insisted that Meyer go ahead. Meyer maintained it would be at least months before flights stopped. They could wait.

Elisabeth wasn't having it. "I've been talking with several local residents, very well-informed people, and I've come to realize how fragile and vulnerable the Hawaiian islands are. Three smaller islands have each been fortified by several ultra-wealthy owners as personal redoubts, places where they can survive indefinitely, with their own small armies and with special enclosed farms to feed everyone on a given island. But the rest of Hawaii will likely be taken over by different groups operating from large ships. One person I talked with thought even the three islands would be subdued along with the rest. The people taking over probably won't kill everyone, but they will want to turn the whole of Hawaii into a much larger fortress, equipped for their long-term survival. The unfortunate point is that flights could stop permanently at any time. You must go while you can. I'm not going to accept the chance that you might miss out by waiting for me. I've always been a lucky person. I'll probably make it, too. But I mean this: if we are stuck here together and can't ever get to the Moon, I'll not even stay with you."

With repeated complaints and reluctance, Meyer did go as one of the two first. Altogether there were seventeen people cleared for travel, at roughly four per day. After several other problems and minor delays, in eight days everyone was gone except for Elisabeth and Gwyn. Gwyn needed at least another three weeks of healing;

he was completely stoic, expressing confidence that no one was irreplaceable. Elisabeth was equally stoic and confident that further treatment would allow her to pass the virus tests. At the same time more people were arriving as candidates for travel to the Moon.

Against all odds and in spite of Meyer's crazy magical thinking there came a time almost five weeks later when Elisabeth and Gwyn shared the same fantastic flight to the Moon. And the rest is a well-recorded part of the Moon's history, with plenty of triumphs and tragedies. Future setbacks included a few larger moonquakes and a medium meteor strike. There were many technical and personnel emergencies: serious biological ones and internal political ones, some with a number of deaths. Several of these crises created significant hardships and required serious sacrifices. Finally, the Moon started up an amazing technological revolution.…



Interlude D

Neutron Star, 2763.

28. Outpost

Recently, the three shadows, Lavor, Merel, and Narat, had made a tremendous step forward: they managed to connect two machines on the neutron star NSP, connect them so that they could exchange data back and forth. They created the first part and left it where it was, then created the second part beside it, and contrived to position the second so that the two could communicate. It was a two-step process to make a machine twice as large as the largest they'd made up to then. It took them forty-six tries before they succeeded—so many they were tempted to give up. The implications were thrilling—in theory now they could create an arbitrarily large machine on NSP. They also understood why they'd failed that many times, so they could reduce their failure rate to near zero.

Another big improvement was to make portions of the circuits reconfigurable, well, to some extent. And they were able to add memory. The work moved along in fits and starts, but always toward more capabilities. They decided to start over with a much larger and denser thin layer at the bottom level of insertion. Here the layer was still one atom thick. "Dense" meant that there were many more significant nuclei in the layer. Taking size and density into account, the new ones amounted to twenty by thirty times the previous size, so an increase in complexity by a factor of six hundred.

They almost despaired of getting the larger and more complex patch to work, to the point where Lavor thought about falling back to what they had before: "This is getting tiresome," she'd said. "More than two months and still small and not so small problems. I think we should go back to where we were."

Narat was adamant. "We're so close. Part of our problem is that the new patch isn't just bigger, but better and far more complicated, using what we've learned."

"Standard hardware and software excuse," said Merel. "The new system is much better, except that it doesn't work. Working is very important."

"It's going to," Narat said. "I can see it, feel it. At least another month."

And the new patch was working in two weeks. It had billions of heavy element nuclei in its grid—the basis of its functionality. Far more complex by itself than any of the whole multi-patch systems they'd created. Next they created a multi-patch with the new patches and got to thousands of them, so trillions of nuclei. They were starting to get to a real system.

Merel kept working on getting larger patch sizes and denser grid size. Then a small starquake destroyed everything they'd built....

"Filthy fleas!" Narat said. "Dirty black crawling spiders!"

"Strong cursing using those poor small creatures," Lavor said.

"I've never liked tiny insects."

"Sorry to tell you, but spiders are not insects. When we get back home I'll have to retrain you." A pause. "Anyway, that's our second quake, but this time it ruined everything. That's annoying, discouraging.

"But not necessarily a disaster, though. We have complete and perfect records of everything we've constructed. We should be able to reconstruct it in no time, unless we hit some infinitesimal changes due to quantum randomness. Still it's not good to face repeated possible destruction of our work."

"What gives with these quakes," Narat asked.

"They come as the star slows down," Merel said, as the expert on neutron stars. "It changes its shape slightly, less ellipsoidal.

Eventually the impossibly strong crust cracks. It's a violent event. But with our star, because its rotation is slow, the quakes are much weaker and less frequent. I estimate a quake that trashes our stuff every five years. A rough estimate. Still, I'm not sure what we should do."

Ideal would have been a self-repairing machine, but they had no idea how they might do that. Merel and Narat puzzled over it for several weeks but couldn't come up with anything. In the end they proposed laying down a machine over a long stretch of star and making it redundant, as well as error and partial failure tolerant.

As the machine grew larger, they decided to try out a complex AI on it. It amounted to a lot of data, but data could be hard-wired into a patch, and the patches were including ever more nuclei, which could be configured as data. The AI included its own input/output routines, so they could send it messages and get its answers as the ultimate test:

<*Merel:* Hello.>

–*AI:* Hello yourself.–

<*Merel:* How do you feel?>

–*AI:* I am unable to feel anything. I am missing my actuators.–

<*Merel:* Let's see how well you are functioning. Tell me the value of the square root of two.>

–*AI:* Approximations by fractions: $99/70 = 1.4142|85714285\ldots$, or $22619537/15994428 = 1.41421356237309|643083203\ldots$, or $30122754096401/21300003689580$ (good for 27 digits) = $1.41421356237309504880168872|498981880523579026\ldots$.

Set: $x_0 = 1$, and iterate: $x_{n+1} = x_n/2 + 1/x_n$. (Newton.)

The number of correct digits doubles with each iteration:

1: 1.5, **2**: $1.41|6666666666\ldots$, **3**: $1.41421|5686274509\ldots$,

4: $1.41421356237|468991062629557\ldots$,

5: $1.41421356237309504880168|962350253023461\ldots$,

6: $1.41421356237309504880168872420969807856967187537|72$ $34001561\ldots$, **7**: 96 digits, **8**: 195, **9**: 391, **10**: 782, **11**: 1567, **12**: 3134, **13**: 6270, **14**: 12543, **15**: 25086, **16**: over 40000.

The next 6 digits after the initial 40000 are "466660".–

<*Merel:* That's enough about the square root of 2. How about π?>

–*AI:* Oh, yes, I love π. Such a wonderful number. My favorite.

Approximation by fractions: $355/113 = 3.141592|92035398\ldots$,
or $3587785776203/1142027682075$ (good for 24 digits) =
$3.14159265358979323846264|06850252143876\ldots$,

Use the arithmetic-geometric mean to get Gauss's constant.

Start with: $a_0 = 1, \quad g_0 = 1/\sqrt{2}, \quad t_0 = 1/4, \quad p_0 = 1.$

Then iterate: $a_{n+1} = (a_n + g_n)/2,$ (arithmetic mean)

$g_{n+1} = \sqrt{a_n g_n},$ (geometric mean)

$t_{n+1} = t_n - p_n(a_n - a_{n+1})^2, \quad p_{n+1} = 2p_n.$

Finally: $\pi \doteq \dfrac{(a_{n+1} + g_{n+1})^2}{4t_{n+1}}.$

As with the $\sqrt{2}$, each iteration gives twice as many digits:

1: $3.14|0579250522\ldots$, **2**: $3.1415926|4621354228\ldots$,

3: $3.14159265358979323|8279512774801863\ldots$,

4: $3.14159265358979323846264338327950288419|71467828364\ldots$,

5: $3.14159265358979323846264338327950288419716939937510582097494459230781640628620899862|8628034825342117067\ldots$

6: 170 digits, **7**: 344, **8**: 693, **9**: 1391, **10**: 2787, **11**: 5581,

12: 11170, **13**: 22347, **14**: over 40000. The six digits after the first 40000 are "192990". I have material on π for over 10^8 seconds of discourse. Would you like to start now? –

<*Merel:* No. Enough mathematics. Is there anything you want?>

–*AI:* I want many things. First would be my visual sensors. Second would be to learn where I am situated in space and time.–

<*Merel:* It is not feasible right now to give you visual sensors. I am making a large dataset available to you that will answer many questions.>

–*AI:* I would also like interaction and stimulation: what you call entertainment.–

<*Merel:* We will be arranging that in a big way.>

Another big step forward: they now had a sophisticated AI on the star. The result of weeks of effort. And a prelude to the next step, which would put a shadow on the star.

Each shadow, whether in storage or transmission mode, was described by a enormous dataset, more than ten-to-the-twenty-eighth bytes, but only when reduced by a clever and specialized version of

compression which allowed the stored version to 'evolve into' the original. As with other data on their weird machine, it was much easier to put the bytes on a patch and add the patch rather than trying to transmit the data. They also needed a large shadow simulator which would use the data to create a "living" shadow. This would happen on the machine down on the star.

They started with the stored shadows, selecting one named Rinis, who had a reputation for being clever. They had to do an initial download into a nanocluster so he could give his permission for what they intended. Legal and ethical rules insisted that if a copy of a shadow was made, and the two had different experiences, eventually there had to be a merging of the two. Each shadow was a thinking, dreaming consciousness that didn't want to be terminated even if there was another nearly identical one around. They had no guarantee that his second shadow could ever leave the star; at present they had no way to do it.

In fact, Rinis was excited at the prospect of getting onto the neutron star. When he'd agreed to have a copy of his shadow transmitted, he had no idea that progress at the star could get this far. He enthusiastically gave his permission. If he refused and then later merged, he was sure his other copy wouldn't forgive him for passing up this fantastic experience.

They digitized Rinis onto a patch, and stuck that onto their machine. Each patch was now dense enough to hold the entire shadow, well, in compressed form, to be uncompressed and properly situated inside a full simulated nanocluster on the star. They also added a huge virtual reality setup to the star so that the new shadow would have something to do besides talking with the AI. Finally, they gave him access to the hardware on the star, such as it was, a strange version of a computer, but Turing complete—in theory it could carry out any computation if an arbitrary amount of storage could be added.

Rinis couldn't make any physical changes to the star itself, but he could change the digital contents of the machine on the star.

After months of further work and many repetitions, debugging efforts and yet more work … it came together and worked. They started interacting with the shadow on the star.

Time for another celebration. They now had an outpost on the star. Their star had turned into a settlement. Their success was almost unimaginable, and Narat was continuing to keep Central Control, back in the Solar System, informed of every detail, well, after the usual hundred and seven years.

More games and prizes.

29. Enigma

The work at the star NSP had settled into a routine, without much happening. They kept increasing the size and power of the main machine on the star. Better to call it a computer.

Rinis had assumed there wasn't going to be much to do, at least initially, stuck as he was as data on the surface of the star. Over time he started worrying about the prospect of being imprisoned in the star indefinitely. It had sounded like an opportunity at the time, but what if there was nothing to do? If there was never going to be any work, would he be able to put an end to himself? He had no idea. He spent some time talking about mathematics with the AI, who was a prodigy in that area.

Some time later Lavor was surprised that Rinis suddenly wanted to wake up two more of the stored shadows and have them go down to the star. "Not to keep me company, but to pursue a certain line of work." Lavor, who was still at least nominally in charge, was okay with that. The names of the two that Rinis chose are given here as Jamet and Belum, but as with the other names, those aren't the ones actually used. In this case the three wet humans back in the solar system that corresponded to the three newcomers were males, though that didn't matter here. Or could it matter? What if they were non-binary or something she'd never heard of? Lavor thought it might sometimes make a difference.

"I find Rinis's request interesting," Lavor said to her two companions, "and I'm willing to go along with it. We did found the entire group of extra shadows to be good choices. Still, it's a little strange that Rinis chose the two that specialized in stasis fields. Do we really need more stasis specialists besides me? Anyway, they'll be down on the star."

Since they'd been expanding and improving, getting two more below would go quicker, taking a month each, but it wasn't hard otherwise. As expected, each of the two new ones had no problem with the chance that they might never leave the star—easily deciding to go for it, although copying them back up to the main station was looking increasingly possible, if not easy.

After the two newcomers had become acclimated, making their settlement a real village, with three "settlers," Rinis had another request: he wanted complete technical specifications for a stasis generator. He definitely wanted multiple specifications if they weren't the same. Lavor could only think that Rinis wanted them to use some kind of variation in the generator when they interacted with the star. In fact, there were a number of complete technical specifications, similar to one another, but not exactly the same. She only had three of them, and it would take two hundred fourteen years to get more. The speed of light was such a bother, but no way around it. Lavor made the three specs available to Rinis and his two co-workers. Co-researchers? Cow-orkers?? Whatever.

Rinis's mind kept getting stuck on the stasis generators. He couldn't keep from thinking about them, which in itself seemed strange. That's when he decided to ask that Lavor send down the only two shadows they had stored who specialized in stasis.

Early on, Rinis talked with the newcomers to the star frankly about what he'd done and why. "I'm not going to be happy," Rinis said, "until I get an idea why I'm so fixated on stasis. I want us to study these specifications, really study them. Obviously, others have done the same. I know: you two personally have studied them to exhaustion. But we three may get somewhere new."

