MARS FRONTIER

Vol. 5

Dust and Gold

Contents

1

Nuclear Fire

Jan. 15, 2044

The pale blue jet extending from the solid core nuclear engine shrank in length and intensity, then flickered out. “The first firing of an SCN-25 to send a crew to Mars has been successfully completed,” exclaimed the terrestrial announcer.

Applause and cheers broke out in Renfrew Hall, where most of Mars’s twenty-nine adults had gathered for a long lunch and the collective experience of Columbus 5’s trans-Mars insertion. The image of the solid-core nuclear engine and the interplanetary transit vehicle *Hellas* shrinking against the backdrop of a magnificently blue and white earth lingered on the large screen. Not visible were the Mars shuttles *Apollinaris* and *Elysium* and the two ITVs they had pushed onto a Mars-bound trajectory, the *Solis* and *Cimmerium*. The ITV *Ophir* was also on the way, but it had been pushed by a lifter, an unmanned, reusable vehicle based on the moon.

“Chocolate’s on the way!” exclaimed Neal Stroger, a geologist and chocoholic.

“And vodka!” added Yevgeny Lescov.

“And Lal’s future wife!” quipped Roger Anderson, slapping Lal Shankaraman on the back. Lal smiled, embarrassed; everyone was asking him how he could marry someone he had never met before.

“And our community grows by two thirds,” added Will Elliott, Commander of Mars Operations, with a smile.

“Well, Érico, the nukes work,” said Roger.

"I never questioned that they'd work," corrected Érico Lopes. "I question their economics. Whether you haul the hydrogen from Earth in a Swift shuttle or from the moon in a lifter, the vehicles were designed to haul hydrogen and oxygen together. They can haul only a quarter as much hydrogen alone because it's so much less dense than oxygen. That makes hydrogen four times as expensive, and you need twice the volume of it, so hydrogen fuel is eight times as expensive as the hydrogen-oxygen combination! It cost more to push the *Hellas* to Mars with a nuke than to push the other three, total!"

"Making and storing enough hydrogen on Phobos and Deimos for use by a nuclear engine would be a big headache for us, and the waste oxygen would become orbital pollution," added Yevgeny, who was in charge of operations on the moons.

"If NASA can get oxygen afterburners funded, nuclear engines will become much more practical," said Will, trying to remain neutral. He was holding his fourteen-month old daughter Elizabeth in his embrace while she slipped into her afternoon nap. His wife, Ethel MacGregor, sat nearby with their son, three and a half year old Marshall, the first child born on the Red Planet. Will turned to Tang Enlai, their Chinese exobiologist, and handed him Lizzie; Enlai loved to hold the children. Hands free, Will turned to his attaché—a clipboard-sized computer and communications device—and set up a videomail to Pete Theodoulos, Commander of Columbus 5.

"Greetings, Commander Theodoulos," he began, recording a formal message that Pete wouldn't receive for almost five minutes. "On behalf of the residents of Aurorae Outpost, a hearty congratulations for your successful burns. We're delighted everyone is on the way. We wish you the best with the rendezvous and reassembly of the Columbus 5

complex, your visit of 2020JB, and we pray for an uneventful flight here. We look forward to seeing you in six months. Bye."

He pushed send. Enlai leaned over. "When do they encounter 2020JB?"

"In mid May, two thirds of the way to Mars. They'll visit it for two weeks, then make a course correction to head our way."

"I have a friend on board. He's excited, even though 2020JB is only two hundred meters across."

"It's a prime candidate for a cycler orbit because its perihelion and aphelion give it a transit time between the planets that is roughly what we want," noted Ethel, who had been listening.

"Which won't make travel between the planets faster, but may make it safer," said Enlai.

Will turned back to his lunch. About the time he finished it, the reply icon on his attaché lit up. "Thanks, Commander Elliott," replied Theodoulos. "We can't wait to arrive. Most of us are planning to stay at least four years and many plan to stay a decade or more. We're practically a colonization flight. So the excitement is almost unimaginable. We're on our way to our new home! We appreciate your words of congratulation. Bye."

Many of the others came over to hear Theodoulos's response; Will played it a second time. Then people began to trickle out and return to work.

Will and Ethel took their kids upstairs to the child care area, then headed for their work stations. Will detoured through the greenhouses and Clarke Dome, formerly known as the Mars Dome, a big transparent bubble thirty-two meters in diameter. He looked at

the lush greenery inside, then outside at the escarpment, a 1,500 meter high wall of rock that rent the northern horizon twenty kilometers away. His eyes fell on the holes they were excavating for the two new biomes, special enclosures with habitations and agriculture. The *Hellas* was carrying one biome; the other would leave Earth on an automated cargo vehicle next month and be propelled to Mars by the SCN engine at such a high speed that it would arrive three weeks before the other.

Will headed for his office on the ground level of Habitat 1. Next to his office was the bridge, which was staffed twenty-four point six hours per Martian day or "sol." Will opened the door connecting his office to the bridge and acknowledged the person there, who began to pack up and leave, since Will was on duty. Then he sat at his desk, placed his attaché on it, and began to open messages.

Gregory Harris had emailed the images of his Beautician's Certificates. That made Will smile. The former Catholic priest, psychologist, and registered nurse was willing to do just about anything for the Outpost; when Will had mentioned in a television interview that the Outpost badly needed someone who knew how to cut hair and handle beautician's skills—matters that had generated criticism of the residents by terrestrial pundits—Harris immediately emailed Will and said he'd get the required training. Looking at the series of certificates that followed the first, Will could see that Harris had kept his promise. He hit reply and set the response to be an audiomail. "Hello Greg! Thank you so much for getting all this training. You'll be mobbed by people sporting funny haircuts as soon as you arrive! Actually, Madhu doesn't do a bad job, but it now takes her a lot of time, and with Columbus 5 we'll have over fifty people here, so we'll need professional treatment. We are really grateful. Bye."

The second message was from Silvio Diponte, and Will opened it with a mix of anticipation and trepidation, because the lawyer-accountant-businessman was proving more innovative than Will had hoped or was ready for. “Hi, Will. In the last week, getting everything ready at Gateway, a lot of people have approached me about their private ambitions for Mars. It would seem that only four are committed to return home in two years because of family; fewer than the official number. On the other hand, because this group has few couples and a lot of single people, many people who want to stay wonder whether they can find a spouse on Mars. That’s a matter to consider. Maybe more arrivals should be taking their cue from Lal.

“I found a crewmember who can run an old-fashioned loom and is willing to learn our new fabric weaving, cutting, and sewing unit. A half-time position could produce about 200 garments per year, or four per person. That could be a crucial quality of life improvement, especially when you consider the range of garments we’ll be able to make. Of course, this person has committed only ten hours a month, paid by me from the store’s income!

“Another crewmember is willing to commit ten hours a month to the plastic fabricator; a small amount, but a start. The fabricator we’re bringing can make almost anything out of plastic, including children’s toys. Again, it’s a quality of life issue, and for me it’s a crucial issue for developing the store. A third crewmember who has training to use our glass-making equipment seems willing to do some cash work on the side as well.

“We have several people with crafts training: ceramics, knitting, embroidery, leatherwork, woodworking. It’s listed on their lengthy life histories. I hope to persuade

some of them to make items for sale as well. I'm still not sure whether to pay them and charge for goods in euros or dollars.

"As for the arts, we've got one crewmember who does landscapes; oil paintings of them, that is. Apparently he isn't bad with portraits either. He's looking forward to the challenge of painting Mars and of course he hopes to get some time to do it. I told him my guess was that he'd have to paint on Sunsols and demonstrate his talent, as well as earn the right to reduced hours over a year or two. We also have two novelists—unpublished—a poet, a pianist lacking a piano, a cellist with a cello—one by Giovanni Verelli, to be exact— a script writer, and a videographer. You may want to think about giving the latter two some time to exercise their talents on behalf of Mars.

"I'm preparing a survey to determine how much people are willing to pay for a Mars-made set of clothes. Getting supply and demand to match each other at a reasonable price could be tricky. Part time paid work will cost me a lot. Bye."

Will wondered when anyone would find time to do extra work for the store. Every sol, Alexandra Lescov was adjusting the construction schedule and asked for more work time. He hit reply. "Thanks, Silvio, for the update. I'm very concerned about our work load. Sunrise typically occurs at 7 a.m. and work starts at 8. We eat lunch from 12:30 to 1:00 p.m., then return to work until 6:30, when we eat supper. Sunset is at 7:20, half a sol after sunrise. Some parents end their work at 4:30 or 5:00 to have time with their children during the daylight, but they make up for the time after the kids go to bed. The schedule's exhausting and is possible only because meals, cleaning, and clothes washing are provided. A few people have already agreed to work 1.1 full time equivalents and the construction people will be working 1.2 full time equivalents for the first six months

here; in other words, no Satursols off. When will anyone squeeze their schedules to work part time for you?

"I should add that I'm skeptical that we can manufacture quality consumer goods here and sell them at a price people will accept. The manufacturing costs will be too high and the quality will be too low. A dress imported from Earth costs $2,000, so we only import high quality ones. A low-quality garment made here will cost almost as much. But we can review the economic and quality issues after you arrive. Bye."

Will had a long list of messages in his inbox, but he indulged himself to read a new personal email before tackling the work-related ones. *Dear Will*, an email from his old friend, David Alaoui, began. *The Venus crew has now been at Shackleton for a month completing our final training and looking at the latest collection of Venus rocks picked up on the moon. A thirty-kilo chunk was just found in Clavius. It's from 4.1 billion years and contains the chemical signatures of Venus's late Diluvian Era ocean. It's a really incredible find.*

Shackleton just installed Habitat 8—it would have been your Habitat 5—and with it the station can accommodate fifty-six. They're very grateful to Mars for not wanting it! It's been a busy tourist season, with three loads of eight tourists over six weeks. Last summer, of course, they had more; I think forty. Everyone complains about tourism, but half the tourists are university professors in the sciences and they're quite interesting, so in one sentence someone might complain about the onslaught and in the next they'll mention fondly someone they met here last year!

Everyone is always comparing Shackleton Station to Aurorae Outpost. Every time one expands, so does the other; the moon is closer, but Mars has romance, and besides, it

used to have life. There's a lot of talk about getting a biome for the moon, but the micrometeoroid problem and the horizontal sun would necessitate a significant redesign. The surface exploration efforts are always being compared as well; the moon has fewer trails, but more extensive exploration via hopper.

Sebastian seems to be doing a good job and is a popular commander. People tell me he's gotten over his fetish for exact control over the inventory. He says hello to you and apologizes he hasn't been in contact for a few months.

In four days we're catching the Lifter Orientale *to Gateway. Project Magellan's equipment arrives there in the* Guinevere. *We'll unpack it, then head home with the last lunar tourists for a month. The* Amazonis *is already at Gateway. The speculation that it was given a name applicable to either Mars or Venus proved correct. The two interplanetary transit vehicles have undergone extensive modification, with larger oxygen and methane tanks and a cargo area replacing the great room on the bottom level. The ITVs now have enough delta-v to propel themselves back to Earth orbit. Eight tonnes of water is wrapped around the living quarters to shield us from radiation. An automated cargo vehicle is ready to go with two high-altitude Samandar sunwings, six telerobotic rovers designed for operation on the Venus surface, and four Phoenix mini-airplanes to shuttle back and forth between the sunwings and the surface. The sunwings have sample recovery shuttles built into them that will manufacture their return fuel from internal hydrogen, atmospheric carbon dioxide, and solar power, just like the Mars shuttles.*

As you can imagine, we can't wait for trans-Venus injection in six weeks! It's Europe's first sponsorship of a staffed interplanetary mission. If this works, people are asking whether Mercury is next! My wife's not thrilled by my two year absence orbiting

around a hell-hole, but the technology's well established. It worked for the six of us on Mars, so it should work fine for four us in Venus orbit. We'll see in five months. Bye.

Will hit reply and wrote a quick note back to his friend. *Thanks for the update! I'll have to give you the latest some other time. I'm delighted for you! The second human being to land on Mars will be the commander of the first crew to set up a Venus orbital station. I hope the station grows, flourishes, and becomes permanent; we have to study Earth's sister world much more if we want Earth to avoid the same hadean fate. Congratulations, Daoud. Bye.*

Will turned to other matters. He read emails about personnel allocation; the staff on Mars always wanted more responsibility and wanted others to do the more tedious tasks, which was easiest to arrange when others with less seniority were arriving. No matter how large the Outpost grew, there was never enough staff; the quantity of exploration, science, and research on ecology and materials to do was infinite.