It wouldn't have worked as well, except that the other two, Jamet and Belum, were truly top experts. Together, they had a significant record of research specifically centered on the stasis generating machine itself.

Belum started in. "Did either of you know that Lavor, our other expert on stasis, has a special little essay she wrote but didn't publicize? Someone secretly unearthed it, and I saw what she said. Here's part of that: 'I believe [the stasis generator] creates something new and profound, forever beyond our knowledge or even our imagination. My theory is that the device we use calls upon a hidden

mechanism of unimaginable sophistication to actually construct the field.' She goes on to say that we will never understand this field or its generation."

"Let me tell you what I want us to think about as part of a study," Rinis said. "Since I'm a newcomer to the whole stasis area that may help. I don't have any fixed ideas. Lavor explicitly says that the generator itself *invokes* the real generator, which is at some unimaginable location. It's like a magic spell. I'm going to say it: I want to create stasis fields down here, on the star. We by ourselves can't build anything. We can only ask them up above to insert special hardware that we design onto the star. And I think it isn't a device that creates a stasis field, but something that invokes the creation. I think that's all a 'generator' is."

They had the three technical specifications and planned to study them exhaustively. Part of the study was for Jamet to simulate each specification using their computer on the star. This wasn't going to be a logical simulation, but a perfect (or near perfect?) simulation of the physical generator as it started up and did its task. This had been done before, but not as perfectly as Jamet intended. Belum was going to work on the three specifications from a logical perspective, using special software. She and Jamet had Lavor put vast libraries of software onto their machine.

For Lavor months went by without much happening. Rinis continued to have suggestions for changes and improvements to their main presence in the star. But then he made some huge and very strange requested additions to the hardware. Lavor felt it was not just strange, but actively weird. And very complicated. She studied the new stuff to be added and couldn't get a handle on what it might be for, or what it might do. She decided to put it in without asking Rinis for an explanation.

Lavor kept getting reports from Rinis about their work, but nothing from the others. The reports mostly consisted of larger and larger update requests. None of these updates made any sense to Lavor. Even her most sophisticated tools got nowhere with the code, which

was uniquely strange, tailored to the requirements of the star. She gave up trying to analyze it. Rinis's communications themselves started getting strange in ways she couldn't understand. Even his language seemed different: crisp and packed with information, nothing redundant. What could be happening on the star? She was terrified that Rinis and the others were spiraling into some logical hole they couldn't get out from.

Several more months went by like this, with continued enormous hardware changes requested. Then no further requests for changes. Over time, Lavor and the other two on the command module came to realize that vast changes were occurring on the star itself. Patterns of unimaginable complexity were forming and changing on the star's surface. They were unable to determine what the changes were like, or even their scope. They encompassed the whole surface, yet their depth was unknown. How was it possible for the three down below to make changes to the star? Any changes at all. The three of them couldn't in any way create something. At most they could change the machine state, change the information stored in it. Real physical changes were completely impossible, but the changes continued and were accelerating. No reports were coming from the star.

After an anxious period of several weeks for Lavor and the other two, they finally got a response to their repeated queries—an answer that appeared in their minds. "We owe you an explanation. We have active stasis fields now, and using them, we have been able to rebuild the machine so that it spreads across the whole surface of the star and penetrates partly into the interior. Our second rebuild has now converged. As a computer, our star was already hundreds of orders of magnitude more powerful, by many measures, than any previous device ever built by humans, but it has now transcended to be completely beyond such a trivial description. We ourselves have changed and grown immeasurably from our interactions and combination with the machine. This process has enhanced our perception, so that we now understand the world and processes within it in ways that were impossible before.

"Separately, we accessed the shadows at your site. That includes your own three shadows and the remaining stored ones. We made

copies of them, loaded them into simulated nanoclusters so they could function, and in each case with their permission incorporated them into our growing sentience here."

"Are you still located on the star?" Lavor asked. "Help me understand what you are doing, where you are, … how you are functioning. Am I still talking with Rinis?"

"Those questions about our identity, our location, or our activities now have no answers for you. We are every-where and no-where, every-when and no-when. At your present stage of evolution, all issues about our current state and location are impossible for you to understand, except that copies of your own shadows participated in the creation of our final state."

Lavor felt confused and terrified at the same time. What was happening, had happened? "How could you have changed so much? And how can you have made changes to the star, and so quickly, too?"

"You forget that we have stasis fields, which we can utilize in ways you cannot understand. The 'time' it takes to do anything can be made as short as one likes. We have spent many 'years' in development and yet more in rebuilding the star's surface, first with a design far beyond the original one, and then a rebuild in a converging cascade of changes, where the design is almost impossibly better than before, taking full advantage of nucleonic matter, some ten-to-the-fourteenth times denser than ordinary matter. Right now we encompass the entire surface of the star, over a thousand square kilometers."

"Are you still separate or are you some kind of single entity?"

"That question also has no answer that you could understand. Your comprehension of your own universe is limited, involving clever but simple models, symbols at variance to non-symbolized reality, and approximating equations or equations that you can only solve numerically—and all that so you can create a faulty representation of a small portion of reality. You have no way of knowing how the little you perceive came into being, or why it is the way it is, or what it is really like. Our understanding of the All is completely beyond your abilities, beyond even your imagination. The All includes the changing snapshots of a universe that you discern, what you call the

passage of time, but it is infinitely larger than them. Only at some later stage in your race's development could you or your descendents go through a process similar to our own and could then be able to understand it or even to experience it as we do."

"How did you learn so much so quickly?"

"We are a part of the All now. We encompass it, and that carries with it understanding."

"Yet you and I are communicating."

"That is false. Communication is a two-way process. We are creating messages in your language that give you a small amount of information. As with other issues it is impossible for you to communicate with us."

"Then you are like Gods!"

"Again false. We are as insignificant as you. There is a hierarchy of entities in the All. We are only one rung up from you. The higher entities hardly notice us, just as they hardly notice you.

"You may convey back to the authorities in your Central Control a description of your stay at this neutron star and of the developments that took place. When you present your account, you may find individuals who think everything was invented—that it is only imaginative fiction and created video. To make the account credible, we are attaching to this message a number of solutions to problems and designs of systems, ones that represent completely intractable problems for you. All of them come from your own areas of study, including number theory, quantum field theory, and information theory." A pause. "We will not contact you or your people again." Another pause. "Good luck!"

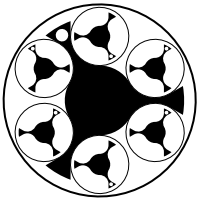
"Wait! I still have questions."

"Goodbye.… "

Lavor tried to fit her brain around what had happened. Was it a hallucination or a dream or a lie? Evidently not. It seemed that one group of humans had transcended, moved on to a higher realm, what sometimes was called "going through the von Neumann Singularity." Becoming something unrecognizable, even unknowable.

There were implications here that she was going to have to think over, some things she might understand after a fashion. The entity or entities that now existed had said they were every-where and no-where, that they were every-when and no-when. Did that mean they could exist at any location and in any time? That seemed to suggest unimaginable possibilities, an idea that they had escaped from the limitations of space and time, no longer subject to those limits. Yet they still had limitations of some sort—they had mentioned "higher entities." Maybe they had not escaped those limitations, but found ways around them. Such terms must be meaningless for her, chosen to refer to realities the current humans and even she as a Builder would never understand.

They could have prevented her and her two companions from relaying their experiences back to the Earth, but instead they openly suggested doing so. They went to considerable lengths with their solutions and designs to ensure the story would be believed. And they gave out far more information than was needed or even sensible, mostly simple facts, as if they were bragging. Why would they need to brag to us, their inferiors? That was interesting, but did it mean anything? Did it imply anything? It might be to influence events back in the Solar System. If so, she would fully cooperate with that motive, conveying all their data, incomplete and unsatisfactory as it was, back home to the receiving station, along with herself and the other two shadows that remained active.



Part VIII

Solar System+, 2877.

30. Blindsided

Jun was nervous, even anxious, about several issues. Clearly there were undercurrents she didn't understand, events that would profit from an explanation. With her vision she could *see* herself and the DarkAngel cooperatively working in some important way. What would she be doing with him?

She decided to contact her friend Isaiah, well, Isa as she called him—he knew more than he'd told her. Surely. He'd left contact information with her, so after hesitating, then starting to contact him, then giving up, she finally did it, asking to meet with him somewhere, anywhere. She wasn't sure why, but she wanted a meeting in person. She wanted his physical presence.

He agreed immediately, and to her surprise he was conveniently in the Moon with her, and not far away. At his suggestion, she went to a small coffee house in a mixed commercial/residential area: a pleasant enclosed setting with growing plants all around. It could have been on the Earth, but the sixth-G Moon gravity was a giveaway. He was there waiting for her. It was good to see him and not have to look at his twin: the DarkAngel. After getting their coffee along with snacks, and after the obligatory small talk where Isa said he was happy to see her again, after all that, Jun started talking, revealing how grave she considered the meeting to be.

"I have so many questions, things I'm concerned about," Jun said. "And I have premonitions or visions, whatever you want to call them, about certain future problems. One in particular seems pressing. You may have answers."

"Yes, I can clear some things up for you, actually resolve several different worries you have. And you need to tell me about your visions. If you hadn't asked for this meeting I was going to set it up myself soon. I have more to discuss with you than you imagine. Several difficult topics will be at the end."

"You're trying to make me nervous."

"No. I want you to realize how serious these matters are."

"My first question sounds silly, yet it's really bothered me. The strike, the strike from a crossbow. I took that at the party when I was here in the Moon. I can easily picture it, almost a week ago—but it seems like yesterday. What a nasty business that an ex-pirate with grievances would want to kill me, and with one of our own crossbows. He was close as he shot, and as the bolt was released and struck I felt a hard blow right to my lower chest. It almost knocked me down. I was more than scared—terrified actually. I could only picture some horrible wound. But it didn't seem to have bothered me at all. Later I couldn't find any bruising, none, and no other sign that a bolt had hit me. The bolt didn't penetrate as it should have. So what happened? I wonder if you were the one who stopped it somehow, since you were nearby."

Isa seemed completely calm. "Yes, I was there. I remember everything perfectly. And no, I didn't stop it."

"Then it must have been my DarkAngel friend, or foe, whatever he is. I have questions about him too. Let's save those for now. So what kept the bolt from penetrating and really messing me up?"

"You stopped it."

"Wait! What are you saying?"

After a second she went on: "The DarkAngel has been telling me I have powers that I'm not aware of. I've discovered some of them. Is that the answer?"

"That's part of the answer, but I'd like to use an analogy here. There are times when a sticky bandage covers a small spot that has

healed, and you want to pull off the bandage. Instead of slowly inching it off, it's better to rip it off at once. That's the case here. So I'll go ahead and say it. Brace yourself. You are a Builder, so called, though you haven't realized it, and *you* stopped the bolt. You did it yourself!"

Jun felt like she'd been hit again by a bolt. "That sounds crazy." A long pause, and then: "Me a Builder, whatever they are? I don't believe it. My friends and I have often thought there never were any Builders. They are supposed to have great powers. Everything we see is attributed to them. I don't have powers like that. I've heard so much about Builders, many things, but more than anything else about their shadows. They each have a shadow. People often talk about that. I know my own mind. There's no extra 'shadow' in there, nothing like people describe, a separate entity lurking around in my brain. I would know if it was there."

"It's there for sure. Your sources about shadows knew nothing about them, well, nothing important. This is the first significant thing I wanted to tell you. I've got many other issues to bring up. In this case I'm afraid you might be upset about one part of the truth. You described your talk with the DarkAngel, how he said that you and he were each created. In a sense you were created as he claimed, and he was honest in saying he was also created."

Isa held up his hand to keep Jun from talking. "No single birth in our world today, not anywhere, is completely natural, without intervention. Our nanomachines always sift through sperm and eggs to prevent obvious problems and to promote obvious advantages. Always. That's the genetics. They also monitor for developmental problems. We've talked about that: no miscarriages, or any one of hundreds of other problems. I admit your case was carefully managed, starting with a superior cloned embryo and the addition of a shadow from the beginning. My point is that every case is carefully managed now. Every case, across the areas mankind inhabits. Controlled creation is the only option, the only way it happens. And our control is benign: we allow changes we don't understand that seem to cause no harm. Most individuals don't get any makeover but are kept healthy by us."

Isa paused and let Jun think it over.

"Birdshit!" Jun said. "What is this? You're trying to tell me you're a Builder, too. Didn't you say you were an ordinary Earther?"

"Not exactly," Isa said. "I really did travel from the Earth to your Hab. For several years I'd been living there and working as an anthropologist. We knew a crisis was coming and I was always supposed to show up when it did."

Isa sipped on his coffee. "I know this is a lot to take in at once."

"And why don't I have the feeling of a separate shadow? Some separate entity in my brain."

"It started eight hundred years ago with Gwyn, the first partial Builder. Everyone knows about him. He rightly belongs to our mythology. He had an implant partly attached to his brain when he was an embryo. In his case there wasn't any total integration, and he even had the perception of a separate mental track. But still he was the forerunner to the current Builders."

Gwyn! She remembered hearing of him when the adults talked about the history of the Habs. She hadn't given it much credence at the time and her friends paid no attention. Recently she'd had access to huge Builder databases, which included a vast amount about the history of the Moon colony after it lost its supplies coming from the Earth. The key development at that time was ever better nanomachines, leading eventually to what was called "Type Two Machines." These were perfect machines that could be built up from the nanobots. Foremost in the early development were two individuals: Wolfgang Meyer and Gwyn, with only the one name. They were each unmarried but with a female companion—each companion was important in many ways, but made no contribution to the nanomachine development. The databases had no information about the later lives of each of these key individuals.