So he send videomails to staff about their requests, approving a few, suggesting modifications to others, offering meetings in other cases, always copying Human Resources, for the allocation of human resources on Mars had huge effects on the support teams scattered across the Earth. By three p.m. Will had completed most administrative tasks, so he went for a quick walk to relax and smooth the transition to his scientific work. He passed through Clarke Dome and briefly stopped to talk to Therese Deschanel, their environmentologist. She was adding Martian regolith—reg, they usually called it—to the soil that had been developed in one of the agricultural plots, building up their supply for the sol when they would need it in the new biome. From there he entered the lower floor of Joseph Hall, which was divided into a garage area and a manufacturing

area. Ethel was running the sheetrock fabrication unit and they chatted briefly. Then he turned around, walked back to Habitat 1, and entered the control room for the Prospectors, or telerobotically operated rovers. For the remaining three and a half hours before supper he ran a rover in Deuteronilus Mensae, rolling from rock to rock, taking samples, placing a sensor against the surface to measure its mineral content, excavating a small trench in an ancient sand dune. They had eight Prospectors scattered across the surface and six people ran them part time. Every two or three months a sunwing—a solar-powered aircraft—visited two or three Prospectors, recovered their sample canisters, and dropped new ones. They recovered a tonne of samples per year from the machines and used them to explore many areas where no geologist had yet been able to set foot. One Prospector, in two years, had rolled almost three hundred kilometers across the Martian surface.

Supper was boisterous; the news that Columbus 5 was on its way was mixed with the exciting announcement that Lisa Kok had gone to the sick bay to have her baby. Many left early and headed for the Great Room in Habitat 2 to join Karol Havlicek, the prospective father, to wait for news. Will and Ethel, however, had other responsibilities; they took their kids upstairs. While Ethel put Lizzie to bed, Will gave Marshall a bath.

“Dad, why does Roger insult Érico all the time?” Marshall asked, as he was putting on his pajamas.

“He doesn’t really insult him. I don’t know how to explain it. . . . Roger and Érico are good friends because they’ve done a lot of things together, but they see the world very differently. Roger doesn’t like the way Érico sees the world, so he teases him about it.”

“Kind of like how Sammie always hits me.”

“Well, Sam’s just three years old. But maybe he’s learning a little bit from his dad. You must always be kind to Sam, Marshall. The two of you will always be good friends, especially when you’re a little older.”

“But I don’t like Sammie, he’s always hitting me!”

“He’s just trying to be friendly in his own way, dear.” Will helped pull on Marshall’s pajama top, then led him from the bathroom across their small living room to Marshall’s small—two by four meter—bedroom. Lizzie had a room of similar size, while Will and Ethel shared a three by four meter bedroom on the other side of the four by four meter living room from the children’s bedrooms. They sat on Marshall’s bed to say prayers.

“Who’s gonna start?” asked Will.

“You. Where’s mom?”

“She’s still getting Lizzie to sleep. Okay, I’ll say a prayer first.” Will closed his eyes and recited a common, short Bahá'í prayer: *Is there any remover of difficulties save God? Say: praised be God! He is God! All are His servants, and all abide by His bidding.*

Marshall’s lips moved slightly while his father recited; it was a prayer he knew as well. It was his turn; he was tired and said one very short: *O God! Make my heart pure, like unto a pearl.* Then he added “Your turn.”

Will nodded, but just then Ethel stepped into the room. She sat on the bed as well. “Mom, will you say your prayer?”

“Let’s not interrupt daddy, okay.”

Marshall nodded, so Will recited a longer prayer: *Say: God sufficeth all things above all things, and nothing in the heavens or the earth but God sufficeth. Verily, He is in Himself the Knower, the Sustainer, the Omnipotent.*

"Now, mom?' asked Marshall.

"Alright," Ethel replied. She paused to make sure she remembered: *Our father, who art in heaven, hallowed be thy name. Thy kingdom come, thy will be done, on Earth as it is in heaven. Give us this day our daily bread, and forgive us our trespasses, as we forgive those who trespass against us. And lead us not into temptation, but deliver us from evil, for thine is the kingdom, and the power, and the glory forever. Amen.*

Marshall nodded, satisfied. "That's one you have to learn some sol," Will said.

"Mom, why don't you say Bahá'í prayers?"

Ethel paused. "Because I don't know them. I'm a Christian, not a Bahá'í."

"But why aren't you a Bahá'í, like dad and me?"

Ethel was startled by the question. They had been praying with Marshall at bedtime for almost a year, now, and he had learned two or three short Bahá'í prayers. He had never said he was a Bahá'í, however. "Well, dear, I don't know what to say," she finally said. "I haven't studied the prayers, the way you have."

That seemed to satisfy him. Marshall bowed his head; it was his turn. *O God, my God! Unite the hearts of Thy servants, and reveal to them Thy great purpose. May they follow Thy commandments and abide in Thy law. Help them, O God, in their endeavor, and grant them strength to serve Thee. O God! Leave them not to themselves, but guide their steps b y the light of Thy knowledge, and cheer their hearts by Thy love. Verily, Thou art their helper and their Lord."*

Will smiled. “Very good! You remembered the whole thing from last night!” He leaned over and kissed his son. “Now, let’s read three stories, and no more, okay?”

Marshall nodded and yawned; they weren’t going to get a fight from him that night. Will read one, then Ethel, and half way through the third the little boy was sound asleep. Will and Ethel tiptoed out. “I’m sorry he put you on the spot like that. He’s now got four prayers memorized, so naturally he’s asking,” said Will.

“Oh, don’t worry about it. I suppose if I were more Christian I would be upset. But the kids have to have some sort of moral upbringing, and a spiritual upbringing is probably good as well. And besides, your morality and spirituality seem pretty sound.”

“Your Presbyterian grandmother would approve?”

“Once she got over the initial shock, yes.” Ethel kissed him. He kissed her back.

“I should probably go to sick bay and see how things are going.”

Ethel nodded. “Yes, the Commander needs to make an appearance. I’ll watch some tv. But don’t stay too long, even if you go to your office.”

Will looked at his watch. It was 8:30. “I’ll get back by ten, how’s that.”

“Okay,” she agreed. She knew he couldn’t stay; it was his restlessness as well as his duties. They kissed and he hurried out.

She turned to the television; they had a large screen tv on the living room wall and her favorite show had been downloaded by the Outpost’s computers earlier in the sol. But first she looked into Lizzie’s room to make sure the little girl was sleeping, then checked on Marshall. She spotted her son’s book of Bahá'í prayers. She picked it up and sat in the living room to read some; the show could wait.

2

Conference

25 March 2044

The seats and tables in Renfrew Hall's Great Room were arranged in a big horseshoe, with two cameras pointed at them. Almost everyone was there. No one wanted to miss the First Interplanetary Mars Science Conference.

The horseshoe faced three large wall screens. The middle one showed an auditorium in Houston filled with a thousand people. On the right and left were smaller auditoriums in Paris and Moscow, respectively, but each was full as well. Tokyo was not present; it was the wee hours of the morning there. The attendees on board Columbus 5 and at Shackleton Station were not shown.

At exactly 9 a.m. Central time, Dr. Douglas Morgan rose to welcome everyone and convene the gathering. When he finished to warm applause in four different locations, Will Elliott's face appeared on the screen in Houston. He had taped his comments an hour earlier.

"Good sol to you all, and greetings from Aurorae Outpost," he began. "We are not only honored, but thrilled by this unique and historic conference. Gatherings have been brought together across continents before by audio and video, but never has a conference been held simultaneously on three continents *and* three worlds. The eleven-minute time delay will be artfully disguised using panel discussions and recordings. We hope all of us will feel as if we are participating together in one gigantic gathering dedicated to the advancement of our understanding of Mars and what it tells us about our home world and ourselves.

“For the next week, the twenty-nine of us up here will offer quite a buffet of choices. Our full-video geological field trips will take you to the widest possible range of geological features and terrains. Tomorrow will be dedicated to a field trip up Little Colorado Canyon, a hike through a half billion years of geological, atmospheric, biological, and climatological evolution. We have forty original scientific papers to offer, thanks to the synthesis and integration of research we have accomplished over the last six months, which have been a Sabbatical period for many of us.

“Our presentations will be interspersed among three hundred papers delivered in Houston, Paris, Moscow, Tokyo, Shackleton, and on board Columbus 5, with most sessions held simultaneously in at least four venues, tied together electronically. Among the highlights: a redefinition of the classification scheme of Martian biota; a new model of the late Noachian ecology in Gangis Chasma; a climatological model of the last three billion years, based on the polar layered terrains and sediment cores taken in Nirgal Vallis; a new division of Martian time into estivals and hibernals, periods of greater or lesser temperature and water; a reclassification of the phases in Tharsis volcanism; a new date for the Hesperian-Amazonian boundary; a new date for the Tiu Vallis 3A flood; a revision of the history of Oceanus Borealis; and a new computer model for moving from horticultural management to ecosystems management here at the Outpost.

“Our understanding of the history of Mars has doubled almost every three years since the arrival of Columbus 1. Nnow, eight years after humans first set foot on Mars, we know eight times as much as we did in 2036. By the end of this year—nine years after the first human steps here—our human population will have increased eight fold as well. The outpost and its human residents will be the subject of twenty presentations, half of

which will not focus on the medical aspects of living on Mars. The social dynamics of this place will receive its first serious attention.

It would seem that the exploration and development of this world has now reached a historic landmark. This is the first of what we hope will be an interplanetary and intercontinental conference about Mars every time the two planets come into opposition with each other. It is fitting to consider what we can accomplish in the next decade. In 2054, a decade hence, one can project that Mars will have between 150 and 500 people. The first children born here will be teenagers. Dusty Red will be crossed by a network of hundreds of thousands of kilometers of dirt tracks. Tourists and specialized professionals will be arriving, staying a month, and returning to Earth about seven months after they left home. Mars will be approaching a new threshold of self-reliance—we will never be self sufficient—with imports per arrival dropping below one tonne and exports approaching a similar value. We will know about sixteen times as much about this world as we know now. Who knows, by then we may have found life surviving somewhere on Mars; and if not, we may be contemplating the creation of genetically modified terrestrial species able to grow and gradually terraform this world. And we hope the Outpost will continue to emerge as a multicultural model for the home world representing peace, justice, equality, and true fraternity.

"These development milestones will take the hard work of the scores and hundreds of us up here, and of tens of thousands of you on Earth. One week every columbiad we will come together to form a learning community. The people of Mars are grateful for your support and partnership and look forward to the learning and collegiality. Thank you."

Will's image faded from the screen and everyone in the Great Room joined the applause they could hear in Houston. Will nodded in thanks. There was a pause, then a video appeared of Madhu doing a classical Indian dance modified for Mars's lower gravity. The terrestrial audience gasped at her jumps. "They have no idea how much you have to change your dancing style," Roger said to Madhu.

The rest of the morning was devoted to major overview papers presented by some of the leading scientists on Earth. They broke for lunch. Will was getting ready to head to the geology expedition—they were doing a trip around Boat Rock in order to present classic outcrops showing erosion and deposition during the middle Noachian floods—when Dr. Martha Vickers and Dr. Kevin Dunbar approached him. Will saw them coming and his heart sank.

"Shall we head to my office?'

Kevin nodded. "Ah, I think so."

The three of them walked through the greenhouses to Habitat 1, where Will's office was private and soundproof. Martha closed the door and looked at Kevin.

"I want a divorce," he began. "Jennie and I have been trying to live together for five months. The counseling helped for a while, but it hasn't solved the underlying problems. I need to move out right away."

Will nodded. "Your old room doesn't exist any more; it's been subdivided into two rooms for the Columbus 5 arrivals. But you could have one of them. How many months pregnant is Jennie?"

"Three."

“I recommend this move,” added Martha. “I’ve spent a lot of time counseling Kevin and Jennie over the last two years. Their differences seem irreconcilable.”

Will nodded. “Then we’ll have to do what we can. Mars doesn’t have divorce law or a set divorce procedure, but we can create one.”

“Good,” replied Kevin. “I was afraid that this silly utopian publicity façade would make divorces impossible.”

Will shook his head. “Oh, no, absolutely not. There is a lot we can do here to help people be happy, such as providing counselors like Martha whom everyone likes and trusts. That’s our strategy. The Mars Commission is putting resources into ‘quality of life supports’ and we want to see what that does to preserve marriages and help people overcome personal problems. But when those efforts fail, we won’t paper over the differences. You and Jennie really tried hard, and I salute you for that.”

“Thank you, Commander.” Kevin sounded relieved.

“Let me know what room you want and I’ll authorize your key card and voice print to open the door. In the absence of a Martian ordinance, the Mars Commission treaty says Texas and American federal laws apply. If you and Jennie can come to an amicable agreement, it can be approved by a Texas court, or both of you can hire lawyers to battle against each other in court there. But if we can put together a local divorce procedure quickly enough, you can use it instead. I’ll get started on that.”

“Good,” said Martha.

Will rose and shook Kevin’s hand. “Don’t worry; we’ll all get through this.”

“I appreciate the support; I do.” Then he and Martha left.

Will made a few notes on his attaché of things he had to do, then hurried to the suit donning area. He barely had enough time to suit up, grab his helmet and gloves, and jump into a ranger headed to the southern face of Boat Rock.

The expedition lasted until 6 p.m., then Will grabbed a bite to eat, caught his breath, and reviewed his presentation. He was the plenary speaker for the evening session in Houston and the early afternoon session in Japan. His talk was a general one about the history of geological study of Mars, a summary of an early chapter of the textbook he was writing. He concluded with a survey of questions that remained to be answered and regions of Mars needing particular attention.

Questions occupied him until 8:45 p.m., then Will hurried upstairs to help put Marshall to bed. The boy was probably still awake because he didn't want to go to sleep without both parents. When Will arrived, he was surprised to see Ethel was reciting a Bahá'í prayer about humankind. When she finished she looked up and smiled; she seemed pleased he had heard her.

"Daddy, she said a Bahá'í prayer!" Marshall said.

"Yes, I see. Now you have to learn the Lord's Prayer."

"I know half of it!" Marshall began to recite, and he did indeed know half of it. Will smiled. "Excellent! You're learning!"

"Your turn, daddy."

Will nodded. He sat on the floor with them and recited a Bahá'í prayer for unity that he particularly liked, one he said almost every evening. Marshall asked him to say two more prayers because he and Ethel had already said three each, so Will complied.

At that point Marshall yawned; he was ready to sleep. Will pulled out one of the boy's books and began to read, but Marshall was sound asleep before Will had finished page 2. He and Ethel tiptoed out of the room.

He wondered whether to say anything. "The prayer you recited is one of my favorites," he observed.

"I know, you've said it many times. I like it, too." She paused. "As you can see, I've been reading a bit; and not just prayers."

"Well, if you have any questions, you can always ask mom or Molly, if you don't want to ask me."

"Molly's always helpful," agreed Ethel, referring to Will's sister. "How was your talk?"

Will shrugged. "Pretty good, I guess. There were a lot of good questions. The expedition this afternoon had 734 viewers; fifty percent more than expected! The amateur geologists we allowed in asked some good questions. Quite a few more are viewing the videotape and are posting questions to the website. Roger said he'd be answering them for the next week."

"The Little Colorado trip will draw the biggest audience; it's so spectacular."

The next week was exhausting for everyone on Mars. A team of geologists led by Lal Shakaraman took geologists on tours of volcanic features in Elysium—on the other side of the planet from Aurorae—when everyone in the Outpost was asleep. The Outpost folks otherwise were busy eighteen hours a sol either showing people outcrops, giving tours of parts of their facility, making presentations, or listening to the flood of papers from Earth.

When the conference finally ended, most people took a few sols off. The next morning Will went to the Great Room to bring breakfast back to their apartment; they ate together at least once a sol, usually in the morning. Érico and Roger were in line to get food for their families and were having their typical friendly debate.

"Your President has finally passed national health insurance," exclaimed Érico. "It only took the U.S. eighty years longer than all other civilized nations! Welcome to the club, Roger."

"What club? The European countries have universal health care and practically no children, so they let in a few immigrants and watch their median age climb above fifty. Only one Frenchman is coming to Mars this time because France is spending a third of its GDP on health insurance and social security. That's no club to join."

"But don't you think the benefits you enjoy here should be universal?"

Roger laughed. "No. Mars is an exception; we work hard and we renounce the benefits of living in a materially rich place. We have good health care because we have no access to stores."

"For a few more months, anyway," said Will, intervening. "We'll have a store by the end of the summer."

"He's really unbelievable," said Érico, pointing a finger at Roger, but he was smiling.

"You're both unbelievable," replied Will.

"What did you think of the conference?" asked Érico.

"I'm pleased. We made a lot of friends, got a lot of ideas, shared a lot of ideas. . . it was good for everyone."

“A geophysicist studying Mercury’s magnetic field shared several clever ideas with me,” agreed Érico. “He and I plan to write a paper about the early history of the Martian magnetic field. We think we’ve figured out some of the puzzles.”

“Madhu’s got several major new ideas about the ecology of the biome,” added Roger. “A waste management expert recommended we set up several waste treatment lagoons outside the main part of the Outpost, maintained at a pretty low pressure—just enough to keep water from boiling at 40 Celsius—and use a combination of anaerobic digestion, combustion of waste gasses, and solar energy to keep the temperature constant and high. A lot of the water will evaporate and can be purified through distillation, and the rest will be clean enough to use for irrigation.”

“She told me. It sounds like a really clever plan, if this guy’s right.”

“There’s a pilot plant on the moon.”

“Yes, but it operates under somewhat different conditions; higher pressure and no solar inputs.”

The three men stopped talking because they had reached the food. Each held a “double decker,” two trays on top of each other, so they could carry enough food home. It wasn’t practical on Earth, but Martian gravity made it possible.

Will waited because the cantaloupe ran out and Marshall had asked for some. As he was preparing to head out the door, he saw Eammon pull Kevin aside. Kevin already looked uncomfortable. “So, you’re divorcing Jennie?” asked Eammon.

“Eammon, it really isn’t any of your business.”

“But Kevin, you’re Catholic, aren’t you? Shouldn’t we take the church’s teaching about this seriously?”

“Eammon, I’ll decide how I follow the church’s teachings in my life, okay?”

Will moved in. “Eammon.” He shook his head.

“Commander, I have free speech here.”

“Of course you do, and Kevin has a right to privacy. And we all have an interest in civility. Civility means we leave private matters like this to each person.”

“Commander, you’re not creating a neutral culture here; you’re advocating an individualistic culture. Shouldn’t we be our brother’s keepers?”

“Yes, but in courteous ways, Eammon.”

He looked hurt that he had in effect been called discourteous. “Very well, Commander.”

“Thank you, Eammon,” replied Will. He glanced at Kevin, who nodded a thanks to him.

3

Heaven and Hell in One Day

May 15, 2044

The asteroid 2020BJ looked like Phobos, Deimos, and many asteroids humans had explored: rolling, bouldery, covered by dust, and gray. Pete Theodoulos, Ruhullah Islami, and the rest of the geological team were just completing their seven hour exploration of the north polar crater aptly named “Santa Claus.” As they stepped inside the *Apollonaris* shuttle, applause broke out in the Great Room. The dozen residents of Mars who had been watching were proud of their future colleagues.

“It’s not a very impressive place, but every data point helps us understand the history of the solar system,” commented Charles Vickers.

“I’m impressed that you had so many ideas for them,” replied Kevin.

“I see far more meteorites here than I ever did on Earth!”

“And the visit helps us protect the Earth from them,” added Lal. “Not to mention Mars; I suppose some day this world will need an asteroid shield as well.”

“That’s planning ahead,” said Kevin. “It’ll be centuries before people are spread out enough here to need an asteroid shield!”

“On the other hand, a shield here can try things one for Earth can’t; there are no cities of millions to incinerate if you make a mistake,” commented Charles.

“We won’t have cities of millions without more nuclear power,” complained Kevin bitterly. No more reactors were scheduled to be flown to Mars.

“We’ll have to wait until the Republicans control Congress again,” replied Charles. He glanced at his watch; it was 11:30 p.m. “An hour before curfew,” he added.

Will Elliott had finally put a closing time on the great room: 12:37 p.m., the last minute of the sol. Otherwise, some people would socialize all night. “I’m heading for bed. Good night.” Charles rose from the table and headed out.

With the end of the transmission, others left as well. Jennie rose from her table, put her tea cup in the dishwasher in the kitchen, then headed to her room. Her pregnancy was beginning to show. Kevin followed her across the room with his eyes, contemplating the meaning of her shape to him. She saw his gaze and glanced at him resentfully.

Lal saw the incident. After Jennie stepped out, he reached over and put his hand on Kevin’s shoulder. “It’s not easy. My brother’s divorced. He went through hell.”

“Lal, it’s not that bad for me; I wanted to be free of her and now I am. I’m sleeping better than I have in two years.”

“For a few months.”

“I know. I’ll have to figure out how to be a father and avoid the mother. This place isn’t very big.”

“And neither of you have jobs that take you in the field.”

“I suggested to her that we get two places, one for the baby and whichever spouse is watching him, and one for the other one. She said no, the baby was living with her.”

“What did you say?”

“Well, I don’t want the minute-by-minute hassle of a baby anyway. But Jenny gets drained emotionally by the child care center. I don’t know how she’ll have the energy for our baby and all those kids.”

“Yes, including Anna.” Lal was referring to Lisa and Karol’s baby, born three months earlier; she had started in day care during the mornings. “I’m sure Jenny will take a maternity leave; if I were her, I’d take the entire six months coming to her!”

“But that’s in dispute, too. The six months are to be split between us and I want some of it as well.”

“Isn’t Martha arbitrating?”

“Yes, and she’s pretty fair. But now she’s pregnant, too, so she has less time and energy, and I wonder how fair she can be.”

“Another baby coming? That’s number seven!”

“Mars isn’t doing bad.” Kevin poked Lal. “You watch out, it’s contagious.”

“I hope it is! Radha wants at least two.”

“Oh, you know that?”

“Yes, we’re in email contact daily, in spite of her parents’ warnings.”

“Why would they warn her against emailing her future husband?”

“Oh, they’re quite right, Kevin. In our culture, traditionally when a marriage is arranged, the bride and groom are not in touch at all until the wedding. Of course, that’s less and less common nowadays. But my friends with arranged marriages have lower divorce rates than my friends who supposedly got married for love.”

Kevin laughed. “That’s bizarre!” He looked around; he had been so loud the privacy of their conversation had been disturbed.

Lal smiled knowingly. “No, it isn’t bizarre at all. It makes perfect sense. You see, my friends who think they got married for love went into the marriage with all sorts of

expectations and were disappointed. But in an arranged marriage, you have no expectations and have to make it work."

"No expectations and no reason to expect it'll work!"

"As I said, it has worked better than the marriages of my friends who chose their mates themselves."

"But now, I guess, you know her some."

"Yes, we do know each other some, so I suppose now we have expectations and dreams."

"How did this marriage get arranged, anyway?"

"When Radha was selected to come to Mars, her parents complained to her that she was unmarried and she said there was really nothing that could be done. So they did a little research and figured out that I was unmarried and contacted my parents about arranging a marriage. That was unusual; customarily the groom's family initiates the wedding plans. My parents contacted me about the matter and I said, 'why not'?"

"So you'll only have yourself to blame, Lal my friend."

Lal shrugged. "Brothers and sisters learned to love each other and they are often opposite in terms of personality. They're stuck with each other; they can't divorce each other; they make it work. People have an immense capacity to love." He saw Kevin's surprise. "I'm sorry, my friend; I wasn't commenting on your divorce, I was speaking in generalities."

"That's okay." Kevin looked down at the table. "A lot of people have been offering me their unsolicited advice, over the last three months, in spite of Elliott's comments."

“The Commander’s position has been controversial among some of us, here.” Lal hesitated. “Can I speak frankly, Kevin?”

“Of course.”

“You Americans are very individualistic; you have a strong sense of personal rights. Some people would say Americans are prickly about it. But the rest of the world is more family- and community-oriented. The rights of the individual are balanced differently against the rights of the group.”

“Mars is a pretty individualistic place.”

“Not necessarily! Some of us very much disagree with Will’s intervention. We all should have the right to talk to each other about each other’s behaviors. If Eammon and Irina set out to have a big Catholic family—as Eammon has boasted they will—shouldn’t we have the right to comment whether we want to devote resources to support four, or six, or eight kids? But it follows if we have the right to comment to them about the matter, they have the right to ignore us. I’d prefer that the line be drawn there. Let Eammon complain to you about your divorce; and let you ignore him if you choose.”

“Hum. I see.”

“Actually, I’d prefer a bit more community involvement than that; but a divorce is hard to forbid. And you guys really did try to make it work. The community did its part via Martha.” Lal drained the last bit of mint tea from his cup. “Well, that’s it for me. Sunrise comes pretty early.”

“I’d better get to bed, too. I’m glad you’re back, Lal. I missed our late-night chats.”

“I did, too. But Elysium was pretty interesting. Volcanoes, floods, mineral zones, massive eolian deposits and eroded areas; not to mention the fumerole we found, with the surrounding chimney of ice.”