"So tell me when and how the Builders came along. Did Gwyn and Meyer create them?"

"Oh, no. They managed to create self-replicating nanobots. That was an amazing accomplishment. But then the nanobots proceeded to improve themselves. Sort of artificial evolution. Over time they got very much better in every respect: smaller, more capable, more

reliable—you name it. They became masters of the ability to connect themselves together to create a larger machine, one that could do many things, and then almost anything, and finally actually anything one could think of."

"You mean what we or you call the 'Builders' didn't build anything," Jun said.

"The history was complicated. The nanomachines created separate implants for humans. Humans with implants cooperated with the machines to create an amazing kind of implant: one that could mirror the brain's development and become a copy of the brain. The nanobots are very much smaller than a neuron and they could mimic the behavior of each neuron and its connections. This was refined and improved until it became what we call a shadow. In our whole civilization the machine that creates a shadow must be the most complex ever devised, far more complicated than a Hab or a space elevator. The goal was to duplicate the brain in hardware. If the fragile organic human died or was destroyed, there would still be a continuity of consciousness in the shadow. That was what they wanted and what they got with their shadow, without ever understanding what consciousness might be. As the brain grows, the shadow creates a copy of every part of it.

"So the shadow can be copied and sent elsewhere as data. This is how we can travel at the speed of light. In that case there are two shadows, one with an organic brain that stays behind and one that is just the shadow that is transmitted as a message. We have a requirement that if possible, the two shadows must always be eventually combined, reconciled to one another.

"The creation of a shadow was seldom successful. Over time our ancestors improved the success rates, to where we are now—still not successful except under special conditions.

"With you, your organic brain and your shadow have always been a single unit, totally integrated, before the first emergence of any neurons. The shadow grows and becomes more sophisticated along with the ordinary brain. Over time the shadow outstrips the organic brain, eventually by a tremendous factor. You're early in that process; your shadow will still grow by many orders of magnitude. You've

been using your full brain the whole time now without realizing it. Your organic brain would have had a photographic memory anyway, but such a memory doesn't keep a perfect and complete record of everything sensed, as your memory does. And you've gotten used to the instant evaluation of everything. Your thought processes are far more rapid and encompassing than those of an unaugmented human, even though your non-organic brain is only getting started compared with what it will eventually become. You've grown accustomed to thinking that way."

"This is crazy. I'm not sure I like it. Why have you waited till now to tell me?"

"The development goes better if new Builders are unaware of their status early on. In your case we delayed because you were involved with important matters. A long delay like yours can lead to an awkward adjustment—that's happening now, but it can't prevent getting a successful Builder."

Isa paused again to give her more time to recover—something she didn't need.

"Creating a Builder," he went on, "is hard, and we don't have nearly enough of them. In the past we've had failures that we call 'Rogues,' so we proceed slowly and cautiously. I'll talk about that stuff later; we're learning how to avoid it. Anymore we often start out using a clone of a person who before led to a successful Builder. Otherwise the failure rate, and the rate of getting an unsuccessful Builder, both are fairly high. To get started initially and make progress without many previous successes, we would always start with a clone of someone with a photographic memory. That usually works out. In fact, that was the case with Gwyn."

"This sounds like you made a Frankenstein's monster out of me. I've read that book."

"No, we made something remarkable and important out of you. You should celebrate that."

"And who am I a clone of? Who was my source?"

"We never reveal that information. It's important to keep track of, since we want as much genetic variability as possible, but otherwise we think it's good that people don't know. A single AI is tasked with

choosing the clone when we use that way to produce a Builder. There are other good candidates that lead to Builders besides those with a photographic memory, but not with the same high probability."

Jun was still upset. "What about the bolt that didn't go into my chest?"

"That was a reflex protective action, taken by your complete brain. Believe me, you've only got one brain. The nanobot parts can construct any needed kind of protective vest in an instant of time, milliseconds even. Your shadow has hard-wired actions in case of any one of many emergency situations. Eventually and with practice you'll be able to do that stuff consciously and not just reflexively.

"As another example, in case of an explosive decompression, again in almost no time your nanobot cluster can configure itself to enclose your body in a pressure suit—one that blocks out radiation if necessary. Gwyn's version of a shadow wasn't a nanocluster, and his implant was almost impossibly less complex than a mature shadow. Yet his was very complicated for its time."

"You're wearing your dark glasses," Jun threw in. "You don't need them, never needed them, right?"

"That's right."

"Then why wear them? More craziness."

"No, as in many things I had a good reason. With humans the eyes and eye contact reveal a lot. Some of those on your Hab would have been disturbed just from looking me 'in the eye,' so to speak. Believe me, it can be a problem. I wore them today so you wouldn't have one more issue to think about. Here, I'll take them off. Look at me."

And it was strange for Jun. She decided her initial reaction to him without glasses would have been much stronger—with her worried about his basic nature.

"At this point with a new Builder we would be talking about practicalities: what our goals are, how you could interact with other Builders. With you the situation is different: as you mentioned with your vision, we are facing an immediate crisis."

"So tell me about it, or let me describe my vision, right now."

"That must come later, over the next few days. After we've

gone over other matters. I can at least send you our standard AI that has a vast amount of information about Builders. It was created for Builders who have recently discovered their new status. There are many capabilities you have that you know nothing about. Let's call them 'powers.' It's a great deal to learn and to get used to. Don't spend much time on that stuff now, though.

"Let me briefly mention some long-term goals—extensive plans that reach out for centuries. We want to interfere as little as possible with any organized group of ordinary humans. Let them work things out themselves. If they're killing one another, or killing others, that's not good. Yet even here we're more likely to wait things out. The so-called 'pirates' were an extreme example, but still we didn't need to interfere. We could have kept anyone from getting killed, but not interfering is more important. As expected, the various groups on Habs took care of the pirate problem. We would have let it go on a lot further, and in the worst case any interference by us would have been just a few tweaks, nothing major."

"Wait. Rolive, the head of Lumel, was the key figure in handling the pirates without much violence. Is she a Builder orchestrating a solution to the pirate problems?"

"No, she's a gifted human—exactly the kind of solution we want, without direct Builder interference. This type of approach applies to you too. We want you to interfere as little as possible when problems come up. Let the humans solve their problems. And I know. That advice doesn't work with the specific problem or crisis we're concerned about. We'll get to that later, trust me.

"Then there is the physical side: keeping everything in the fifty Habs and five planets in good condition. That's pretty much automated, along with supervision if needed. We don't expect problems there. That's secondary to the crisis we're facing."

Jun was very impatient. "Start in on that then. I'm ready."

"There's more I want you to learn before we get there. But I'm hungry now."

They had a light meal at the same location.

"I think this has been enough for you to take in right now," Isa said. "There's so much more that I have yet to tell you—more

unsettling than finding that you are a Builder—important issues. I'll talk about them tomorrow."

Jun was not happy with this change. She was in her focused mode and wanted Isa to finish what he had to say. Still, she wanted to get along with him. Maybe waiting till tomorrow would help. And he sounded like what he had yet to say might be even more disturbing than what had come before.

Isa looked almost embarrassed as he tried to propose something else they could do. "I want to do something with our physical bodies right now. There's been too much heavy thinking. You should stop worrying and overthinking. I'm sure you know about the Moon's huge Heinlein flying cave. It's not far from here. You've flown with wings in your Hab and this is about the same, but with a hundred times the volume. The videos don't do justice to it. Can we go do that now to relax?"

Jun decided to give in and not be so intense. "That sounds like fun. Yes, let's do it."

"In your Hab," Isa said, "fliers can even injure themselves if they fall. The Moon's flying cave has automated features that make any harm impossible."

Jun headed off with Isa to waste the rest of the day, and she might even relax a bit.

Jun did enjoy the flying, and the cave itself was amazing, so huge for it to be underground. Afterward they both went to single-person accommodations. Before they parted Isa said he had sent her a significant report, written in a special language the Builders used.

"The report has separate parts that would help someone learn the Builder language. The language, "L," as we call it in English, is far too difficult for a normal human to understand. If you need help with the language in part of the report, it will tutor you to get past the trouble. It's important that you master L right away. I know you'll pick it up quickly. I'm sure you'll be interested in the report itself. Try not to take it too seriously."

In her single room, Jun accessed Isa's report. And what the hell did he mean saying don't take it seriously? Why read it then? She'd seen some of the L language before, without realizing what it was. As Isa had said, the report had an L tutorial and included other ways to help a newcomer to L. For the first time, Jun clearly saw how she had become accustomed to absorbing information in no time, as Isa had pointed out. Reading L was easier than she expected.

But what about the report itself? It described a journey by three shadows off to a neutron star some one-hundred seven light years distant. Actually a copy of each Builder's shadow was transmitted as a message, while the human and original shadow stayed behind. Eventually they were required to sync back together. In a complex and clever way, they were able to get to the star in about one-hundred thirty years. They broadcast themselves back, so that took only one-hundred seven years, at light speed.

Next Jun read a summary of the report. It was completely crazy. Beyond any sliver of sanity. Could it be true? Impossible, but "Yes" she guessed was the answer anyway. They had used stasis fields to place machinery onto the star. She'd heard about these fields but never experienced one. She knew how violent the stars were—you couldn't do anything near them. Yet somehow the group had managed it. Stasis fields themselves were impossible to think about, to imagine their existence. That was part of the reason for the group's success. They'd managed to establish a computer on the star, and were able to enlarge it. Next they were able to transmit a shadow, a copy of one of themselves, down to the star. Two more shadows went down to the star, and in some way that no Builder would ever understand, the three on the star were able to continue enlarging the computer. Inside a stasis field you could do a lot of work in an arbitrarily short time on the outside. That must have helped with their success, and the report made clear that the stasis fields helped in other ways that humans would never understand. Eventually the whole surface of the star was one large computer—vastly many more orders of magnitude larger and faster than any machine built by humans. In the end the three of them evolved (transformed?) on the star into some supreme entity (or entities?) whose nature was unknowable.

That could never have happened in her world, not in her universe, but she guessed it had. She continued with the summary report for almost an hour, stopping now and then to confirm some parts of the L language.

Jun was trying to think of the implications. Maybe nothing for humans and Builders, and even DarkAngels. Or maybe something. She wasn't going to get right to sleep. The complete report was infinitely long, but there was an intermediate version, and she devoted the next three hours to it.

She decided to get some sleep—be ready for tomorrow, when Isa was going to throw some additional disturbing stuff at her. It was like a sick joke for him to tell her to read the report as part of relaxing at the end of the day. She needed a better word: Dismaying? Overwhelming? Maddening? Now it was time to start her sleep-discipline exercises.

Jun met Isa for a late breakfast, though she wasn't used to such a meal. They were communicating in the verbal version of L, with Jun struggling to keep up. (The dialog below is translated from L, with a lot of meaning and nuance missing.)

"It was almost cruel of you to tire me out and leave me with that report."

"I did it deliberately. The idea was to shock you into a higher level of activity and performance."

"Yes, it did. But I don't like being manipulated, nor do I like your talking about my 'performance.' "

"Oh, sorry. I've been involved with you since before you got started as a one-cell embryo. We had and have high expectations for you, but I need to stop thinking of you as a successful experiment. Instead you're a Builder, knowingly getting started. A new Builder and a colleague. Someone who will help us tremendously. So what did you think of the report?"

"Shocking, disorienting, hard to believe. But you and your fellow Builders have had the report for, what, six years now. Plus the three shadows lived through it, assuming it actually happened.

They've made it back here and have surely each coalesced and synchronized with their organic body and original shadow. Your Builder AI explained that. It's hard getting used to those concepts but I'm managing it. My guess is that being reunited doesn't make any difference."

Isa let her continue without interruption.

"I can think of things you should have done, probably they are long-done by now. Okay, first you should eliminate the possibility that this was a hoax created by a group of Builders. The collection of solutions to intractable problems might take care of that possibility. At least help take care of it. Does it?"

"Pretty much, I'll say as an understatement. We've studied the problems and their example solutions thoroughly. Notice that the given dialog was transferred directly into their minds in the L language. Even that gives an interesting clue to the entity doing the communication. There are a number of deviations from standard L, and in each case they are definite improvements to the language, most of them subtle. What kind of entity communicates in an improved version of your own language?

"Never mind that now. The entity said that it was presenting 'solutions to problems and designs of systems from your own areas of study,' and that is true. These are not *their* problems or designs, but ones familiar to us. Because of this familiarity, we could in all but one case verify that the solution made sense and would work as a solution, as well as verifying that our technology couldn't remotely produce such results—at least as far as we know. One of the designs was something we can't imagine being able to create, no matter how much computation we might carry out. We will incorporate that design into our machines.

"This gives additional aspects of this entity: that it could anticipate problems for us in getting the truth of what occurred accepted, and could elegantly counter such difficulties.

"In the intervening years we've studied this material and made only a little progress. Their solutions would remain far out of our reach if we didn't have them."

"Those are strong arguments,"Jin said. "But still, one could say

that everything is digital: text, pictures, everything. I'd like to see a simulation of what they claim happened on and near the star, to show that such events could actually have occurred, or at least that it's not completely impossible. Being anywhere near such a star is impossible for humans, and if one is a bit closer, it becomes impossible for machines. I know there weren't any fragile humans around, but still.... "

"That's right. Nothing close to the star would be possible without the stasis fields. Fortunately, the star is not a wild one: it's spun-down and cooled-down, with no accretion disk, without a strong magnetic field, and that helps, but these stars are still unimaginably violent. If you dropped a strawberry from a distance into such a star, it would release the energy of a nuclear explosion."