“Still active; quite a coup for geology.”

“And a blow for exobiology.” He shrugged. “Maybe this place is dead after all.”

“It’s a shame, but it means we can revive it.”

“We already have. The snow deposits near Nirgal have terrestrial bacteria in them.”

“I heard. Now we have to figure out whether the contamination came from us, from a space probe decades ago that wasn’t sterilized properly, or from a meteorite blasted off the Earth.”

“Tomorrow,” replied Lal, with a sleepy smile on his face.

Will didn’t want to devote his entire birthday to administrative duties, but he didn’t have much choice; there were emails to answer, minutes to read, video digests of meetings to watch, heads of departments to talk to, and he messaged Commissioner Morgan several times a sol.

He decided to start with the videomail. Louisa Turner, the impeccably dressed and perfectly organized director of the Commission’s public relations. She videomailed him about the publicity themes for the next three months.

Will pushed reply. “Good sol, Louisa. Thanks for the update; I’ve read it carefully. So clever, shifting from the discovery of terrestrial bacteria in Nirgal’s snows to the theme of Eobiology, then in mid June to the theme of the shift from horticultural

management to ecological management! I never thought anyone could connect the Nirgal discovery to the arrival of the biomes and crew over three months! But you did it. Let's hope nothing upsets the plans. Start emailing interviewees to line up the stories. Bye." He hurried his last sentence because an emergency icon began to flash red in the corner of his attaché's screen. He pressed on it; "emergency on Columbus 5" appeared on his screen. He jumped out of his seat and hurried into the bridge, which was unstaffed at the time. The central screen already had the details; Ruhullah Islami's space suit was losing pressure fast. The audio and video from the team exploring 2020BJ was already being broadcast aloud in the bridge and the sick bay.

"I've got it, Ruhullah!" exclaimed Peter Theodoulos. "I've got it!" He was slapping something onto his colleague's leg. But the pressure drop was not slowing very much.

"Negative effect," said Ruhullah grimly. His voice sounded pained. He had ripped his suit on something sharp, which was almost impossible to do; suits were tough.

"Then let's go. Hold the patch on," said Peter. "Come on, Ruhullah."

"Acknowledged." His voice was weak. Theodoulos picked up his colleague and hooked the two of them together, then fired his maneuvering jets. They took off from the surface quickly. Theodoulos turned them and fired the jets again, heading them toward the shuttle about a kilometer away.

The pressure in the suit kept dropping, though slowly now. Will watched it drop to 0.10 atmospheres, which with pure oxygen was marginal for life.

"Keep talking," said Pete.

"I'm okay."

“Keep talking.”

“I can hear you!” Ruhullah raised his voice, but he was beginning to gasp for air.

“Count, Ruhullah!”

“Yek, do, se, chahar. . .” He began to count in Persian. “Five, six, haft, hast. . .”

“English!”

“Nine, ten. . .” He hesitated, then kept counting while the two men flew through space toward the shuttle. Pete kept his focus on the airlock and increased their speed, then as they approached he began to slow them, while Ruhullah continued to count, less and less coherently all the time. It was a thirty-second flight to the shuttle; a record, and a violation of all the speed rules.

They floated toward the airlock and the crew at the shuttle was already there, ready to grab them and pull them inside. They reached out and snared both men, then the four of them more or less tumbled into the airlock. The door closed and the emergency air flood began.

“You’re okay, Ruhullah,” said Pete.

“I am?” The man replied, unable to understand.

“Phew!” said Will involuntarily. The pressure in the spacesuit was already increasing. There was nothing Mars could do; Columbus 5 was tens of millions of kilometers away.

Will called Columbus 5’s bridge. “Congratulations, guys, for a quick and successful rescue. If we can do anything here on Mars, let us know. The medical personnel are standing by.” He sent the message, knowing they couldn’t reply for six minutes.

The rest of the morning and half the afternoon focused on the emergency. Even though there was little Mars could do, they had to drop everything just in case their assistance was needed. Meanwhile, reporters were sending questions and expressing their usual skepticism about spaceflight and Mars exploration. Will was busy by that as well.

As a result, when he arrived at the Great Room for supper he was tired. He was surprised when everyone immediately rose and sang happy birthday. Out came a cake—no candles because of the fire hazard—and he was handed a big cake knife to cut it for everyone. “Speech, speech!” said several.

“Speech?” replied Will. “What do you want me to say? I’m forty-three this sol; nothing special about that number. I don’t feel any wiser. In fact, I had completely forgotten it was my birthday from shortly after breakfast until now! If there’s any insight produced by today’s crisis, it’s that we need a regular bridge officer instead of rotating the task. But I suppose I do have this tidbit to share: I want to thank all of you for being my friends. I can’t say we’re a perfect team, but we don’t do badly together, and we’re learning. So, thank you for everything.”

Everyone applauded. Will smiled in spite of his fatigue. “Is Ruhullah still resting?” he asked Shinji, after everyone had cake on their plates.

“Last I heard, yes. He needs a few sols rest, but he’ll be fine.”

“I sent him a message expressing our concern and our thoughts for his speedy recovery, but he hasn’t replied yet.”

“Give him a sol or two.”

“I’ll ask Pete, also. The Columbus 5 people really performed this sol.”

“They did, it was quite impressive. They’re pretty young on average, too.”

“And it didn’t matter. We’re getting some good people.”

“Definitely.”

Will headed back to his table with his cake, even though he still hadn’t eaten supper. Marshall was eating his piece enthusiastically and asking for more; it was clear that sugar, fatigue, and excitement were a bad combination. “I had better take him home,” Ethel said.

“Okay, I’ll stay here with Lizzie a while longer.”

Ethel nodded. She squeezed his arm affectionately; she could see the fatigue and stress in his face as well. She took Marshall upstairs to bed.

Will hurriedly ate his supper and cake—in that order—and helped Lizzie do the same. Then he carried the little girl upstairs. She fell asleep in his arms; she was very tired. He awakened her to brush her teeth and get her into her nightgown, then laid her in her bed.

When he came out of Lizzie’s bedroom, Ethel was seated on the couch in their little living room. He smiled and sat with her.

“A birthday from hell,” she observed.

“Yes, I’m afraid it was. But it could have been worse. No one died, and we now know that at low temperatures, nickel-iron meteorite can shatter into razor-sharp pieces. I’ve never seen such a thing happen before, but I’ll be sure to watch for it.”

“It’s amazing that he brushed into such a thing.”

“I hope he’s alright. I sent him a message, but he hasn’t replied yet.”

“Are you worried about it?”

“Yes. His first name ‘Ruhullah,’ according to his biography, was given to him, when he was born in 1997, in honor of Ayatollah Ruhullah Khomeini. All reports indicate he’s a good Shi’i Muslim; and no doubt he knows I’m a Bahá'í.”

“But that should make no difference.”

“I hope it doesn’t.”

“Understandable. Speaking of Bahá'í, I have a little gift to give you.” Ethel reached down and picked up a card and handed it to him. He looked at it. “What is it?. . . . Oh! Does this mean. . .”

“I’ve decided to become a Bahá'í, like you and Marshall. It’s a declaration card.”

“So I see! What a surprise! You never asked me a question or anything; are you sure you’re ready?”

“Yes. I talked to Molly and read a lot. It’s not like I’m giving up Christ or Christianity, after all; Bahá'ís accept Jesus Christ as a divine messenger and Christianity as a divinely revealed religion. I suppose I accept Jesus more than I did before.”

“That’s true. How will we enroll you?”

“Molly said she’d talk to her local spiritual assembly there in Stamford and take care of it. She suggested I send them an email about why I’m becoming a Bahá'í.”

“That would work.” Will smiled. “Welcome to the Bahá'í family, my dear.” And he kissed her.

4

Arrivals

Late July 2044

David Alaoui sighed a great sigh of relief as a series of screens in the bridge of Magellan 1 lit up with data from the two automated cargo vehicles that had just aerobraked into orbit around Venus. “So, that’s both of them?” he asked

“Affirmative,” replied Sally Greenleaf. She looked over the data on her console. “They’ve both performed a nominal aerobraking; they’re in our orbit. It’ll be another hour before we have all the GPS data.”

“Mission Control will have a plan for rendezvous tomorrow, then.”

“Which means we’ll be able to proceed with set up of the hydroponics pretty soon,” noted Juliette Delafontaine, with a smile. As the mission horticulturalist, she was looking forward to setting up the first greenhouse in interplanetary space.

“Anything else we can do here” asked David.

Sally shook her head. “I’m on watch tonight, but the rest of you can go to bed.”

“Okay.” David looked at his watch; it was 2 a.m. local time, which meant it was also 2 a.m. in Europe. “Sounds like a good idea to me.”

They all wished each other good night. Ludwig floated up the shaft connecting the *Guinevere* to the *Amazonis;* like Sally, he slept in the other ITV. Juliette headed up the shaft to her bedroom on the third level. David tarried a moment to review the data on the screens one more time; Sally reminded him that if something happened, he would be awakened immediately. About twice a week some sort of glitch was sufficiently significant for the ITV’s computers to awaken him. Then He glanced around the tiny

bridge and the small common room on the ITV's second level where they shared their meals and meetings. For three and a half months they had put up with cramped quarters; the first or bottom level of each ITV was a large cargo bay and storage area for oxygen and methane propellant. The top or fifth level was stuffed with food, leaving the second level for two bedrooms and the third level for laboratories. But now that they had arrived, the cargo bays could be emptied and converted into living space. That would be a welcome development.

David pushed himself across the room to the shaft and then up it to his bedroom on the third level. Once in his room, he glanced out the window at Venus, huge and so bright it made his eyes water. He'd have to close the window's shutter before going to bed, it was so bright. But first he secured his attaché on his desk, turned it on, and wrote an email to his friend Will Elliott, Commander of Mars.

Dear Will: As I'm sure you know, fifteen hours ago we aerobraked into orbit around Venus. Both the Guinevere *and the* Amazonis *performed flawlessly. The ACVs arrived about an hour ago and they aerobraked according to plan as well. So here we are! Four human beings, two interplanetary transit vehicles, and about sixty tonnes of stuff—everything from frozen dinners to hydroponics to airplanes that fly in the atmosphere of Venus. We're well equipped and should be extremely safe, since we have so many redundant systems.*

I can't help but think back to Columbus 1 and make comparisons with our flight to Mars almost ten years ago. It's hard to believe it's been so long! In both cases it was a flight to the unknown. But the differences strike me more sharply than the similarities. Columbus 1 went to the surface: Magellan can never do more than orbit Earth's sister

world. When I look out the window at Venus I have a wholly different feeling than when we were orbiting Mars. The latter world was inviting; you looked at its old, cratered surface and you thought about the water and other resources available to you and wondered whether the day would come when millions would live there and build a great nation. But when I look at Venus I think: smog, poisonous clouds of sulfuric acid, heat greater than any oven, temperatures that can melt lead and aluminum, and pressure equal to the ocean depths. I see death instead of life. Even searing Mercury is more inviting than this place. I shutter in spite of our safety features.

"And those differences have profound implications for the futures of these missions and these worlds. Our presence in Venus orbit is controversial; many more people cannot imagine that the advantages of science outweigh the dangers to us. We will accomplish ten times as much as could be accomplished from Earth alone; that is indisputable. But ten times does not seem enough. Even if we are able to leave the Guinevere *here to serve as the nucleus of a permanent station, there is no guarantee people will keep coming. None of the four of us plan to stay and cover the four-month gap between Magellan 1's departure and Magellan 2's arrival. I suppose eventually this place will acquire several ITVs and the resources for a permanent crew, but it is not clear that even then, a crew will remain. I look at the romance sprouting between two of the crew members here and think that they will never stay in consequence, like they might on Mars. I may even recommend to them that they apply for Columbus 7; Mars is the place for married couples in the astronaut corps.*

"All these thoughts weigh on me as we start our mission here. It is immensely exciting, but it will never be the same as Mars. With any luck, we will achieve some very

important breakthroughs. Each ITV has an inflatable greenhouse patterned after the prototypes used in low Earth orbit and at Gateway. With very efficient recycling we will make possible an expansion of Magellan 2 to six crew. The various telerobotic rovers on the Venus surface—all dead, at the moment—have collected thirty kilograms of very interesting samples, and the Samandar 2 Sunwing still flying has another thirty kilos of samples on board. If we can get them and another forty kilos up into orbit, we will have achieved a particularly remarkable milestone. It means Magellan 2 can bring a geology lab to orbit and samples can be studied actively here, which will greatly speed up exploration of this place.