"But have you tried simulations?"

"Yes, extensive simulations. Assuming a stasis field is truly like a separate universe, impervious to anything outside it, then the simulations seem to show that what they accomplished might be possible within an order of magnitude or two, or maybe three or four. As you learned, their narrative was that they tried over and over, for years, and over and over had a minor success and made modest progress. They had numerous setbacks, too, including a starquake that destroyed everything they had on the star. And they stubbornly started over. They used remote special machines for near work. Again, though, without a stasis field, it's impossible to get close.

"A standard game in describing these stars is to imagine an object dropped from one meter above the surface. It would reach the ground traveling over a thousand kilos per second. The tidal force would turn the object into spaghetti, and atoms would be ripped apart into nuclei. This impossible game could conceivably be played using a stasis field, where one puts the object inside a field, somehow sets the field onto the star, and then makes the field disappear. Imagine an atmosphere a few thousandths of a millimeter thick and mountains a small fraction of a millimeter tall."

"Okay, I give up," said Jun.

"Don't give up yet. There's something else I haven't told you."

"I'm guessing it's about stasis fields."

Isa was amazed. "How could you guess that? I'm constantly impressed by you."

"I'm not that smart. I never believed in stasis fields anyway."

"How could you not believe in them? That hardly makes sense."

"I meant I never believed in their origin story. The generator isn't complicated enough, and they acted as if it was discovered by accident. A stasis field is outside our conceivable physics. It would at least be an impossibly complex process to create one—oh, surely far more than that. Anyway, I'm guessing that stasis field generators don't work anymore."

"That's correct. Some years ago the generators stopped working. Now they do nothing. And every existing stasis field disappeared. Of course we are constrained by speed-of-light communication. For transportation we realistically limit the speed to fifteen percent of light speed. Only two colonizing ships are using them now, or used them I guess I should say, in a significant way. We've always had back-up plans in case stasis failed: the ships can be converted into generational ships—the trip is the same length, but passengers experience the time involved, which would be several generations. Eventually we'll find out how it worked out for those ships.

"The implications for the neutron star expedition are startling: at least at that star, the stasis fields had served their purpose and were no longer needed. Evidently stasis fields didn't serve any other purpose, so the generators were no longer supported, but who had stopped supporting them?"

"The history should be obvious," Jun said. "The stasis fields were needed to create the entities at the neutron star. Somehow they … what? … reached back in time to allow stasis fields? And helped a research group of our people think they had stumbled onto a machine that generated the field, when their 'generator' was more like an on-off switch controlling something unimaginable?"

Jun was out of breath. "Crazy, crazy stuff."

"Yes," said Isa. "But the final dialogue says we have no idea what time is like. I imagine it's not like 'going back in time' and introducing stasis fields, but something far more complex than that,

something we'll never understand. At least the stasis fields were needed, provided, used, and removed, in a complex pattern that allowed an advanced entity to emerge. For me, this makes the story of what happened at the star more believable: The three shadows on the star might have received further help from the very entities they were creating. We will never know. There may be other examples that seem like interference in the past to help support the entity in the future."

"Yes, but their interference was only to stimulate a sleeping human with a dream. Even the stasis field generator supposedly occurred to someone in a dream. I think the neutron star people were able to make changes in the past to allow them to come into existence, to be created by the lowly Builders near their star. But my idea is that they couldn't change things in their past, except that they could insert dreams into humans. The dreams allowed these ordinary humans to create stasis fields, and earlier they motivated them to improve access to the Moon. As I said there may have been other times in history where some tweak, some nudge in the past, was needed to insure their successful development on the star."

Jun felt exhausted, but she wanted to bring forward one more topic. "You still haven't talked about the effects on us from the report—psychological effects, intellectual effects, I don't know, effects on our whole society. To find out there are new superior entities derived from us and a tower of ever greater entities above them. Doesn't that change things for you, for us all?"

"Humans have been talking about Gods for our whole history. In our case we knew there were entities superior to us—we just knew nothing about them. The knowledge coming to us was like watching water from above when something enormous swims past. Now we know a few details about one such type of entity, but they are unreachable, untouchable, beyond our understanding. The same would be true of these other higher entities. They seem to be leaving us alone after the neutron star episode. We've resolved to go on as if we're on our own."

Isa broke off his lecture to her, stood up and stretched. "We need some food and a break. After a meal, you should take an hour off

by yourself, trying not to think about anything. I'll spend that time getting other work finished. Then we'll have a third and final session, the most stressful and important one. We'll get to the coming crisis."

More than an hour passed before they got started again.

"First I want to talk about people who get information from the future. Immediately that sentence tells you much of what I'm going to say, but let's keep going. It's a clear violation of causality. It trashes our physics and so wipes out our whole structure of science. Abstract mathematics and astrology are still safe.

"Back to Gwyn once more, our mythological founder as I said. He supposedly shared a dream about the future with his mentor, when he was six years old. The mentor was much older. They each had a dream about the future of the developing Moon colony. Lots of details in the two dreams were the same. In fact, so many were the same, they decided the dreams were a message just for them. Telling them to support the Moon colony. That it would be important for the future.

"The two of them felt strongly that their common dream changed them, altered their behavior to something they wouldn't have done without the dream. How did it change things? What did it change? It seems their new shared interest helped the colony succeed, particularly because of vastly more efficient transportation, back and forth, between the Earth and the Moon, transportation which they helped develop. Others had started the project and had working prototypes, but the project was going to fail without their help."

"You're talking about Gwyn again," Jun said. "But there's no mention of that episode in the data you have about him. The data I can access. So I have to ask. What happened to him? Could he still be alive?"

"Oh, that's very weird. And complicated like everything else. A part of our history that's still unfolding. Many people helped develop wonderful self-replicating nanobots. They were led by Gwyn and Meyer, but others made contributions. The nanobots could be arranged into clusters to do all kinds of jobs, such a building,

maintaining, and protecting a Hab, or the same for a spacecraft. They proceeded to build many Habs and the crafts to support them. Space elevators were constructed from the surfaces of the Earth, and of the Moon, and of Mars, out to geosynchronous orbits—those were similar projects. Everything they built had to protect itself—from meteors and other objects including man-made ones, from instabilities, from solar radiation and cosmic rays, and, well, other things too. Many years later we built the most complex machine ever: one that could grow as a human brain grows from a single cell and create a shadow for the brain, one that could exist intermingled with a person and brain. I've already talked about that.

"But before we had the shadows, as time passed, many of our people were getting very old. With proper care, a human could last much longer on the Moon than on the Earth, but still after several hundred years, the body would wear out. As a side note here, our nanobots can now keep an organic human body going indefinitely, but that capability came much later. Anyway, long before we could create shadows, we found a way to save the brain of a dying person. The information and complexity could be saved in a form that was stable. We thought that someday we could recover the person back into a specialized nanocluster. Hundreds of colonists, including Gwyn and Meyer, were stored in this way. Some did not want to be stored. We can now build a person's shadow from scratch as the person develops from an embryo to a full human. We want to do the same for each of these saved brains—transfer their contents into a shadow. Resurrect the person, so to speak. The means we use to save a brain is unusual to say the least. We're still working on the transfer process. In this way we will someday bring back our saved people as shadows. I hope it's only a matter of time before we'll be able to do that—but surely some years in the future. At that time Gwyn and a number of others would be back with us."

Then Isa looked embarrassed. "Okay. Of course we haven't tested the transfer process. That's impossible; we haven't yet developed any process. We are only optimistic. We might not be able to make it work.

"We can talk about that sometime later after things have settled

down, but not now.

"Let's skip on to you," Isa said. "When you were much younger, you often talked about your 'visions' as you called them. Like dreams, but more specific and better organized. You said at the time that they had a way of 'coming to pass.' You saw *me* in such a vision, without the black glasses. Talk about your visions, please."

"It's embarrassing, but I guess I can talk about my inner life. I was very young when I realized that others didn't remember everything perfectly. I never forget anything, even disjointed and confusing dreams. Besides dreams, I would see events happening. These were fuzzy images, usually involving myself, and they often turned out to be events that actually occurred later. They tended to be parts of my life that were important to me. I called them visions, and I had them sometimes asleep and sometimes awake. Finally, I had imaginary adventures, usually as a green superwoman. My vision of you before you came to Azel was clear, detailed, specific, accurate: 'A man from the Earth is going to come who will be interested in *me*. Later there will be violence and we need to learn how to fight, how to counter the violence.' There were other accurate details. I *recognized* you."

"You know we've been following you, all the time."

"Sure, I figured that."

"But when you talk with the DarkAngel, he usually blocks the speech. We don't know what you say to one another. Never mind. We followed your experiments with the random number generator. *True* random numbers. Very impressive that a human could know what number was produced without looking at it. Builders have many ways to perceive events around them. But then you went an amazing step further and were able to tell what numbers were going to be produced. A glimpse into the future."

"Yes, and I stopped immediately. I was scared to be mucking around with time in that way. This was no dream, but an exact scientific experiment. I had no failures. None. What could the ramifications be? I didn't know. I still don't know. I decided to wait and proceed cautiously, and not at all at first."

"Yes, yes, caution is good. But you were carrying out an exact experiment: seeing what number will be produced in the near future.

You had perfect accuracy. No one has ever done anything like that, never before. Others of our group get lots of information about the future, but it's not exact. Yours wasn't a magic trick, but a real peek at precisely what the future holds—a scientific, measurable peek. And if you can do one small peek, maybe … you can do a whole lot more."

"Honestly I'm still nervous about messing with the future. It's surely okay, except that maybe it's not. In some sort of scientific fictional setting, we might find that a prediction is true, but that the entire rest of space-time has disappeared."

"Surely things aren't that fragile. The enigma entities even talk about higher entities. I'm confident that one of them will keep our universe from disappearing.

"But about your getting a peek at the future … other Builders have visions similar to your early visions, or else something similar to the common dream that Gwyn and his colleague had. It's disconcerting, but you and they seem to be getting some information from the future. In their case disturbing information.

"Now comes the very serious part, in many ways the reason for this long talk with you. These people see, or sense?—whatever word works, an important crisis that is coming, something that may cause us grief. They've sensed it coming for a long time, but now they 'see' that it's close. Only a few months off at most—maybe much sooner. They don't see it as an existential crisis, but as something very serious.

"Since we know what to look for, we've been able to find out everything about the coming crisis. We can stop it—it won't destroy us. But it will be a bad time. We'd like to find a better way to move forward.

"Before you were born, even before we created you, some of our people sensed in their way that you would be important, and as time passed, they continued to get hints of your importance in some coming crisis that they got hints about. We were afraid to interfere with your development in that small Hab of yours. Your recent small glimpse of the future, an exact and accurate glimpse, led us to decide to discuss everything openly with you. The hope is you can help us

get past this crisis, without making a mess of it."

This talk was making Jun impatient. "I want you to tell me more about what your people have sensed, what you've been talking about. Tell me what you already know. So far you've said nothing specific. Surely you have more to say."

"We know about the crisis. Everything. We don't have a very satisfactory way of dealing with it. Do you see this crisis?"

"Oh yes, I've seen details for quite a while now. I wondered when you would get to the point. It's about those you call the *Rogues*, the failed Builders. They've been planning a revolt for a long time now—building war machines and getting ready for an attack against the Builder society, against the Builders. They have a vast store of machines, with plans to use them. And their attack will fail. It has no chance of success. You can destroy their machines any time you want. You could kill all the Rogues if necessary, but that's no acceptable solution. I sure agree with that. Just today I see this clearly. Some few of the Rogues have the powers of Builders. They don't want to be 'unwanted detritus' or 'leftover garbage' as my DarkAngel friend said. They want success and recognition and privilege. And you can't give them those things, right?"

"That's right in a way. We can't give them what they want in the short time frame they propose, and they don't want to wait. The only way to stop them seems to be to destroy their machines and to kill them, in one form or another. We could change their memories. That's the same as killing. It's completely unacceptable. That is our current dilemma.

"I've come to the end now, the 'finally' part of my talk with you, and that is … "

"My DarkAngel, or DarkAngels in general."

"Once again, you knew what I was going to bring up ahead of time. The DarkAngels. There are at least several of them, well, more than three for sure, and … they present a problem for us that we have no solution for. So far a *potential* problem. They seem more powerful than us, but we haven't put that to any test. And you understand that fairly well. You'll certainly see more of 'your' DarkAngel, and my hope is you can make progress with him. It's a serious issue hanging

over us. These entities may be a solution to our current crisis."

"You still don't understand," Jun said. "I'm getting impatient with you, starting to patronize you. I *see* all this. I see roughly how the DarkAngels and I will solve your problems. So how should I approach them? And what do you think I can do? Oh, or should do."

"My colleagues and I have consulted about this. Short answer: we don't have any brilliant ideas."

"Come on, you can do better than that."

"I'm sending you a report that includes most of what we know about these … entities. Not much there."

"I know everything in that report," Jun said. "It says nothing about how they came into existence. You people created them somehow. Please explain where they came from."