"And who knows, maybe a permanent orbital population will be possible. If we can lift geological samples to orbit, we can haul up other things as well, like deuterium. As the cost of sending things from the Earth's surface to interplanetary space keeps dropping, it'll be cheaper and cheaper to build a really large station up here. So perhaps my pessimism is misplaced. Long term, this world may have a human future.
"I'm looking forward to hearing from you, sister world to sister world. I hope all is well on Mars, as well as with you and your family. Kiss Ethel for me. David.

Will was sitting at his desk when he received the message eight minutes later. He read it carefully and had to smile to think of his friend. But he wasn't in the mood to reply right away. David hadn't mentioned that Magellan 1 was stealing Mars's thunder. Of course, there was nothing to be done about it; Magellan had arrived at Venus on July 20, 2044 because that was the time celestial dynamics and the mission's fuel supply dictated. The arrival of Columbus 5 was similarly constrained, though in its case the decision to visit 2020JB had delayed its usual arrival time from July 15 to July 20.

Further embarrassing Mars and highlighting Magellan was the near disaster that had occurred three weeks earlier when ACV-1, flying from Earth to Mars at an unprecedented high speed, had a software failure that nearly doomed the vehicle and its cargo, including Biome 1. In contrast, Magellan's two manned and two unmanned vehicles had aerobraked flawlessly.

But Will couldn't complain about any of that to his friend. He hit reply and recorded a warm, gushy congratulations, then sent it. He didn't have much time; the shuttle *Hadriaca* was about to hit Mars's atmosphere with six crew on board. He headed into the Bridge for atmospheric passage, which was quick and routine. In a mere three minutes the *Hadriaca* descended rapidly to a landing on pad 6, spouting a hundred meters of orange-tinged blue flame. As it approached the ground the flame shortened and weakened, but it kicked up a cloud of dust and snowflakes anyway. Then shuttle settled onto the ground softly; a safe and smooth landing.

Before the dust and ice fog cleared, two Conestogas hurried over to the vehicle, circled it, and inspected it. Cameras carried the images to the Outpost's bridge, where Érico, who was the capcom and local "Mission Control," scrutinized them closely. Meanwhile, inside, the six crewmembers were powering down the vehicle and suiting up. Once Érico gave them a clearance, the first two hopped out, singing.

This land is your land, this land is my land,

From Tharsis Montes to the Hellas Basin,

From the cratered highlands to the Mariner valleys,

This land was made for you and me.

Who's that?" said Érico to Will, surprised.

“Ah. . . it sounds like Boris Ivanov,” Will replied. He glanced at the passenger manifest. “Yes, it’d be him.”

Boris began to sing the song again and a second voice joined in; that of Tatiana Ivanov, his wife. Then Taehun Kim and Kimberly Irion joined as well as they stepped out of the airlock.

“What is she carrying?” asked Érico. Then he answered his own question. “Isn’t that a so-called ‘Mars flag?’ ”

“I think so; the Mars Exploration Society uses it,” replied Will. “This is going to be an interesting bunch!”

“They’re pretty zealous!”

“It’s my fault,” replied Will. “I’ve been insisting for years that we had to recruit younger people who would be more willing to stay long term, people who work their way up through the Mars Commission in its support staff or who have spent time on the moon. The median age of Columbus 5’s personnel is 28; the youngest yet. And most of them have spent at least three years working for the Commission or in one of the support teams before beginning their training. They were in college when Columbus 1 arrived and they’ve directed their careers based on coming to the Outpost.”

“I had no idea,” said Érico. “This is going to be an interesting change!”

“I hope it’s just ‘interesting,’ ” replied Will, with a smile.

They began to load the Conestogas with luggage and high-priority cargo. Pete Theodoulos, who had piloted the shuttle, came out last with the copilot, Zachary Hersey. When the two vehicles were loaded up and began to head to the garage, Will sent an email notifying the “buddies” of the six to head there, and walked over himself.

All the way he contemplated the people he would be meeting. Pete Theodoulos, a Canadian of Greek background, was in his early thirties and had been a Canadian Air Force pilot; he had acquired a Ph.D. in volcanology and had spent parts of the last five years on the moon. Zachary Hersey was one of the four Americans on board and was the informal head of the American team; he was a Prospector specialist. Taehun Kim, the first Korean on Mars, was a metallurgist and their new waste management technician; they now created so much waste that they needed an expert to handle it. Kimberly Irion, another American, was an eobiochemist—she was still teaching the subject at Stanford, even during the flight to Mars—and a well-published expert who had led the effort to reconstruct the chemical pathway that permitted Martian photosynthesis. Finally, there was Boris and Tatiana Ivanov, the two Russians on Columbus 5; he was a sociologist who had retrained to serve as a geology laboratory technician—work still needed more than sociology—and she was an architect, interior designer, and an accomplished artist and poet.

They were a remarkable group. And the six of them were only a third of the Columbus 5 crew; the *Apollonaris* would land with six more about noon and the *Elysium* would follow with the last six in late afternoon. The celebratory dinner was already being prepared.

The first Conestoga entered the airlock, then a minute later the inner door opened and it drove into the garage. Will watched through a big window separating the garage from the tunnel connecting Joseph Hall to Renfrew Hall with Carmen and Enrique, who were “buddies” for Kimberly Irion and Taehun Kim. Once the inner airlock door had

closed, they entered the garage; it was a precaution they took to avoid accidental depressurization injuries.

The rear airlock door opened and out stepped Kim Irion, Mars flag in hand. Will had to smile. “I’ve never seen one of those before, Kim. Welcome to Mars.”

“Thank you, Commander.” She was excited; almost giddy. She shook his hand enthusiastically. “Is there any possibility we can run it up the flagpole?”

“Ah, no, not right now. We’d create a diplomatic incident. But maybe in the future.”

“Okay.” She sounded disappointed. She moved out of the way to let the next passenger out. Will extended his hand to him. “Welcome to Mars, Taehun. We’re delighted to have you here.”

“Thank you, Commander, I am ready to serve.” They shook hands.

Pete Theodoulos came out next and extended his hand to Will.

“Welcome, Pete, and congratulations for a remarkable voyage.”

“Thank you, Commander. We’re all very happy to have arrived safe and sound.”

They shook hands. “We’re delighted as well. The flight, aerobraking, and landing are the most dangerous parts. Mars is a piece of cake by comparison. How was Phobos?”

“We really enjoyed the visit; it was fascinating. And as you know, the moon now has a very nice habitat buried under four meters of regolith.”

“It’ll be a great assistance, as will Deimos Station and the enlarged Embarcadero Station.” The last was a collection of vehicles and habs in an elliptical 24.6 hour orbit around Mars, where all arrivals and departures to and from Mars occurred. Will turned back to the Conestoga to help them pull out the luggage and cargo. Roger Anderson, who

had been driving the ranger and was Pete's "buddy," helped as well. There were a dozen carts available and they loaded three with personal possessions; the other three were loaded with priority cargo.

Meanwhile, the other Conestoga pulled into the garage and Will went over to welcome the others. "Zach, welcome to Mars." Hersey was a handsome man with carefully blow-dried hair, a low-cut shirt that showed a lot of his chest hair, and tight pants. Will was a bit surprised; everyone else was wearing a uniform.

"Commander," he replied, offering his hand. They shook; Hersey had an intentionally weak grip. "I'm delighted to be here."

"It's good to have you. You have a reputation for driving Mars Prospectors from Earth with intuitive exactness."

"Thank you, and I enjoy construction as well. I'm looking forward to getting the biome set up."

"Excellent." Will leaned past Hersey to shake hands with Tatiana. "Welcome to Mars. We need your interior design expertise."

"You're very kind, Commander. Delighted to be here."

"Boris, welcome to Mars. Your sociological research on the lunar station has been fascinating."

"Thank you, Commander. We're very happy to be here."

"Commander, any possibility we could go to our rooms via the biome? Is it pressurized now?" asked Pete.

"Yes, we finished pressurizing it yestersol," agreed Will.

“I’d like to see the source of our grief, three weeks ago,” added Tatiana, alluding to ACV-1’s near disaster

“Oh, don’t remind me!” groaned Will. “The *Olympus* chased it for ten sols before it caught it and secured the cargo! We had never sent a Mars shuttle into an orbit so high above Mars before!”

The carts were loaded with luggage and everyone had one to push. Will led the procession of people and carts across the industrial area and out the building’s north airlock. They entered a steel-lined tunnel four meters wide, three high, and ten long that angled downward steeply, though in Martian gravity the carts were not hard to control on the ramp. At the far end they opened a door and found themselves in a big open space.

Several gasped a bit as they walked in; Will smiled, pleased by their impressed looks. They had entered a circular enclosure forty meters across. Outside the hemispherical skin—a transparent teflon FTP film and tefzel with a mesh of kevlar cables running through it every meter—shiny metal walls rose ten meters all around them. The enclosure soared thirty meters above the center of the space. The biome’s plastic bottom rested on a duricrete layer interrupted periodically by small drainage openings and larger holes containing the tops of steel I-beams. Zach stood on the plastic skin over one of the holes and looked down at it.

They walked to the middle of the biome to admire the huge, open space. Their conversation echoed off the taut walls. “The bubble’s barely 1.5 millimeters thick,” said Will. “It’s enclosed by an outer dome of ultraviolet-absorbing plastic we made here. It’s rated for inflation to 0.05 atmospheres and rests almost a meter beyond the biome to

protect it from dust and capture any leaking air. Powerful pumps will be able to put most of the air back inside, giving us extra protection against depressurization."

"Where's the outer dome? All I see is the metal," said Zach.

"The outer dome is beyond the metal wall. If you look up, you can barely see it." He pointed; Zach looked and nodded. "First we dug a big hole. That took six months. Then we installed the outer dome to hold in enough heat and pressure to allow duricrete to set quickly and to simplify construction in spacesuits. We installed two circular nickel steel walls a half meter apart and poured a mixture of eolian dust, sand, and water into them, which set to make duricrete. The wall is thirty centimeters larger in diameter than the biome. Eventually the inner sides of the biome will be covered with vinyl panels to protect it and to give climbing plants something to grab onto."

"Underneath?" asked Kim, pointing to the floor.

"A duricrete layer, a meter of gravel with steel support beams strategically placed—you can see the tops of them—then a thin nickel-steel layer with a rebar-reinforced duricrete floor on top, on which this biome rests. The gravel layer provides drainage if the biome leaks, there are sensors to detect gas and moisture buildup underneath, and we have an access port."

Zach pointed to a nearly invisible, inflated bubble inside the biome opposite them. "And that's a future building?"

Will nodded. "Take a good look. There will be another one where we entered the biome, but it hasn't been installed yet. The crescent-shaped buildings will hug the southern and northern quarters of the biome respectively. The area between them, where we're standing now will be called 'the yard.' Each building bubble is an airtight

superstrength plastic mixture identical in composition to the biome's dome. It's about thirty meters long, six meters wide at the north and south ends, and widens to twelve meters in the middle. Each is three stories high, including the basement area. Basically, we build a building inside each bubble, leaving openings in the walls where we want windows, and erect vinyl siding outside the bubble, leaving the bubble to serve as an airtight membrane in between the two walls."

"Like nested Russian dolls," commented Tatiana.

"So, where we're standing now will be underground?" asked Zach.

Will nodded. "Yes, the yard will have a steel box with a watertight plastic liner filled with two and a half meters of soil; plenty for big trees. The buildings will have similar boxes of plastic-lined steel above them filled with soil for growing food; the soil and plants also provide excellent radiation protection for the housing underneath. The dome has almost 1,400 square meters of surface area, including the overhang; the upper gardens will project two meters beyond the edge of the building, providing additional radiation protection and shaded areas for play and for shade flowers along the edge of the yard."

"We'll also seed the ground inside the soil boxes with bacteria, so that water trickling through will be purified," added Taehun. "The biome will recycle all our water and sewage."

"Supplemented by solar distillation," added Will.

"God, this will be a lot of work," said Kim.

“For now, it’ll be more work than the previous system of concrete buildings and greenhouses,” said Tatiana. “But once we learn how to make them and perfect the designs we should be pretty efficient.”

“This system was sold to us on the grounds it’d be simpler and faster,” added Will. “But like any good idea, it took on a life of its own. Safety systems made it much more complicated. The result, however, should be much more pleasant than the old system because people will be living in a small park, rather than living in igloos of plastic, sandbags, and ice with small windows and having greenhouses stuffed with plants to walk through.”

“How flexible is the final layout of living space?” asked Zach.

“Very,” replied Will. “We can’t finalize everything until everyone is here, has gotten to know each other, and has decided what sort of space they want, especially what they’ll pay for.”