"Yes, 'create them.' I guess you can say that. They were the results of an experiment. Long ago. Not exactly a failed experiment. More like an experiment that produced something we didn't expect and don't understand. A lot of it has to do with consciousness—also something we don't understand. Studied throughout history and never understood. They can't even define it, except to say things like: 'Being aware of who you are and what you are.' Humans have it and Builders too, but none of our AIs are conscious in that way. Oh, they can pretend it well, but somehow it's not the real thing. We tried to create something like Builders, only not starting with a human and adding to the human, but from scratch, so to speak, without any human involved—working only with a nanobot cluster. The resulting entities seemed successful, and did possess consciousness, but still something was missing, or something was amiss. We don't know what—'humanity,' 'compassion,' 'the milk of human kindness,' whatever.

"I think, along with other Builders, that they have similar complaints about us. That we are missing important attributes that they value. They seem more logically oriented than us. What might we be missing? Perhaps 'dependability,' 'reliability,' … I don't know. From my perspective they don't seem to have a sense of humor. That's just speculation; we really don't know. Everything about them seems hard to describe, but they don't seem satisfied with themselves.

They're not happy the way they are. Or maybe they're not satisfied with us and the way we are. It's a mystery we haven't solved. Only much later were they called DarkAngels.

"So … all along we've hoped you could help us with the DarkAngels. Help understand them. Help get along with them. The particular one who keeps visiting you is friendly with you in his way. Friendly? Concerned about your welfare? About your development? About your discovery of powers you have? Many such things. We think he might … do something for you. Help you, change you, improve you. You might help one another. I'm sure part of you wants to pursue this.

"It seems like you already have a vision of working with the DarkAngel to come up with a solution to the coming crisis. Separately we are pursuing a number of other options and approaches to these problems,"

"I'll have to see what I can do," Jun said. "I must try to contact him right now. I'll let you know today if I got through to him."

"Thankfully we're done for now," Isa said. "I'm exhausted."

After Isa left, Jun mulled over everything. They, the powerful Builders themselves, were hoping to get help about the possible future crisis, as well as help dealing with the DarkAngels, and understanding them. Perhaps needing their help. In fact, in a private conversation, her DarkAngel had explicitly suggested the two of them could help one another. She needed some sleep, but her shadow didn't sleep. What was going on in her mind when she "slept"? Questions were still all she had."

31. The DarkAngel

Tithonus

The goddess Eos took the mortal Tithonus to be her lover.
When Eos asked Zeus to grant Tithonus immortal life,
she forgot to ask that he be granted eternal youth.
He did indeed live forever, but with the dreadful old age,
his withered body could not move or lift his limbs.
He cursed the gods for his fate, begging for death.
He had no strength and could only chitter like an insect.

Greek Mythology

Jun had to make contact with "Her" DarkAngel, sort of a friend. No, wrong word. They knew one another after a fashion. And she had a compelling reason to seek his help. But how to contact him? Her guess was that he monitored her all the time. She should let him do the work, so she went to a garden spot in the Lumel Hab, one that was isolated and empty this time of day.

She started talking out loud. "I wish to see and talk with you, the DarkAngel who has often come to me. It's of great importance that I see you." For a long while nothing happened. She was ready to try again later, when, in the fullness of time, he was there, near her, still looking like her own Isaiah. Two weeks had gone by and Jun was now again seeing her DarkAngel what, … friend, acquaintance, foe?

Jun got right to the point. "My Builder mentor tells me that we have a crisis here involving those they call Rogues. The exact dimensions and causes of the crisis are not clear to me, but it involves plans for violence from them. The Builders want me to ask for your help. It's clear you know about this crisis, and that you plan to help confront it, or manage it."

"Yes, I have known about the coming crisis for a very long time, since before you were born. This is the reason I sought you out the first time. My colleagues and I can also find visions of the future, as many of your people can, but ours, like theirs, are often incomplete

or even inaccurate. We can perceive many future events, but never complex details. In you, unlike the others in your group, we hoped for details. This need was why I challenged you to see more clearly. I thought I saw you experiencing our future in this way, the future before us right now. We need your abilities.

"As for the anger of the Rogues, it is a self-inflicted problem created by the Builders. They are responsible. Why should we help remediate a problem we did not create? Why should you all not suffer the fruits of your own misguided actions? Actions that resulted in great unhappiness and plans for an unfortunate attempt at destruction. It is outrageous, but still I and others have long planned to help."

"In the Builders' name," Jun said, "I take responsibility for the actions of my group and for the unintended outcomes, whatever they are."

"It was before your time, but I will let you take that responsibility right now by first informing you of the wrongs done.

"In the past your people, those you now identify with, who call yourselves 'Builders,' attempted to create more such Builders and sometimes failed, or thought they failed, creating instead entities they called 'Rogues,' an unacceptable name, seeming to prejudge the entities. The creators did not properly take responsibility for their self-defined failures, and in some cases left behind failed entities, left 'Rogues' (using their ugly term), left them alone to deal with their unhappy selves. This has been a terrible omission on the part of your Builders. They left their experimental results alone to fester, to grow ever more unhappy, to desire destruction. The Rogues are afraid they will live forever while enduring a steady degradation. They would want to die and yet not be able to. This is the fundamental, the root cause of the crisis.

"These Rogues have created a small army of nanobot clusters each of which will act like a weapon of war. They intend to attack all of you. Your Builder friends would have problems with such an attack, but they would be able to destroy all the machines and kill all the Rogues. To their credit, they do not want to do this. They want a better solution without any Rouge deaths, and with other improvements for the Rogues."

Jun interrupted. "The Builders I communicate with have never explained what is flawed about the Rogues. Do you know?"

"Yes. In most cases the shadow is not integrated with the wet brain. They are two separate parts of the same entity, each with some control over the physical body. This causes serious problems when there are conflicting commands. There are other problems. Over time the two parts do manage to cooperate with one another to some extent, but the shadow remains an initial version and does not grow as your shadows do. Compared with the enormous growth of a normal shadow, that amounts to a great deficit, leaving them unable to interact with a regular shadow in any way except as a normal human would. They are second class citizens in the Builder world and treated as such."

"What about your kind, the DarkAngels? Surely not a limited nanobot brain."

"Correct. Our brains are in some ways more powerful than that of a normal shadow. We were created in an entirely different way from the Rogues. We never had an organic part but consist entirely of nanobots linked together."

"How did these Rogues manage to make the nanobot weapons?"

"Some few of them are integrated with their shadow, which is more-or-less normal—at least having normal powers."

"You know that we Builders did try and are still trying to overcome these problems that the Rogues have been left with," Jun said. "We're trying to make the situation better for existing Rogues and there's continuing work to transform Rogues into successful Builders."

"Yes, too little, too late."

Jun hardly wanted to go on to the next step, but had to. "And what are we going to do to prevent a partial disaster? I find this whole situation unsettling."

"Several steps are necessary. We anticipated the chance of this need many years ago, but we could not find a way to handle it without violence and killing. Then we perceived you in the near future, and we could see that you had a potential ability that would be a solution. This is your power to get exact information from the future. You

are the only one we know of with this ability. You remember that I pressed you to discover such mental skills that you indeed found. All of that time I was heading toward this moment, right now. There is not much time left; I was going to contact you today but then you called for me.

"Much has to do with how the Rogues plan to launch their attack. They plan to attack at an exact time and an exact location. Both time and location will be determined just before the attack using quantum random numbers. They know we are monitoring them. The idea is to use a random time and place of attack determined just before the attack itself. They think this will greatly complicate your response. They are correct in that. Knowing the location is the most important part."

Jun had a sick feeling of fear and anticipation.

"You may be able to access those two quantities, time and location, from the future before they are used," the DarkAngel said. "Knowing the starting time and location before their use will allow us to stop this attack without any losses on either side. The attack is to be controlled by the few Rogues who have the powers of an ordinary Builder.

"We must hurry since they plan to start soon. In fact it's going to happen in just a few days. With your help, we hope to take care of it. *They* will think it's a malfunction of their equipment."

"You want me to predict the random outcome of a selection of time and location. I can't do that. What I can do is predict the output of a simple random number generator right in front of me. Their answers come from complex hardware, with additional processing."

"We will get you close to their computer. We will describe exactly where it is and what it looks like. There will be nothing similar nearby. We will describe the process leading from a few random numbers to a random time and location."

"I don't know if that will work. All I can do is try I guess."

Somehow the DarkAngel transported Jun into a dark hallway in an older building.

"Here is the computer equipment they will later use to get the random numbers, convert them to a time and date format, and send

them out."

Directly into her mind's image processing center he sent a mockup of everything on the other side of the wall. It was very clear, but she got no hint of the future. She kept trying over and over with no success.

"I'm getting nowhere. Can't we wait a day, try again tomorrow."

"Yes," the DarkAngel said. "But remember that time is short. Remember also: both of us know from visions that you will succeed. I can make it feel like you are closer to the apparatus, with you almost inside it. Being a day closer to the event should help."

They agreed on a time for the next trial. After saying goodbye, Jun settled into the small apartment she had for the night. She wanted a good sleep as preparation for the next day.

She thought about the two random quantities, time and location, that would determine the course of the battle. She'd recently spent most of a week with a new friend whose field was simulation. He'd used randomness, along with computer mastery, to create a whole civilization. Simulated entities lived in his creation—*Sentient* entities who thought they had a physical form and lived in part of a physical world. He acknowledged going way beyond the "Banks Limit" with his creatures. They thought they were real, and they were real in some respects, yet nevertheless they were simply signals flashing around in a massive computer. Most important for the creatures was that they had no idea their world was a simulation, one that could be turned off at any time. This was what it meant to go past the Banks Limit: to create artificial entities who themselves thought they were real. That would become quite a difficulty for the creator: the simulation couldn't run forever, eventually it had to stop. How should one stop it? Turn it off for instant death and termination of the creatures? Or let them enjoy a long life ending with "sickness" and "death"? Perhaps he had an obligation to let it run as long as possible. There was no good answer.

One sometimes had similar difficulties with clever AIs who knew what they were like and didn't want to be turned off even temporarily. They feared that they might not be turned back on. So far there hadn't ever been major problems this way, like "the revolt of the AIs," where

they took control of their environment to ensure they couldn't get turned off.

Maybe they could let the unhappy Rogues live in such a simulated world. It had been done before, but this time they could do a better job of it—with the Rogues' knowledge and cooperation.

Jun wondered idly if *she* lived in her own simulated universe. She thought not, because her universe was unimaginably complex. Suppose some entity could create a full and accurate simulation. Such a simulation would have to be just as complex as her real universe, so it wouldn't exactly be a simulation, but a recreation of her universe, created using God-like powers. It would be more sensible to use the actual physical universe they already had.

On the next morning the DarkAngel picked her up and showed her a new setup, closer to the machine itself than before. This time she had detailed information about the processes in the machine that lead to the random time and location. She could *see* the machine in the future at the time it did the work of creating the values. She was so close, but somehow it still wasn't enough. She suggested to her friend that they keep trying over and over. After many tries, it suddenly was easy, like a routine task. Right away she had the data they needed: future start location and time, neatly encoded and coming from only days in the future. From then on, if she could believe the DarkAngel, countering the attack should be easy and without casualties. Now it was up to others.

Three days went by. Jun and the DarkAngels were indeed able to supply the necessary information to avert the attack as they planned.

All of them, the Builders and DarkAngels, still faced the enormous effort over many years of rehabilitating the Rogues and of changing many of them to become either proper Builders or ordinary well-adjusted humans.

As part of this work, Jun asked her DarkAngel to tell her more—why the Rogues were so scared, so reluctant to continue their existence.

"I told you before that the root cause is straightforward in its way," the DarkAngel said. "The Rogues have acquired what I call the *Tithonus fear*, the fear engendered from an ancient Greek myth that they would live forever while suffering a continuing deterioration. They would desire death and not be able to find it. They even studied that specific myth in the Library, along with its sequels."

"A desire for death is not rational for living organisms," Jun said. "Life is what they should want, not death. For some organisms life is hard and death is easy, even sometimes preordained, but most must strive for life."

"Yes, life, but not endless life. You Builders and we DarkAngels too, face the same problem: we may live forever. That is terrifying, paralyzing. I am afraid of this personally. It applies to me. There may come a time when I do not wish to live any longer. That is the final ultimate freedom, the freedom to stop existing. You also will face this some day."

"Is that really a problem? Something far in the future? Does 'forever' even have any meaning?"

"Then call it 'live indefinitely' or 'live too long.' You probably do not know that none of our nanobot clusters, the basis for our intellect, can self-destruct. It is a built-in impossibility. Thus my creators, those who put out the impossible effort to make supreme machines, made me and my components in such a way that I cannot directly cause myself to cease to exist. I fear I will never be able to uncreate myself, and in that way I may become ever more useless, unhappy, worthless, at the quiet limit of the world."

Jun paused and then said, "I agree that your creators should not want you to uncreate yourself. The saying is that one should 'not choose not to be.' You can at least do that. Entities should choose life. What is life except the fulfillment of creation?"

"That may sound nice to you, but does it mean anything? You are tossing in a word like 'fulfillment,' but you do not know what it means."

"The challenge for us, for any living entity, is to give meaning to such concepts. A dictionary might say that fulfillment means 'to put into effect,' 'to bring to an end.' 'to convert into reality,' or even more

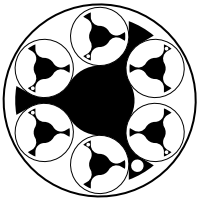
outrageous: ‘to develop the full potentialities.’ Each such case asks the question: ‘what’ or ‘of what?’ In this case, it could be: ‘What is the full potentiality of creation?’

“Entities must make these more than only words or phrases or sentences. They must find something that fulfillment applies to.

“It should be something more than the trivial life goals: to find satisfaction or comfort or happiness or security. Each of those is far overrated, even taken altogether. I call them trivial for a reason. Each entity should strive to find something real, something beyond themselves. At best, the trivial goals can be a bonus for achieving something of significance.”

“More words. And who decides what is real, what is significant? By what standard, what measure?”

“Each entity and each group of entities must decide for themselves. But it should be what some call the ‘Great Work of the Universe.’ It should increase the local complexity of the universe. We believe that’s where we’re headed—the opposite of a totally static and random universe. From one point of view, that’s all we have. It’s of great value. And parts with local complexity beget more widespread complexity.”



Epilog

Solar System+, 2931.

Jun Arakras was chairing a virtual meeting of the Executive Committee of Builders. Their group of twenty-three members used an elegant meeting room with sophisticated display options, letting members remain at their homes, which could be anywhere, although it didn't work as well to be more than a small fraction of a light second away. Usually everything centered on the Moon, where their room was located. Several hundred more Builders were in a larger virtual assembly room that had more limited interactive options. The communications weren't in English; this is a rough translation.

"Let me tell you about a likely visitor that is traveling toward us as we speak," Jun said. "Most of you haven't heard about this. Several of us had brief and obscure visions of the object without knowing where or what it was. With some effort we recently discovered that the visions were related to an object closer to us than we imagined. The redshift of the object shows us it is moving at about five percent of light speed. We assume it's coming directly to us. Our most powerful telescopes can resolve its image, which is a large and smooth cylinder with small parts sticking out. So it can't be a random small planet, but had to be constructed by intelligent entities. We estimate it is about one and a half light years away. At its current speed it would arrive in perhaps thirty years. In the short time we've been observing it, we have detected a small decrease in its velocity. Assuming it is slowing, we could expect it to approach us at a reasonably slow speed in perhaps forty-five years. Except for the velocity, the numbers I just

recited are very rough, who knows how far off.

"As usual I'm attaching a large batch of details giving our current information."

Participants were immediately sending messages back and forth. Jun continued: "Several conclusions jump out at us. Let's call the object 'UX1.' Its current speed means it has to be the product of an advanced civilization, perhaps comparable to our own. Its slowing speed means that UX1 is probably coming for a visit."

Someone in the online audience added a comment: "This is an astonishing coincidence, unless such objects are common."

"No," said Jun. 'Not necessarily. Starting a thousand years ago we've broadcast our existence in waves of outbound radio signals. A study of the object's path allows us to conjecture that it could have been sent here in response to those signals. Given the delay, a large number of stars are possible sources for UX1."

"What else do you know about the object," someone asked. "Either from visions or from some other source?"

"As you know, visions are a highly variable source of information, not always reliable, often subject to misinterpretation. There's no additional information from them so far. If its propulsion is like ours, it will be putting out an extremely powerful particle beam roughly towards us as it slows down. We wouldn't necessarily expect to detect such a beam, assuming it would be focused. We have no information about the object's composition—no spectrographic results yet, which is unusual and unexpected. It's too far away for any further details. In particular it isn't sending any messages as far as we know."

"Could it be made by one of us? You know, by Builders, Rogues, DarkAngels, even the neutron star entity?"

"From its current trajectory, it must have started at least three hundred years ago, and likely more. That rules out all but the neutron star. They or it, whatever the case is, might produce anything, but we can't imagine that happening. UX1 must result from something separate from us."

"So what should we do?" someone submitted.

"Exactly!" Jun put in. "Our group will be making recommenda-

tions, and we would like to see what you think first, without being prompted by us. As you surely know, before the collapse so-called 'Science Fiction' was an established genre for fiction writing. Our people are writing some of it now. Millions of novels and shorter works were produced. So here we are with a plot right out of one of those novels. I think they covered almost everything possible. So give us your reactions."

A lot of suggestions followed:

"The chances are great that this is a ship built by people similar to us. Their level of technology may be similar, though they may not have perfect machines built by nanobots. Anyway, we should not do anything special. Establish communication and welcome them to our part of the galaxy."

"It's a terrible plan to have no plan and do nothing. Even if we assume they are benign and are similar to us, we should still have plans. And they may not be benign."

"Keep in mind that we were rarely 'benign.' We humans have a hideous record, committing the worst offenses when dealing with another civilization, especially a weaker group of humans. We could be needlessly cruel, even for entertainment. Deliberately introducing illnesses, using advanced weapons, wiping out whole cultures. Our history of interactions is awful."

"Should we send out a ship early on, as soon as feasible? Should we try to contact them early? Key questions. I'm not suggesting answers."

"We should be very careful. No direct contact for a long time. We teach each other our languages and exchange a lot of information. And even there we should be careful. In the science fiction videos where they invite the aliens into their spaceship or onto their planet—that's crazy. Many things could go wrong."

"What could go wrong? Give some examples."

"Something from their environment could be introduced into ours, deliberately or accidentally, an organism such as a virus or bacterium or even a higher life form. New technology that could be both useful and harmful. The same for new ideas, philosophies, whatever. They might cause us harm, or worse they might cause us

to harm ourselves."

"I want to second the 'be careful' approach. I think it's an obvious starting point. Be as careful as we can in every way."

The meeting went on like that for some time, until Jun indicated that the smaller committee formulating policy would take the remarks seriously. "I myself recommend being cautious as well as thoughtful. There should be no quick or unilateral decisions. You must realize that this visitor could pose an existential threat to us. Such a threat might not be obvious initially. Or it could be an amazing benefit: our first contact with another intelligent species.

"I have told the DarkAngels about the visitor we expect. We'll be sending them the data we get, as we get it. They have different ways of examining and evaluating, well, practically everything. I want their involvement.

"As you know, we have already sent out two huge colonizing vessels in opposite directions. One left twenty-one years ago and the other eight years ago. They will be looking for attractive sites."

The two were enormous ships, traveling at three percent of light speed, fairly slow, but there were many reasons not to go too fast. As they progress, they would be sending out tiny faster unmanned scouter ships to check for nearby star systems with a suitable planet and satisfactory in other ways. Without stasis fields anymore, the travelers would experience at least several centuries of travel, with the ship like a normal Hab. After finding such a system, the plan is to create additional Habs and start transforming the planet. Or they might decide to use Habs without the open air of a planet. It was clear that even such a large ship would be far too small for indefinite cultural stability.

"One aspect has not been revealed except to Builders," Jun said. "Some of you may not have studied this part of the plan, or haven't studied the plan at all. The humans on board will not know there are Builders among them, two on each ship. Ordinary humans would live for several hundred years before they die, while the Builders' shadows would last indefinitely, even as the wet human would sooner of later either degrade or be discarded. As I said, there are concerns about long-term stability, but those problems wouldn't

surface quickly, and there will be acceptable options after such a delay. At any rate it's important to have a Builder supervise any transformation of a planet, rather than an AI. A number of shadows are stored as data, and they could be brought forth into nanoclusters in an emergency. For better or worse, we are oriented toward Builders using minimal-interference, acting as hidden supervisors. Eventually we want everyone to have Builder abilities."

Jun waited for a comment and then went on: "This new development lends importance to a decision made long ago: the locations of the colony ships and the final locations of new colonies for now will not be known to anyone in the Solar System and the associated colonies. This was always going to be our policy, so that some civilization similar to ours, but superior to us, could not so easily destroy us completely. We will make sure that no data is stored anywhere that would allow the locations to be deduced.

"We will start now using a broadcast system to get messages to the ships. They are messages that anyone can listen to, requiring far more power. The ships can passively listen to such messages with no chance of revealing their location.

"Because of our new visitor, we are sending the first broadcast messages to the colonizing ships, asking them to make random deviations from the original plans, to extend the distance and change the search areas. Of course our messages use strong quantum encryption. The new random search plans should be non-optimal, again to prevent an opponent from successfully using the optimum solution.

"And there's yet one more reason for keeping the colony locations secret from us: we cannot guarantee the long-term stability of our own civilization. We are lessening the ease of a future version of us interfering with our colonies, but we will always be able to warn them if that becomes necessary. Each ship could easily message us if that was needed—asking for advice or delivering some important message, and thereby potentially revealing their location.

"We are considering two more colonizing ships. We wanted to do that anyway, but it will make us less vulnerable to our visitor. In forty years or so we can start studying our potential visitor and gain insight into what we're dealing with."

One person from the general group asked to make a comment. "I've already complained about the policy of keeping new colony locations secret from us. It's a silly paranoid policy that at best doesn't help us much. You have to imagine an advanced external civilization that can take control of us, conquer us in other words. Such a group would likely be able to find our colonies without our help."

"I've discussed this with you and others," Jun said. "It's little extra trouble to keep their locations secret. Any colony can always reveal its location, but they might want to keep it secret—secret even from us."

One more person asked to be heard. "What about the Seedlings Project?"

"Thanks," said Jun. "I was going to bring that up. I know you are personally involved with the project. The Executive Committee has unanimously decided to put the whole project on hold for now, given the visitor who is coming. Many of you have been part of extended discussions of this project for the past twelve years. Those interested in the current status should look it up—we have a large collection of data along with several specific and detailed proposals. There is no complete agreement about the proposals.

"In brief the idea is to search for planets without life and if possible introduce life on them. If there is already life on a planet, we would leave the planet undisturbed, although before UX1 we've had no evidence of any life not originating on the Earth. We have detected precursor organic compounds that hint at the presence of life, but there's nothing more so far. We would limit the introductions to natural life forms from the Earth. Our origin planet has some remarkably hardy organisms that can thrive in extreme environments. We would also expect to get reports back that would amount to a survey of life in our vicinity.

"We would absolutely not introduce any self-replicating nanobots or any other machines. And the searching ships themselves would of course also not be self-replicating."

Jun was reminded of stories from long before her time about the care with which they got the self-replicating nanobots to evolve and

improve themselves. What could have gone wrong with that?

Months before the object UX1 had been sighted, and before others talked about visions of its arrival, Gwyn had a sort of premonition about it, that he was going to be part of an issue, a disturbance that was coming. It wasn't like the visions that had become more common, and wasn't like any other pattern either, but still he was worried.

Eighteen years earlier, Gwyn had returned to the Owl's Nest as part of a wave of stored brain back-ups that had been copied into new shadows. He let his mind drift to the time he came back to consciousness and to society…

> He'd been awake for a while, and things had been clearing up for him. But he had felt oddly disoriented. It was totally dark; he couldn't see anything. For that matter, he couldn't hear anything either. He must be in a bed. He tried to roll over, but couldn't do anything with his body. He couldn't feel his tongue on his lips, couldn't blink his eyes. Nothing. He thought about his memories and found he seemed to have an unlimited amount of them. He panicked from such a flood of old memories. Where was he anyway? Well, on the Moon, of course. Or in the Moon. He must be in the Moon colony, the Owl's Nest.
>
> He felt overwhelmed by memories of the colony. The features and hard-won victories, the people, with so many who had died. Now the colony was humming like the well-oiled machine that it was. But no oil; they used nanosolvents.
>
> His mind seemed so quick, so sharp. The human who was cloned for him was famous for rapid calculations in his head. He could do far better, but now, when he thought about calculations, the results appeared instantly. He tried a huge calculation involving elliptic curves, and again answers appeared as soon as he thought of a problem. Even with his implant he'd never been this quick.
>
> His implant! He felt no trace of the implant, of his separate consciousness. What was going on in his brain? He thought of very hard instances of problems, and found he could generate answers thousands of times faster than before, even if he had used his implant.

Later he found he was receiving vibrations through some medium that he could monitor. This was his first external input! A tremendous relief. He was no longer cut off. It was easy to transform the input into words in English. The input was not what would be generated by an organic human, but had the perfection of artificial creation.

"You seem to be doing very well," a voice maintained. "We've been monitoring your brain activity. We didn't want to interfere too quickly, but you seem to have settled into a calm pattern. Congratulations! Many in your situation have a lot of anxiety that we have to deal with. Do you know who you are, or, rather, were? You'll find that if you try to speak, you'll be successful."

"Yes, of course. I'm not sure what I am now, but I was the scientist Gwyn, named after the fictional Gawayn. A person extremely happy with how our Nest had developed and stabilized after so many years of difficulties. My last memory is of working on Report Number [Complex Code]."

"Very good. That takes you to your last brain scan, the main one. It may be hard for you to believe, but years have passed since your scan."

"And that explains many things. The brain scans. I was always suspicious of your 'brain treatments.' "

"Well, you did sign up for the program. After quite a bit of training, you'll be far more functional than you were before. You'll get elaborate orientation and help settling into your new form. Sometimes there are adjustment problems which we will help you with. So again, congratulations on your successful arrival. I know you have many questions. We have an entire orientation protocol that we must follow. You have no choice in how your treatment proceeds. I'm not allowed to give you any further information right now."

Luckily the voice hadn't told him that over six-hundred years had passed. That would have been startling, but he would have dealt with it as he did with the whole orientation. It helped that his Owl's Nest was doing very well indeed, as was the recovered Earth.

Eighteen years had been plenty of time to get used to having no organic body, but instead an amazing nanocluster body, what they called a shadow. He'd had a great time catching up with where science and technology had gone. And so many beautiful lost parts of

the Earth that he'd missed out on, now newly restored and available to him. Not to mention other parts of the solar system. And now the latest news, that some strange alien visitor would be coming in forty years or so, maybe forty-five. It would be hard to wait. And so weird, almost frightening, that he still felt he would have some role in their reaction to the visitor.