“We’re finalizing building materials, too,” added Tatiana. “The equipment that is arriving will bring capacities to make better wallpaper with brighter colors, for example, better ceramic tiles, a wider variety of furniture, etc. The use of the space has a lot to do with whether any of the equipment is lost and how quickly we develop its capacities.”

“And we have two of these biomes? What will we do with all the space!” asked Pete.

“The second one won’t be finished until Columbus 6 arrives, and Columbus 6 will need all the space,” replied Will. “It’ll arrive with the biomes for Columbus 7.”

“Commander, I may need to talk to you about my housing plans,” said Zach. “They may change.”

“That’s fine. We’re developing a plan for creating and selling condos to everyone who wants them.”

“Good,” said Zach. “I may have plans to purchase.”

They lingered in the biome a few more minutes, then walked into Clarke Dome. They crossed it, then the party began to break up and go in different directions. Will went back to the bridge for a few hours until he had to return to the garage to greet the next wave of arrivals. Lal was waiting as well.

“Is she on board this flight?”

Lal nodded nervously.

“Then good luck, my friend.” Will offered his hand and they shook.

The inner airlock door opened and the conestoga pulled into the garage. The small group that was waiting entered the garage and Will approached the vehicle first. The door opened and waiting to step out was Radha Bhatt.

Will smiled and stepped out of the way, gesturing Lal to step forward instead. He hesitated, not wanting to get in the Commander’s way, but when he saw Will was staying out of his way he stepped forward. He offered his hand. “May I help you step out of the conestoga?”

“Thank you.” Radha smiled shyly. There was no need for either of them to introduce themselves to the other. She took his hand and stepped down onto the garage floor.

“Did you have a good flight?”

“Yes. It was a bit crowded, but pleasant.”

“I think you will find the Outpost more spacious.”

"And more green."

"Definitely more green. Here, I'd like to offer you this." Lal held up a small box.

"Oh, you are very kind." She opened the box; inside was a gold necklace.

"This is beautiful! Thank you, Lal, this is very kind of you!"

"It's Martian gold, made right here. Have you luggage I can get for you?"

"Yes, in the back. I gather I have a temporary residence, until the wedding."

"Yes; Habitat 3, room C4. It even has a window." Let's get your luggage." Lal led her back inside the conestoga; Radha never shook hands with the Commander, who was busy greeting other arrivals anyway.

About 4 p.m., the third shuttle landed as well. The safe arrival of Columbus 5's eighteen crew was a cause for celebration. Everyone came to Renfrew's Great Room at 6:30 for a reception, to be followed by the most sophisticated and elaborate banquet that could be produced on Mars. Ethel showed up right on time with Marshall and Lizzie. The little boy, now 4 ½, immediately headed to the corner to play with Sam Anderson, who was 3 ½. Lizzie, six weeks short of her second birthday, joined them, and soon Corazon, born just twelve hours after Lizzie, joined her. Lisa Kok sat nearby with Anna, now six months old, to watch the kids. She was joined by Jennie Dunbar and her newborn son, Jake.

Reasonably free of her children, Ethel began searching for several particular arrivals. The first one she spotted was short, with black hair and a Mediterranean complexion, about 40 years old. "Ruhullah, I presume?" she said, walking up to him.

"Yes, that's correct. Whom am I meeting, please?"

"Ethel MacGregor." She extended her hand to him.

“Oh, pleased to meet you.” He kept his hand away from hers and even pulled it a bit farther back. “It’s quite an honor to be on Mars, with such well-known and talented people.”

“Thank you.” Ethel put her hand down, uncertain what the problem was, though she then remembered that many Muslim men would not shake hands with women to whom they were not related. “I hope you had a reasonably comfortable flight?”

“Yes, as well as can be expected. I’m very excited to be here. There’s an incredible amount of work to be done.”

“Indeed. I was wondering about another matter, Dr. Islami. You may have seen on the schedule that Sunsol morning we are planning an interfaith worship service at 11 a.m. Madhu Gupta-Anderson and I are planning it. We were wondering whether you were willing to select a passage from the Qur’án on interfaith cooperation and discussion—it could be on tolerance, respect for others, love for others, or related themes—to read at the service.”

“I see.” Ruhullah considered a moment. “Is this a Bahá'í-sponsored event?”

“Bahá'í sponsored?” Ethel was surprised. “No, not at all. The Commander has appointed a committee of two of us to plan it.”

“Will there be Bahá'í involvement?”

“Well, I am a Bahá'í, and we will include Bahá'í scriptures.”

“I see. I apologize, but I think I will have to decline your kind offer. You see, my marj’ah—Ayatollah Najafi—has said that it is appropriate for Muslims to mix as equals with other peoples of the book—in other words, with Christians and Jews—in an

interfaith context, but it is not appropriate to mix with infidels in that context as well, as it would imply equality of Islam with infidelity."

"I see. Thank you for letting me know; we will be sure not to invite you to participate in other interfaith gatherings, then. But you are always welcome to attend them if you desire." She smiled, seemingly undisturbed by his comment.

"I mean no offense. This is the teaching of Islam."

"I understand. Enjoy the reception; I'm sure I'll see you around." She turned and walked away. Islami watched her go, wondering why a European woman of middle age would ever join such a crazy religion as Bahaism.

Eammon also watched Ethel; he had been within earshot and heard the conversation. He hurried after her. "Ethel, did you say you are a Bai-hai?"

She turned to him. "Yes, Eammon, I became a Bahá'í several months ago."

"Oh, I had no idea."

"Well, I didn't announce it publicly. It's a fairly private matter, one's faith, don't you think?"

"I suppose. Weren't you Christian before? Or maybe I should say, Protestant?"

"Yes."

"Ah-huh," he replied, wondered what to make of a Christian leaving the fold, though at least she hadn't been Catholic. Ethel turned away from him as well, not very pleased by the sudden onslaught of negative feelings around her. She spotted John Hunter nearby and headed to him. He was fairly easy to recognize because of his American Indian features and his braided black hair.

"Dr. Hunter, I am Ethel MacGregor. Welcome to Mars."

“Thank you, Dr. MacGregor. I’ve read some of your research about polyethylene manufacture here. Very clever techniques to overcome technological limitations.”

“Thank you. I had no idea you were following such research.”

“Well, I’m a geochemist, and that means I needed to get more training in general chemistry in order to be able to provide assistance and backup to the chemical and plastic making processes.”

“Oh, of course. Well, perhaps we will work together. If I recall, you are Lakota, correct?”

“Yes; part Ogallala and part Yankton.”

“I ask because the Commander has asked Madhu Gupta-Anderson and I to coordinate an interfaith service on Sunsol, and we were wondering whether you could offer us anything native American for the program.”

“Yes. By the way, I prefer to be called ‘American Indian,’ not ‘native American.’ Legally, ‘native American’ refers to Indians, Eskimos, Hawaiians, and Samoan Islanders; and I am not a Samoan.” He smiled slightly.

“Oh, I see. I had no idea. Thank you for explaining these terms to me.”

“I’m delighted to be of help. Yes, I can offer a prayer in Lakota; is that the sort of thing you’d like?”

“Yes, exactly.”

“I would be honored to participate.”

“Excellent.” Ethel spotted Gregory Harris come into the room. Eammon made a beeline for him, much to her disappointment. “If you’ll excuse me, I now see the other person I need to invite to the program. Perhaps we can speak more later.”

"Sure."

Ethel turned away from Hunter and walked over to Harris. He seemed slightly relieved that someone else was coming to speak to him. "Mr. Harris, I am Ethel MacGregor."

"Please call me Greg; everyone does."

"Thank you. I'm Ethel." She offered her hand with a slight hesitation, since Ruhullah had rejected it; Harris shook it warmly.

"I'm very pleased to meet you. You've been here the longest, right?"

"Ah; I'm one of the first six to arrive who is still here, yes."

"You were the second person to walk on Mars, after Laura Stillwell."

"No, that was David Alaoui. Shinji was third, so that would make him the record holder. Then Sergei, then me, then Will."

"Ah, I see. I got confused."

"I really don't keep track of it. Did you have a good flight?"

"Yes, absolutely. As you probably know, we went to Deimos to set up the station there. It was a fascinating experience."

"I very much enjoyed my trip to Phobos; I'll always remember it. Greg, as I understand it, you are a former Catholic priest."

"Yes, that's correct. I did not come here as a priest, of course; I am here to serve in any capacity I am needed."

"I understand that. Your experience as a priest makes you able to serve in various religious ways as well, though, and that would be welcome. Madhu Gupta-Anderson and

I have been asked to plan the interfaith service at 11 a.m. on Sunsol, and we were wondering if you would like to participate."

Greg smiled. "I'd be delighted! What did you have in mind?"

"Could you offer a biblical text on a subject related to interfaith cooperation and discussion—it could be on tolerance, respect for others, love for others, or related themes. If you could offer a brief explanation or discussion of the passage, also, that would be an excellent addition."

"Sure, that's easy. How many faiths will be represented?"

"So far, Catholicism, Protestantism, Hinduism, the Bahá'í Faith, and American Indian beliefs. I'm still looking for others."

"You can count me in. This is just the sort of activity I want to support. You might want to speak to Taehun Kim, he considers himself a Pure Land Buddhist."

"Excellent. Thank you, I will." She had seen him come in and began to look around. Greg pointed. "Oh, thanks." Ethel hurried to find Kim. Harris watched her go.

Eammon had been patiently waiting for Ethel to leave. "May I ask, Father—well, that's presuming my question—are you still ordained?" he asked.

"Yes. I was ordained about eight years ago and four years ago I asked to be relieved of my priestly duties because I was becoming busy with my career as a nurse, but I never renounced my vows."

Eammon smiled. "Excellent. We do have a supply of consecrated host and wine; it was just shipped up. I was ordained a deacon many years ago and was given permission by the diocese of Houston to distribute the Eucharist here. In this manner we have managed to hold mass about once a month. But it will be much better with a priest here."

He smiled. “To think: you can effect the transsubstantiation of the elements right here on Mars!”

“Yes, I can work the magic,” replied Greg, a bit startled by Eammon’s enthusiasm. “But perhaps I shouldn’t put it that way. I was hoping to host a mass every few weeks. I gather of the fifty or so of us here, about ten are Catholic.”

“That sounds about right to me. Father, can you also hear confessions?”

“Yes, of course. I think if I get very involved in priestly duties, I should speak to the Commander about it; I wasn’t flown here for that reason. But I’m off duty on Sunsols anyway.”

“Exactly. Oh, Father, I am so excited to have you here. There’s one Catholic woman here who might appreciate your support; Jennie Dunbar. She has a newborn baby.” He pointed to Jennie. “Jake was born four weeks ago, about the same time we almost lost the automated cargo vehicle; it made for an exciting twenty-four hours, I assure you. Her husband, Kevin, is divorcing her. He basically abandoned her.”

“Really? How unfortunate. Perhaps I should go speak to her.” Greg started toward Jennie, who made a good excuse to get away from Eammon. When Eammon began to come along, he shook his head. “Priestly privacy, please.”

“Oh, sorry,” replied Eammon.

Greg walked over to Jennie Dunbar. “I love babies, and yours is so small; how old is he?”

Jennie smiled. “Jake’s just twenty-seven sols old.”

“His formal name is Jacob, then?”

“Actually, no; we gave him Jake as his formal name. We both liked it.”

“He’s a beautiful child; can I hold him?”

“Yes, he’s very good with strangers. Everyone here holds babies, so they get used to it.” She handed Jake to Greg. He took Jake very tenderly and held him close.

“I love babies. Among other things, I’m a nurse, so I have a certain amount of experience with them.”

“You’ll get all the experience you need, here. I’m Jennie Dunbar.”

“Honored to meet you. Greg Harris.”

“American?”

“Yes, from Oregon originally.”

“And you’re a nurse?”

“Yes, but I’m here to serve. Everyone else here is a mission specialist; well, I’m a mission generalist! Among other things, I’m in charge of all housecleaning and the laundry.”

“Wow, that’ll wear you out!”

“No, we have a team of new robots in the cargo. Have you seen the Schoonmaker model 25 at work? It’s shaped like a big sea tortoise on wheels, a meter in diameter. It has a vacuum attachment in front. It moves forward, vacuuming the floor as it goes, and it has a little arm that it can use to pick up stray objects off the floor and place them in a basket in its back. Underneath it has a rotary wet mop that pulls water from an internal tank and washes the floor. Finally, the heated and filtered vacuum exhaust is expelled out the rear, where it helps dry the floor. Very clever; they’re now on sale to the middle class on Earth, the price has come down so much. I’ve got four of them. Then we have a Polly model 170 for the laundry room; it can take a basket of laundry, sort the whites from the

colors, spray bleach onto stains, transfer loads to the drier, transfer those loads into the ironing and folding unit, then stack everything neatly. It's something to see. Satursols I switch hats, though, and will operate the beauty salon. I can provide haircuts, trims, perms; you name it."