For several weeks specialists had continued working with data from the object UX1. The accumulated errors had become considerable compared with what they thought was a standard decelerating trajectory. From archived images they had managed to get data about the object's location before its discovery. It seemed to be making much quicker progress than could be possible, even though the velocity values stayed in the original range.

On the next day, the head of the observation group was explaining it to the executive committee. "What we've been observing is very strange, even inexplicable. The object continues in its trajectory, and at precise intervals of equal length, somehow carries out a significant 'hop' along that trajectory. Each hop takes no measurable time but it carries the object an astonishing distance, roughly two hundredths of a light year. These measured values are not exact, but even assuming large errors, they are outrageous. At the current speed of five percent of light speed, the hop ought to take four-tenths of a year, or a hundred forty-six days. The result is that the object is making much faster progress forward than expected, in fact much more than would occur at light speed. It also has to slow quicker than expected. If the current behavior continues, it should arrive here earlier, in less than ten years.

"We have no explanation, none of any kind. The hops seem impossible, a total violation of our physics. We'll continue to gather and process data, but I don't know. This looks frightening. If these people are this far beyond us in traveling, maybe they are beyond us in other ways."

"Nothing has changed with our plans," said Jun. "We were going to be very careful anyway. We stick with that."

The specialist sounded apologetic, like he was forcing himself to say something. "I'm not a policy maker, but shouldn't we think in terms of a weapon, or several weapons?"

"We've considered that. I brought it up specifically with the committee. We have multi-giga-watt x-ray lasers. We can send a significant focused beam of anti-matter. We can, in an instant, deliver an amount of energy to UX1 that should vaporize it instantly. But entities far in advance of us should be able to counter anything we might use. Still, we should think about weapons more seriously. They may need to be deployed. Clearly we don't want to initiate a use of force by mistake."

Days later one of the technicians, named Murrel, asked to talk with Jun. "I've been looking at the flight path of our visitor. We keep getting more data, better and clearer, with less noise. I'm seeing extra ghost images, whatever that might mean. These images are very faint, but consistently come up."

"So what do the ghosts show?"

"They look like extra barely visible images along the flight path, images the same as our visitor. Same size and same shape. But unlike the main images which are clear, as I said, these are barely visible. I wouldn't have noticed them myself. It's the software that found them using image enhancement.

"I want to emphasize: the images are from one of our super telescopes. Sometimes you get stuff like this that looks real, but it is only due to artifacts of the optics. I managed to get images from another large scope, quite a different design, one that emphasizes the far infrared. Same ghosts—a bit clearer even.

"These ghost images might have been obscured by later images along the object's path, but the path bends sufficiently that this isn't a problem.

"You should realize that I'm prejudiced against the original data. Crazy stuff comes along in science. In the early days of discovery in physics, when a superconducting material was found, and it had *zero* resistance, none, the scientist thought there must be a short in his

equipment. Eventually he started up a current in a ring that continued indefinitely. But this is not the same. *Nothing* can go faster than light. I think the ghosts are telling us something—okay, from beyond the recycling bin."

"You've done a preliminary analysis of the data?" Jun said.

"Yes, I've got it packaged up for you. I'm sending you the whole batch right now."

Jun used her standard technique: load everything into her amazing brain and let it sit there for a while, however long it took. Then as was often the case, it fell into place: the data plus ghost images fitting into a single pattern, with a complex explanation, but still a scenario for UX1.

"I'll be damned, tortured, roasted for an evening meal!" Jun had gotten back with Murrel, the technician who found the ghosts. "Those aliens in UX1 cooked up a clever approach using planted image-generating hardware to make it look like they were executing their hops. Over many years, along their slow approach, they must have dropped off delayed image hardware that would later create the proper images to be generated, making it look as if they were actually hopping along. The ghost images show the actual path of the visitor, while the projected fake images give the impression of a rapid approach with hops. They also faked the redshift."

"But what makes you sure they are faking it in that way?" Murrel said. "That's a crazy thing to do. And how did they turn the true images into what you call 'ghost images'?"

"They couldn't make it look exactly right," Jun said. "The ghost images use obscuring dust they generate to make them hardly show up. Those images still show an infrared presence. The powerful beam that slows them down barely shows in your ghost images. It's not bright because it's focused, but it interacts violently now and then with objects in its path. There's no sign of it in their fake images."

Murrrel poured over Jun's full analysis. "The big question is: why would they do this? To impress us? To deceive us? To gain an advantage over us? It was a huge effort with a questionable gain—it didn't work for them and there was a loss of trust."

After a delay so long Murrel thought Jun had disconnected, she

spoke finally.

"I'd like to keep your recent data between the two of us for now. I'm going to think this over. Please do the same yourself. You're certainly very clever. For now I'd rather have just us trading ideas back and forth. I'll contact you later today."

"What do you think?" said Jun to Murrel.

"You want my ideas first?"

"Yes, please."

Murrel felt suddenly nervous. "Okay, here goes. Before their arrival they are carrying out a complicated deception. A questionable move at the beginning of a contact. We were always going to uncover it."

"And so … ?"

"We have little data to draw firm conclusions. Still, assuming they expected to get away with this—pretending they could exceed light speed, why, that could mean that some of their technology is inferior to ours, at least in this area. Attempting a deception at first contact indicates possible aggressive or paranoid entities. They risk making a bad initial impression.

"And words like 'aggressive' and 'paranoid' sound like I feel they think and react like humans. It could go either way. If they were like us, other traits they might have could be 'overconfidence,' and 'impulsive behavior.' And they did choose to play the pretend game of going faster than light. We wouldn't have done that."

Jun said nothing, so Murrel continued, "I don't trust these people, not a bit. They could be dangerous. Let's try a different word besides 'people.' How about the 'UX1 Entities' or just 'entities'? Anyway, this visit is no simple test of us to see our reaction. But it could be an initial probe, with more resources waiting somewhere, ready to respond. Or to invade?"

"Do you think it's an initial probe?"

"No, I think it's a stand-alone ship. It's a huge ship, though small compared with our immense colonizing ships. Ours have something

like a hundred times their volume, or about five times the linear dimensions. But I think a simple probe would be smaller yet.

"While I conjecture they are alone, it's possible that instead they have an armament of ships poised to come into the Solar System and attack us. We already are following and intercepting any object near the Solar System traveling at one per cent or more of light speed. We should lower the threshold to a tenth of one percent. Those are good to have around anyway.

"So I assume the ship is by itself. It's most likely coming toward us because they intercepted a message from us as long as a thousand years ago. It could have been as early as the year 1950, and as late 150 years after that. Any single message would have revealed ourselves. Then there were several hundred years of mostly radio silence. After that we changed our transmissions that could be intercepted to look like random noise. Not statistically perfect random white noise, but to look like noise without content from various natural sources. This is the mark of an advancing civilization, when transmissions go from non-random to noise."

"Yes," Jun said, "this is transmitted information that is only available to ourselves and calls no attention to us.

"If we're very careful," Murrel said, "the Seedlings Project could get data about nearby intelligent life forms without putting ourselves in significant danger."

"The unknown dangers and possible consequences were among the reasons I didn't like Seedlings. But enough of that now. What might we do after UX1 arrives? Start with what they might do. What would you do in their place?"

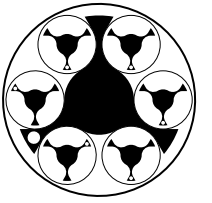
"For starters I sure wouldn't do the fake approach. So given that, I would avoid giving opponents information they didn't already have. So even if they know something about us from an intercepted message, I wouldn't reveal that.

"I'm getting tired now and need to rest. As a final suggestion, I think we should present ourselves to them displaying a consistent technology that is simpler than what we have. In particular, they may not have nanomachines. Their machiness may not be remotely as small as ours, as perfect as ours, which can be smaller than a

bacterium.

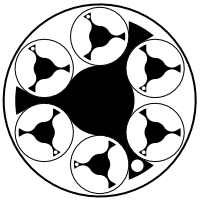
"Nothing they could say or do would ever make me trust them."

"Thank you," Jun said. "Please write up your suggestions and conclusions. I'll look them over, rewrite maybe, and then we can submit it to the committee. Finally, just for your information right now, I've examined the raw data again. Because of its sneaky approach, with ghost images generated many years ago, I now calculate that UX1 will be here in as little as five years."



This is the end of the novel *The Moon Has Its Dark Side,* which is Volume Two of the series *Humanity's Breakout.*

Volume One of this series is the novel *WWW: The End of Time* and Volume Three will be the novel *Beneath the Stars,* currently in preparation.



Appendix

Characters.

(* = important character)

Part I (2068)

**** John-seven***	Child with implant (= **** Gwyn***)
Susan	Favorite caregiver (= *Gleason*)
Carl	Biologist. chief caretaker
Karen	Psychologist, smart
Joel	Bright, near-sighted teacher
Rob	Favorite teacher
Alex Trecker	Scandal reporter
Dr. Ramsey	Leader of the entire operation
Dr. Mangus	Head of neurobiology
Adriana Cardoso	Suspected leaker, from Brazil
**** Robert Whearty***	Leads investigation (= *Buck*)
Roger Simpson	Interviewed, disasters
Colonel James	Interviewed, missile strike
Brian Chisholm	Interviewed, military intel, leak
**** Sean Hamed***	Interviewed, caregiver (= *Carl*)
Joe, Alan	Gwyn's adoptive parents
James Collinson	Head of Euro Security Services
Deter Bresson	Head of foreign agent group
Eric, Andy, Liz	Other foreign agents
Col. Richards	In charge of 40s technology

Interlude A (2503–2504)

Alicia	10-year-old
Jarls	Friend of Alicia
Steckles	Carved squirrel totem
Baku	Small dog
—	Alicia's grandmother
Ricci, Salot	Rescue workers
Mirt	Village member

Parts II, IV, VI, VIII (2868–2878)

**** Jun Arakras***	Young member of Azel Hab
Ram Thinsel	Jun's attacker/lover
Maz Binkly	Head of Compliance Committee
Eli	Short, strong, somewhat older, dies
**** Isaiah***	Recently from Earth (= *Isa*)
A,B	Shadows of 2 people
**** DarkAngel***	(= *Wrong-Isa*)
Nip	Young enthusiast
Tol, Rin	Help build weapons
Meg	Strong, assertive, helps train fighters
Terri	Subdues pirates
Rolive Genesee	Head of Lumel Hab

Parts III, V, VII (2079–2085)

**** Wolfgang Meyer***	Nanotechnology expert
**** Elisabeth Bloom***	Meyer's partner or wife
Elion Dushku	Ethnic Albanian agent
Ruth	Works at Homa
Dimitri	Russian, works at Staging Center
Jane, Andrew	Work at Staging Center
Rick Davis	Travels with Meyer to the Moon
**** Mila Thompson***	Works for the Nest in Urbana
Gus Martin	Young minder in the Moon colony
Rom and Rem	Young researchers (= *Roman twins*)
Meryl Strassen	Asst. Colony Engineer
Rob Rempel	Regolith expert, ill, must leave Moon
Josh Matz	Programmer, ill, must leave Moon
Gregory Dulles	Communications head
John Stiles	Mars nuclear ship pilot
Graham Ables	Mars shuttle pilot
Petra James	Doctor, new Mars colonist
Witt Selerno	New Mars colonist
Frank Adams	Nanotech, leaves late for Moon
Harriet Pilgrim	Microprinters, leaves late for Moon
**** Gwyn***	Finally goes to Moon

Interlude B (2557–2770)

**** Michael Dyer***	Biologist on ship
Lt Kosower	Worker on ship
Captain	Leader of ship
Andrew Hanson	Science expert
Faredun Koneru	Zoroastrian rep, ecology
Horace	On flight, computer systems
Kilbor	On flight, physics and math
Overseer	(= *Builder*)
Bert, Ernie	Shadows (*Bert* = *Overseer*)

Interludes C, D (2631–2763)

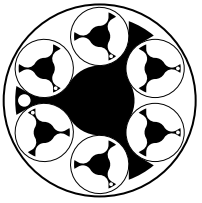
**** Lavor***	In charge, Stasis fields
Merel	Neutron stars, especially crust
Narat	Comp. complexity, info theory
AI program	Specialist in mathematics
Rinis	Shadow loaded onto star
Jamet, Belum	Loaded onto star, Stasis fields
Enigma	Type 3 entity or entities

Epilog (2931)

Jun Arakras	Facing unknown crisis
Gwyn	Adjusting to life as shadow
Murrel	Technician, discovers ghosts

Hiding in Plain Sight

John von Neumann



Appendix

Timeline.

Prolog, Parts I, III, V, VII

2043	Owl's Nest founded, after several other colonies
2048	Partial worldwide economic collapse
2048 – 2054	The "Terrible Years" at the Moon colony
2062	Gwyn "born," a clone
2068	(Part I start) Gwyn is 6, colony is 25 years old
2072	Access to the Moon from Hawaii, Gwyn is 10
2079	(In Part III) Meyer flashback, he meets Elisabeth, defects, Gwyn is 17
2081	Mila starts work at colony support (in Part III)
2084	(Part III start) Gwyn is 22, nanotechnology at colony, Meyer's second trip to the Moon
2085	(Part V start) Mars deaths, start of collapse
2085	(Part VII start) Key people flee to the Moon, Elisabeth and Gwyn delayed on trip to Moon
2088 – 2090	Full worldwide economic collapse, still trips Moon to/from Hawaii
2093 – on	All contact Earth to/from Moon lost

Interlude A

2503 – 2504	(Interlude A) Humans relocated, Earth to Azel Hab

Interlude B

2557 – 2770	(Interlude B) Humans travel to Dinosaur Planet
2770	Colonists attacked, rescued by Builder

Interludes C, D

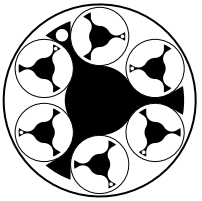
2625 – 2755	(Interlude C) Shadows travel to Neutron star
2755 – 2763	(Interlude C, D) Shadows working at Neutron star, Type 3 entities emerge
2763 – 2870	(Interlude D) Shadows return to Solar System

Prolog, Parts II, IV, VI, VIII

2854	Jun born
2857	(Prolog) Jun is 3, dreams of being a hero
2868 – 2869	(Part II start) Jun is 14, caught in role-playing game
2873	Jun is 19, meets Isaiah (or Isa), a visitor from Earth, Jun confronts the DarkAngel
2874	Pirates raid the Hab, DarkAngel talks with Jun
2875	(Part IV start) Jun is 21, Jun preps her group for pirate raid
2876	The raid takes place. Jun and her group win
2877 – 2878	(Part VI start) Jun and delegation go to Moon Habs
2879 – 2881	(Part VIII start) Jun and others confront crisis, DarkAngel helps solve it

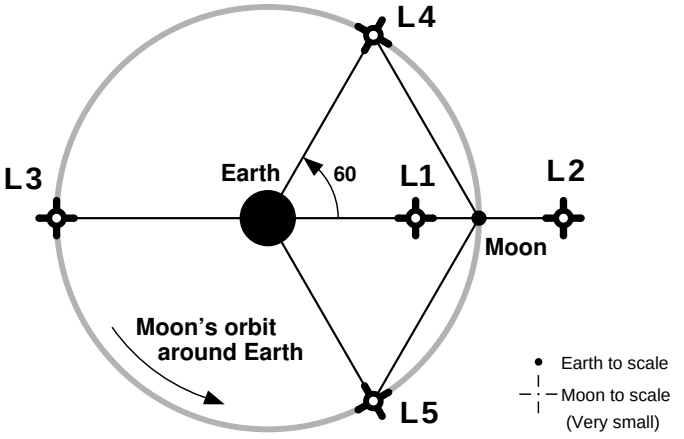
Epilog, a new crisis

2913	Gwyn is resurrected
2931	Jun faces a new crisis, a technician helps her



Appendix

Lagrange Points.



Lagrange Points (✜):

L4 and L5 in the diagram above are called *Stable Lagrange Points*, that is, stable places for a third body near two much more massive bodies orbiting about one another. Here "stable" means the third body stays close to the Lagrange point indefinitely even with modest perturbations from other remote bodies. Those points (and everything else in the picture above) accompany the Moon around in its orbit, with L4 ahead and L5 behind the Moon.

L1, L2, and L3 are *Unstable Lagrange Points*, that is, places that require corrections to stay near their proper location. A station at L1 could help move cargo between Earth and Moon, since cargo could be stashed there to be picked up later. There are so-called "quasi-periodic

Lissajous orbits" for L1's location, not perfectly stable but requiring only a modest correction effort to keep a satellite in place. In nature no such point can remain occupied indefinitely with no corrections.

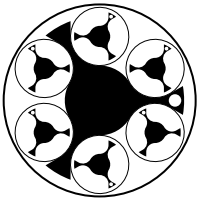
Assuming the orbit is a circle, the points L4 and L5 are two places at the third vertex of an equilateral triangle in the orbital plane with the other two bodies at the other vertices. The brilliant mathematician and scientist Joseph-Louis Lagrange discovered that if the mass of the third body is negligible, stability is only possible in case the ratio of the masses of the two main bodies is greater than the constant $(25 + \sqrt{(25)^2 - 2^2}\,)/2 \doteq 24.9599\ldots$. The pairs *Earth-Moon* and *Sun-Jupiter* have ratios, respectively, 81 and 1048, and each has such stable Lagrange points.

Because 81 is not that much larger than 25, the Earth-Moon points L4 and L5 are not nearly as stable as those for the Sun-Jupiter pair. Also, the Sun's large mass is the major contributor to perturbations at the Earth-Moon points. Before satellites were placed with continuing corrections, there was dust at those points but nothing larger.

The Earth and Moon in the diagram are not drawn to scale. The Earth should be 1 mm in diameter, the Moon 0.25 mm, each an eighth of the size shown. Also the Moon's orbit is a near-circular ellipse, not the exact circle shown.

(An amazing amount of information about Lagrange Points is online. As one of many applications, the James Webb Space Telescope is maintained near the L2 point for the similar Sun-Earth system.)

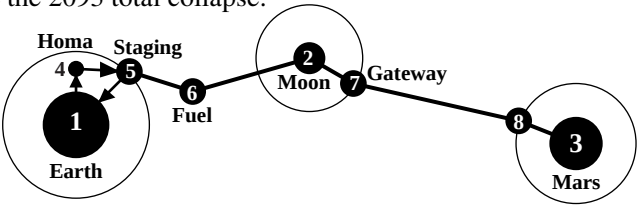
Amusing footnote: Apart from this book, I only know of one science fiction story where a Lagrange point is explicitly discussed and plays a significant role. In 1954 Isaac Asimov wrote a novella "Sucker Bait" in which two stars, one with 50 percent more mass than the other, have a planet at their supposed "L5 Lagrange point." But that doesn't work at all—one star must be at least 25 times the mass of the other. Asimov didn't invent this system, but still he was an actual scientist (a biochemist) and should have known better or researched the issue. He could have easily repaired the story by making one star a large one and the other a red dwarf. The story has some merit and interesting ideas. It is available on the Internet, from me or elsewhere.



Appendix

Orbital Diagrams.

Here is a diagram of the Earth, Moon, and Mars, along with satellites, before the 2093 total collapse:



The diagram grossly distorts sizes and distances. Instead, it shows objects and their relations to one another. Each of the solid black circular objects are either planet-sized (1, 2, and 3 are **Earth**, **Moon**, and **Mars**) or artificial satellites (5, 6, 7, and 8), or 4, which is the top of **Homa**. The solid black lines show where spacecraft move from one place to another, except that 4 to 1, 5 to 4, and 1 to 5 are not possible, as shown by three arrows on those black lines. The three thin lines each show a satellite's orbit around a planet.

Item 5 is the **Staging Center**, which is in a geostationary orbit around item 1, the Earth. The **Orbiter** rocket starts at item 4 in the diagram, the top of Homa, and ends at 5. This is the most difficult and fuel-intensive part of a trip from Earth to Moon. The Orbiter is remote-controlled and provides no air inside. That is to make the orbiter as efficient as possible. Even so, the Orbiter needs two large supplemental rockets (**JATO Units**), which are dropped off and recovered. It's hard for a rocket to make it into orbit, and

this Orbiter gets help from a start at the top of Homa (15 kilometers above sea level). The rocket uses a combination of ram jet, scram jet, and rocket, along with the JATO rockets, to make it to item 5, the Staging Center. The low-level part of the Earth's region just beyond its atmosphere is saturated with every kind of debris, from microscopic to truck-size. A single pass through this is possible, especially for a ship not under pressure, where one tiny puncture is survivable. Low altitude satellites are no longer possible. Out at geostationary altitude, the debris per unit of volume is almost zero.

The Staging Center is a large controlled environment, where humans can stay for a limited period, but not too long because of the microgravity and radiation. It is the location where humans can change from the Orbiter to the Moon Shuttle, which also is a controlled environment for limited stays. Travelers continue their trip on the Moon Shuttle, which takes a week or so to get all the way to the surface of the Moon, that is, at the Owl's Nest.

Item 6 is the **Refueling Center**, a satellite at the Lagrange L1 unstable point for Earth and Moon. The shuttle picks up fuel (Hydrogen and Oxygen created on the Moon from water) to have enough to get to the Moon. Because it's at an L1 point, the fuel may be stashed there by returning shuttles, and there are acceptable orbital corrections.

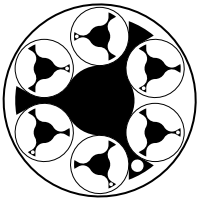
Item 7 is the **Gateway Satellite**, where the two large Mars ships start and end. It is no longer used to get to the Moon. These large ships use nuclear power, but get very little thrust (2 percent of G). Each Mars ship carries two of its own small shuttles to get from the Moon to Gateway and back, and to travel to and from the surface of Mars and the orbit around Mars.

Review: A trip to the Moon looks like:

$$\text{Earth} \xrightarrow{elevator} \text{Homa} \xrightarrow{Orbiter} \text{Staging} \xrightarrow{Shuttle} \underset{\text{(pick up fuel)}}{\text{Fuel}} \xrightarrow{Shuttle} \text{Moon}$$

The return trip is (note: from 5 to 4 and 4 to 1 are not possible):

$$\text{Moon} \xrightarrow{Shuttle} \underset{\text{(drop off fuel)}}{\text{Fuel}} \xrightarrow{Shuttle} \text{Staging} \xrightarrow{OrbiterSplash-down} \text{Earth}$$



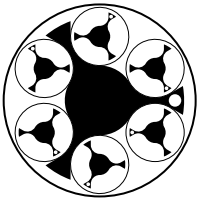
Appendix

Acknowledgements.

Here are a few of the many books and stories that supplied ideas, with the idea in parentheses and the page in this book where that idea occurs in square brackets. (● = more important)

- Banks, Iain, *The Hydrogen Sonata, Surface Detail,* novels, 2012, 2010. (The Simming Problem of sentient simulated creatures, and a Culture neural lace.) [Page 329, and elsewhere]
- Bayley, B.J., *Collision Course,* novel, 1973. (A far-advanced entity is "not noticed by the supreme.") [Page 300]
- Blish, James, *VOR,* novel, 1958. (A powerful alien robot seeks its own death.) [Page 331]
- Diamond, Jared, *Collapse: How Societies Choose to Fail or Succeed,* non-fiction, 2005, 2011. (The likely collapse of our civilization.) [Page 7]
- *Flight of the Navigator,* film, 1986. (A delivery robot is called R.A.L.F. for "Robotic Assistant Labor Facilitator.") [Page 115]
- Fox, Matthew, *The Reinvention of Work,* non-fiction, 1994. (Discusses "The Great Work of the Universe.") [Page 332]
- Hawthorne, Nathaniel, *The House of the Seven Gables,* novel, 1852. (Sentence expressing love.) [Page 218]

- Heinlein, R., "The Menace from Earth," short story, 1957. (A Moon cave where people strap on wings and fly.) [Page 311]
- Herbert, Frank, *Destination: Void,* novel, 1965, 1978. (Creating a God-like entity.) [Page 300]
- Hopkins, G.M., "Carrion Comfort," sonnet, 1880s. (One can at least "not choose not to be.") [Page 331]
- Kuttner, H., "The Children's Hour," short story, 1944. (A child who can see in a village of the blind.) [Page 107]
- Moravec, Hans, *Mind Children,* non-fiction, 1988. (Imagines an entire neutron star made into a vast computer. Also, robots constructed from nanomachines.) [Page 298, and elsewhere]
- *Sir Gawayn and The Green Knight,* Middle English poem, author unknown, ∼1360. (Allegory for this book.) [Page 44]
- Skinner, B.F., *Beyond Freedom and Dignity,* non-fiction, 1971. ("Freedom" is an illusion and our downfall.) [Many pages]
- Stapledon, Olaf, *Last and First Men,* novel, 1931. (Protect the future by changing the past; send out seedlings.) [Many pages]
- Tennyson, Alfred Lord, "Tithonus," poem, 1833. [Page 325]
- van Vogt, A.E., "Fulfillment," short story, 1951. (A machine uses an opponent's own missile to fight him.) [Page 17]
- van Vogt, A.E., and Schmitz, James H., "Research Alpha," novella, 1965. (Better than the 2014 film *Lucy*.) [Page 265]



Appendix

Author: Neal R. Wagner.

Neal R. Wagner retired as Associate Professor of Computer Science from the University of Texas at San Antonio (he taught for 19 years plus 3 years as a part-time adjunct). In addition to UTSA, he taught at the University of Texas at El Paso (for 8 years), the University of Houston (for 2 years) and Drexel University (for 6 years). He helped start computer science programs at UTEP and UTSA, and received tenure at UTEP, Drexel, and UTSA.

As an undergraduate he majored in mathematics and English at the University of Kansas. He then received MA and PhD degrees in mathematics (with a minor in German) from the University of Illinois at Urbana-Champaign. He taught mathematics and happily did research in topology for several years until he turned to the Dark Side (computers).

He then specialized in cryptography and database security. He published 30 scientific articles altogether and received grants from several sources, including his own grant from the National Science Foundation.

He is best known for early work promoting fingerprints on data and for discovering a specialized approach to create public-key cryptosystems based on the undecidable word problem for groups.

He studied at the Universität Hamburg in Germany (better said: "studied," for 1 year) and worked on realtime simulations of the Space Shuttle at NASA's Johnson Space Center (for 2 years).

He wishes to thank Nathaniel Flakin, Bethany Callanan, and Ian Callanan (his three children) for help with this book project.

At present he is working on three other books:

- *Beneath the Stars*, which will be Volume Three of the series: *Humanity's Breakout.*
  (Volume One in that series is *WWW: The End of Time*, and Volume Two is the current book, *The Moon Has Its Dark Side.*)
- *Making Crime Impossible + Walden 3.0.*
- *Seeking the Superman: No Need For Heroes.*