"Really? Incredible!"

"And what do you do?"

"I'm the child care specialist here. I run day care, though currently I'm on maternity leave. Except right now I'm watching the kids out of reflex!"

"Well, that's not fair. Why don't you leave Jake with me and I'll introduce myself to the kids. Get yourself a drink, something to eat, sit and chat for a little while; I can watch them."

"No, that's alright—"

"Seriously."

"Oh, really? Maybe I should." She considered, then stood up. "Alright, I'll go get something. But I won't be far."

"Don't worry, I can handle children. Take your time."

"You really are very kind, Greg." Jennie stood and walked to the refreshment table. Greg cradled Jake in his arms and watched the kids playing. Eventually he walked over, sat with them, and played with them as well. When Will came in, he saw Greg with the kids and hurried over.

"So, you've met our youngest astronauts!"

"Yes. And which ones are yours? Let me guess; him and her."

"Correct. Are they being good?"

“Yes, so far. But don’t worry; I can watch them for now.”

“But you should mix with the crowd.”

“No, the crowd will come mix with me anyway. God will provide.”

“Okay.” Will smiled. He headed to the refreshment table. Ruhullah was getting another carbonated water for himself. He watched Will a bit suspiciously as he filled his glass with the same. “Have you completely recovered your health from the accident on 2020BJ?” Will asked.

“Yes, Commander, thank you, I have.” Islami seemed a bit stiff and uncomfortable.

“Good. I was very concerned about you. A group of us said prayers for your health the next sol; it was Sunsol and we were scheduled to pray together anyway, so we focused on your needs. I am very impressed by your study of Noachian magnetic stripes. I think your theory of sporadic crustal spreading is persuasive. Have you thought about what sort of sampling pattern would yield better data for you?”

“Indeed I have, Commander. There are seven magnetic zones in particular that should be sampled to confirm the spreading pulses I’ve proposed. Most of them can be reached if the Pisces Trail is extended westward as planned. The trail would need minor deviations in the proposed route or some side trips to sample them.”

“You should write up a proposal and get it to Roger Anderson right away. He’ll be working on the road-extending schedule in a week or so. I’m not sure we’ll have Prospectors available to sample the spots.”

“Thank you, I’ll talk to him.”

“Good. Dr. Islami, I want you to feel comfortable to come to me about anything. We try to be a big family. We try to be friends here. So please, feel comfortable to speak to me.”

“Thank you, Commander. I appreciate the sentiment and I’ll keep it in mind.”

“Good.” Will could see Islami was keeping an emotional distance from him, no matter what he tried. He nodded a goodbye and returned to the refreshment table, then mingled further.

John Hunter sought him out. “Commander, I have a question for you.”

“Certainly; what can I do for you?”

“As you can see, I’ve been growing my hair back; NASA wanted it cut for training and the launch. I hope you have no objection. The traditional way that many of my people wear their hair is long, with braids. It’s cultural.”

“I have no objection, John. If you can fit it in your helmet comfortably and safely, then I have no problem with it.”

“Thank you, commander. I have another question for you. I have brought a sacred pipe with me and a small quantity of tobacco. It isn’t any kind of tobacco, it’s the traditional kind my people grew. It seems to me the Mars dome is large enough to smoke a pipe in, if I wanted to do so. The biome will also be large enough for a small amount of tobacco smoke.”

Will thought. “Yes, those are the best choices, I think. Habitats are rather small and their air purification systems may be strained by a lot of tobacco smoke. I have no objection to traditional ways or traditional ceremonies here as long as they do not cause an endangerment of any sort. The Outpost is no longer a small place; it now has hundreds

of cubic meters of breathable air, and in the next two years that number will expand to thousands of cubic meters. We can be far more flexible now than we could have been six or eight years ago. We also have a much larger human population and it is more diverse. We have to accommodate that reality as well. Or perhaps I shouldn't say 'have to' because that sounds forced. We can afford the costs of diversity better and will gain more benefits from diversity now than in the past."

"I am very happy to hear it. It is a great honor to represent native, indigenous peoples on Mars. It is also a burden that I feel."

"Many of us represent a people or a nation, so it is a burden you share with others. Let me ask you this. What do you wish in your heart to accomplish here?"

"To accomplish; do you mean besides the science?"

"Besides science, in addition to science; or it can even be the science itself. What is your cherished wish?"

John thought a moment. "To feel the spirits of the land. I don't know if that makes sense to you. This is a concept beyond mother nature, which is the white idea that is a bit similar. For the Lakota, the land is sacred; it is alive, it is inhabited or peopled you might say. That is as true of Mars as of the Earth."

Will considered John's thought for a moment. "If you can, share your experience with me. Because I dearly wish I could feel the spirit of this world as well. I love it too much. To me, Mars is not a mother nature. Mother nature feels green and verdant to me. Mars is a father nature, a powerful whirlwind, a cloud of reddish dust."

"Perhaps you have already felt the spirit of this place, then," said John, with a smile.

Will considered the idea. “I would think this place has to feel different from the Earth because there are no human ancestors here.”

“Perhaps. But there are already two dead humans who have left something here, not to mention your mother in law who is honored by the rock structure on top of Boat Rock. And there is the spirit of the fossilized life. It must contribute something ancient and primal.”

“Definitely, tell me what you feel, then.”

“If I can, I will share it. Normally I would hesitate, but I can see these matters of spirit have an importance to you. I will try.”

5

Vivification

Aug. 2044

On their first Sunsol morning after Columbus 5's arrival the portion of Mars's population inclined to worship their Creator—26 of 47 adults—gathering in Clarke Dome for an "open air" interfaith devotional program. In spite of the strangeness of the program to everyone, it was exciting to worship together. Five of the six religions on Mars were represented, as was humanism. An unexpected treat came from the three pairs of canaries that had been flown to Mars on Columbus 5 and had been released into Clarke the sol before; they sang at various times during the service. Afterward the participants walked to Renfrew Hall for lunch, instantly swelling the great room's population.

"I was very moved by the Bahá'í reading," Enrique Delrio said to Ethel. "How did it begin? Be generous in prosperity. . ."

"Be generous in prosperity and thankful in adversity," replied Ethel. "It's one of my favorite passages as well. Something I like to meditate on."

"It's very moving; could I have a copy?"

"I'll email the text to you."

"It's one of my favorites as well," added Will, who overheard the discussion. "The part on trustworthiness sticks in my mind, and looking on a neighbor with a 'bright and friendly face.' I try to do that."

"Some time could you tell me a bit more?" Enrique asked Ethel.

She nodded. "Of course, I would be happy to."

"I may want that reading at the wedding," added Radha. "Of course, I'll have to see what Lal says."

He smiled. "It would be fine with me, my dear. It'll be a Hindu wedding, but it has to have other elements, since it has to be for our friends as well."

"Definitely," agreed Radha. She smiled at him.

Will turned to Silvio Diponte, who had walked over to him. "How was the service?" Silvio asked.

"I think it went well," replied Will. "Come some time. It looks like we'll try this every other week."

"Perhaps I will, some Sunsol. This afternoon we'll be pulling cargo out of the shuttles. By suppertime we should have your orders ready for pickup."

"Including my three rose bushes?"

"I'm referring to the packaged items. You'll have to get the roses from Lisa. Why did you order three rose bushes?"

"My parents always raised roses, so I used to as well; it's just part of what home ownership means to me. Now that we've been here eight years and the ecology's well established, I was told that I could indeed fly up some roses, if they were certified free of a long list of microorganisms. These are."

"Interesting." Diponte didn't seem to know what to say about the Commander's hobby. "I hope by tonight we'll have everything off the *Olympus.* Certainly, by Monsol noon. With any luck, we'll have the *Daedalia* unloaded by Tuesol noon and the *Apollonaris* by Thursol evening."

"Pretty good; forty-four tonnes of stuff unloaded in six sols."

“A big chunk of that is the second biome. The industrial equipment will be pretty routine, also.”

“I’m glad you can serve as quartermaster and coordinate this task. You’re better qualified to coordinate it than anyone else, and you’ll save me a lot of grief.”

“It’s my grief instead! No, that’s fine. I spent part of yestersol afternoon looking through the basement area of Habitat 3. Needless to say, I don’t want the temporary store set up there; it’s off the beaten path, dark, and unattractive. I’d rather take over the tunnel connecting Renfrew to Clarke Dome and Habitat 4. The tunnel’s two meters wide; plenty for people to pass through and for shelves. There may be too much light there; we may want to cover part of the tunnel with shades. We’ll have to install more night lights; it’s pretty dim and cold at night right now.”

“The tunnel’s not rated for that sort of use,” noted Will. “It has no connection to life support, so the air is replaced pretty rarely.”

“I asked Lisa about that. She said they have a portable carbon dioxide scrubber. We don’t have to add oxygen; it’ll drift in through the airlocks. The tunnel has an electrical connection and it can handle the power load we’re talking about.”

“The tunnel has never had a problem with leaks.” Will considered. “Usually we keep the tunnel filled with pots of vegetables and fruit trees, but we moved them out for the arrival because of all the carts of stuff we had to move through it. They’re going into the biome, so there should be room in the tunnel. Have you decided whether to use dollars or euros?”

“Yes. Neither. I’ll sell in Mars currency units.”

“What?”

“Mars currency units or MCUs. With all the inflation lately, economists have been calling on the euro and the dollar to drop the use of cents. Japanese economists are calling for a new yen worth 100 old yen. But more important, prices in either euros or dollars will cause sticker shock, so I want to use MCUs.”

“Well, since it’s for use just in the store, I guess no one can object. What’ll it be worth?”

“Roughly ten dollars or eight euros. That’ll reverse about fifty years of inflation and take us back to 1990 prices on Earth! Bread would be a dollar a loaf and a candy bar fifty cents. But with transportation costs to Mars running about 1,000 MCUs per kilo, a 50-gram candy bar will be 50 MCUs, not half an MCU!”

“And about $500. I see what you mean about sticker shock. How will people pay?”

“The credit card payment system can be programmed to accept any currency. I’ll assign the MCU a code and a value. Simple.”

“Clever. Okay, give the MCU a try, and use the tunnel to set up the store. Oh, on another matter: the Dunbar divorce. You need to talk to both of them. It’s getting complicated.”

DiPonte nodded. “I was looking over the case on behalf of the borough on the flight out. I need to be named the borough’s official judge before I do anything. The real work is being done in the Houston courts, but since they live here and the child is here, we have to play a role.”

“Thank God you’re here to get the paperwork right. There’s a town meeting scheduled for next week. We’ll name you the Borough Judge then.”

Will spent the afternoon helping the crew unload sixteen tonnes of items from the shuttle while DiPonte, inexperienced in a pressure suit, coordinated the inventory area. Will left supper early to get the family's purchases; each person was entitled to transportation of twenty-five kilograms of items plus two kilograms for every year they stayed on Mars. Hence Will and Ethel got forty-one kilos each; Marshall got thirty-three; Lizzie got thirty-one. It was a huge amount of stuff, requiring two trips with a cart to get it all. He carefully put it in his and Ethel's room before the kids came upstairs to go to bed. After the kids went to sleep, he and Ethel went into their room to open the packages.

"Here's your new bathrobe," Will said, pulling out a beautiful green silk bathrobe.

"Oh, lovely," replied Ethel. "Thank you. Look at this outfit; won't Lizzie look cute in it?" She held up a strawberry-covered summer dress and matching top.

Will nodded. "She'll love the colors, too. What'll you do with this, now that you're a Bahá'í?" He held up a bottle of Scotch.

"I'll give it away. It'll make a nice birthday present. Here's a present for you." Ethel held up a beautiful tie.

"Oh, that is nice. It's a shame I never wear ties!"

"I know. Marshall wanted to give it to you as a birthday present."

"Then I'll be sure to be surprised."

"I think you could wear a tie on various occasions, like television interviews. Talk to Louisa about whether it'd be good for your image."

"I will." He began to pull out shirts, pants, underwear, and socks; those were the most important items he'd ordered. He began to put them in the closet. But within a few

minutes he and Ethel found that they had run out of space for more clothes. “Now what,” he said.

Ethel looked around the room. “We could put another clothes cabinet over there; there’s room. Tomorrow I’ll see whether there’s a spare we can take. But we’re going to need more space. You can’t raise a family in fifty square meters.”

“Yes, this apartment is too small for us.” Will looked around. “It’s been a nice place to live.”

“It has a lot of good memories. How much more space will we have in the biome? Fifty percent more?”

“At least, and real windows instead of portholes. It’ll be a nice development.”

With Columbus 5 safely arrived, the Outpost was palpably crowded. The Great Room was packed at meal times, the habitats noisy, the work areas cramped. It felt live a bee hive full of activity. There was equipment to unload and set up and safety training to complete; half the first month was devoted to it. There were outdoor hikes, trips in the rangers and other vehicles, industrial equipment demonstrations, and safety drills at odd times. There was even a 1 a.m. depressurization drill in Habitat 4, which housed twelve of the new arrivals.

It wasn’t until the second week when there was time to set up the store. Sometimes DiPonte labored well after midnight, putting together metal and plastic shelves and loading them with perfumes, toothpaste, chocolate, tampons, liquor, and dozens of other consumer goods. There were sections with clothing, housewares, linens, and children’s toys. The prices were shocking even if they were strange; a tube of

toothpaste was 100 MCUs. Silvio had bought the absolute highest quality knowing that 95% of the price came from transportation. Martian consumers cautiously window-shopped for a few sols, then began to buy. Diponte soon encountered a problem: some people wanted to pay with cash.

The opening of the store coincided with Aurorae Borough's first town meeting since the arrival of Columbus 5. It was held after supper on a Frisol and, except for a few parents putting children to bed, every adult attended. Will rang the Outpost's bell to mark the convening of the meeting and after a few opening words of welcome, projected the proposed agenda on the screen. Érico, as borough clerk, took minutes as the meeting proceeded, and they were projected onto another screen. When Will offered the floor to those present, he was surprised to see that almost every new arrival raised his or her hand. "Let me start a list of speakers and call on the names," Will said. "Thierry."

Thierry Colmar, the sole French addition to the crew and a Prospector specialist, rose. "I'm surprised the question of purchasing condominiums isn't on the agenda."

"That's for a future meeting," replied Will. "The legal framework is still being drawn up; there are American, European, Japanese, Canadian, and other laws to consider and we have to come up with a modification that fits our technological circumstances as well as our cultural situation. That'll be addressed in about two months."

"How often are these meetings held?" asked Zach, who was sitting next to Thierry.

"Your question is out of order; let's raise hands, please. We can hold them as often or as rarely as we want. Last year the town meeting was convened four times; the year before, twice. Ernesto."

Ernesto Alves, a Brazilian horticulturalist, cook's assistant, and accomplished oil painter, rose. "I'd like us to discuss the length of the work week. Fifty-five hours a week is really a lot, and lately we've been working over sixty. I'd prefer that we reduce it to fifty; longer hours limit our ability to socialize and become friends, which is essential if this place is going to become unified and socially strong. Longer hours also limit us artists; we're too tired to do our art."

"Let's add that topic to the agenda," replied Will, with some hesitation in his voice. "Tina."

Tina Hvitmer rose. She was a Dane, a journalist, and a geological technician. "I have a similar concern to Ernesto. I need time to do journalism as well as geology, and lately I've been doing construction instead of either one! But the issue I wanted to raise was media strategy. I think a community discuss will help us be on the same page, or at least know when we don't have to be."

"I think that's a good idea. Coordinating our media presence is complicated and tricky. Greg."

Greg Harris stood. "I think quality of life should be on every agenda."

Will glanced at the agenda, which was growing in length. "Very well, we'll add to this agenda the question of adding it to every agenda. Pete."

Theodoulos stood. "Election of borough officers is on the top of the agenda for tonight. I think it should be postponed a month or two. The eighteen of us who are new barely know everyone else, and vice versa. In two months we'll be better able to vote for borough officers better."

"Another topic to discuss. Silvio."

“I’m concerned that this free format is difficult for some of us and wonder whether Robert’s Rules of Order should be adhered to instead.”

“Oh, please, no,” replied John Hunter.

Will glared at him for speaking out of turn. “That’s everyone on my list, and maybe we should start with the last point. Comments about Robert’s Rules of Order?”

“Never liked them,” said Zach.

“Not helpful for non-westerners,” added Qingtian Li, their Chinese geologist.

“Divisive and Eurocentric,” added Ruhullah.

“Okay, anyone in favor?” asked Will. Silvio raised his hand and everyone giggled.

“Since I don’t even have a second, I withdraw the motion,” said Silvio with a smile, and everyone laughed again.

“That’s that,” said Will. “We’re moving along. Postponing the vote.”

Ken Dunbar raised his hand. “We need a judge rather badly.”

“Why?” asked someone, and after a moment of whispering he said “Oh.”

“Then let me speak,” said Érico, raising a finger first. “I’d rather get the selection of officers over with, so we will have a judge.”

Pete waved his hand and Will nodded. “Let me modify my proposal, then. Let us select a judge tonight; I think that is a fairly straightforward matter, since we only have one person here with the necessary legal training. But let’s postpone the election of the other officers a month.”

Will looked around the room. He could see nods from quite a few of the new arrivals. “I can see this is an important matter for some of you, which seems to be yet

another reflection of the sense of citizenship you have already displayed. Shall we move to a vote on the matter?" He paused, and when no one spoke he said "All in favor of selecting a judge tonight and postponing the election of our other officers a month, please raise your hand."

Many hands went up; Will and Érico immediately started counting. "Thirty in favor, so the resolution passes. I suggest we open the floor to nominations for judge." He nodded to Pete when Pete raised his hand. "We only have one lawyer here, so I nominate Silvio Diponte."

"Second," said Qingtian, who added, "Even if we don't follow Robert's Rules."

People laughed at that. "Other nominations?" asked Will. There was a long silence. "Then let us close the floor to nominations and vote. All those in favor of Silvio DiPonte as Borough Judge raise their hands."

Everyone raised their hands. "Very well, it is unanimous."

The Borough meeting marked the end of set-up and training and a shift to construction of the first biome. Everyone was anxious to get it set up; everyone wanted to move in, which was not possible, so those with seniority would get preference. But even that would set off a rearrangement of space, since their vacated apartments would be available for refurbishment and reoccupation. Hence Mars saw a great burst of construction.

Almost everyone spent some time on construction, even the geologists and exobiologists, who were going out on longer and longer expeditions around the valley. Alexandra Lescov started work on the outer shell of the buildings first so that the ecology could be set up. The insides of the buildings, inside their bubbles, would be constructed

later. By late August, as automated cargo vehicles 1 and 2 were aerobraking into Mars orbit with thirty-six tonnes of supplies—supplies that would sit in orbit some time before they were brought down—the steel beams to support the outer walls and roofs of the two buildings were being attached to the steel beams already built into the duricrete floor. The procedure required rupturing the biome's airtight plastic skin, but before the plastic was cut away a heavy steel ring was placed around the hole to hold the plastic against the duricrete floor and additional weight was placed on and around it. As a result, the hole in the bottom of the biome produced a very slow leak; the escaping oxygen-rich air flowed into the airtight envelope around the biome and a pump put it back inside. Once the I-beam was in place, the plastic was sealed airtight around it, the weights and ring were removed, and the procedure repeated at the next attachment point. Each building required fourteen beams—eight supporting the convex outside and six supporting the concave inside—each took two sols to secure in place, and two teams were at work. By the end of September, the beams of the first building were in place.

Work then shifted to the flat roof that would support two meters of soil, water, and plants. A crane was jacked up a pair of I-beams to the roofline and used to lift beams to span the open space. Workers riveted the beams in place, then robotic welders finished the job. Robotic welders welded heavy nickel-steel plates to the horizontals twenty-four point six hours a sol to form a solid floor. Alexandra was busy verifying everything, with teams on the Earth checking videos and x-rays of the welds.

By early September the 2.5 meter high sides of the first agricultural box were welded in place. Rangers began to pull trailers loaded with sorted sand, silt, and gravel to the airlock and another ranger inside the biome pulled the trailers inside and dumped

them. A team set up a pneumatic chute to blow the thousand tonnes ingredients for the farm up to the roof. Once the first agricultural box was set up and filled, a Satursol morning ceremony was scheduled.

Everyone was lifted to the roof by the crane in groups of six and ascended a ladder into the welded metal box, ten meters long and six to nine meters wide. It was filled with 2.4 meters of gravel, sand, silt, and finally topsoil taken from the greenhouses; it was rich, black, and smelled like ground. Will walked to the edge and looked down on the courtyard, but the lack of a railing kept him from lingering. The view of the outside was excellent because they were actually above the ground level. The escarpment was impressive.

Almost all the adults came up. Lisa Kok was last and she carried two large potted plants in her arms. She went to the center of the box and they formed a circle around her.

“On Earth there is a tradition,” said Will. “When a building reaches its highest point, a freshly cut tree is attached to the pinnacle. Our Martian equivalent of the tradition is to plant a tree instead.

“We’ve all worked incredibly hard for the last month. On a typical sol, half the Outpost has been laboring on these buildings, and all of us have spent some time here. There’s a lot of work left to accomplish; building one has one agricultural box completed out of three; building two still has two vertical beams to erect, and then the horizontal beams and metal sheets have to be added. And work on the housing hasn’t even started.

“This is an excellent occasion to look back and reflect on our accomplishments. We have clicked quite well as a team and every sol our friendships deepen. Later this sol we will all celebrate the marriage of our friends Lal and Radha, which will enrich our

lives here. And we have learned how to build these buildings; each specialized construction team has successively been trained and can now continue their work until it is complete on both buildings. So we have those accomplishments to celebrate as well.

"Now I'll turn the program over to Alexandra Lescov. She developed the idea of the biome, so it is fitting that she would dedicate the first one and give it a name. Alexandra."

Everyone applauded as Alexandra stepped forward. "The Commander asked me to decide how we would dedicate this biome. As he noted, in some parts of the world, a dead tree is erected on the top of a building when it reaches its highest point. Since this place is a 'biome,' derived from 'bios,' meaning 'life,' the parallel is to plant a tree, so that's what we will do. We have two trees here, a date palm and an orange. The first symbolizes the richness of the Garden of Eden; the second, the richness of our modern agriculture. This act of dedication is the 'vivification' of the biome.

"As for the name, we should name this biome for a place on Earth with a similar climate. Eventually we will need biomes representing the full range of terrestrial climates; tropical forest and savanna, desert, Mediterranean, temperate forest and grassland, perhaps even tundra. Each biome will have an ecology appropriate to its climate, and collectively they will allow us to raise a wide variety of plants. Other biomes, as we develop them, may have partially Martian climates where we will research the transition of terrestrial life to a Martian environment.

"This biome is now named Yalta, which is a Russian-speaking resort city on the Black Sea. It has a lovely climate with very mild winters and comfortable summers. When the sun stands over the equator and shines straight down on us, Yalta will have its

comfortable summer. When the sun is as far north as it gets—northern summer solstice—Yalta will get ten percent less sunlight. The southern solstice coincides with perihelion and the dust storm season, when the dust cancels out the increase in sunlight and insolation drops to as little as ten percent of average. The solstice periods will be Yalta's mild winters. Thus Yalta will go through two terrestrial seasonal cycles per Martian year, each about 334 sols in length.

"We have a small shovel here. If everyone will form two lines, we'll dig the holes for these trees together."

Everyone formed into two lines and took turns digging holes for the two trees. Then Alexandra put the date palm in one hole and Lisa put the orange in the other. Then everyone formed the lines again and filled the holes. The trees were planted.

6

Storm

Early Dec. 2044

Will pushed through the revolving door into Yalta's Building 1. Since the yard still hadn't been filled with dirt, he had walked up a long ramp to get to it. He had to pop his ears after entering; the revolving door maintained a slightly higher pressure inside the building in order to keep the pressure shell inflated and to detect leaks. He noted the curved pressure door that could be closed over the revolving door unit in case the biome lost pressure; so far it had not been used at all, besides testing.

The interior of the first floor was rapidly taking shape. The revolving door brought Will into a small lobby onto which four doors opened: one led to an apartment with a living room, three bedrooms, and a bathroom; another to a flat with a living room, bathroom, and two smaller bedrooms or one large one; the third and fourth doors opened to a small living room, two ample bedrooms, and a bathroom. The apartments would take up four fifths of the floor; the remaining fifth, on the eastern end of the building and having its own door, would be the store. The top floor would be identical. The basement "garden level" had been scheduled to have work spaces, illuminated by high basement windows and a light well penetrating the back of the building from top to bottom, but the demand for housing in the biome was making them reconsider that decision.

Most of the interior was still open except for metal studs every meter where walls would go. Enrique was busy preparing two-meter wide panels of sheetrock by drilling holes where screws had to go. Zach and Thierry were screwing the panels onto the metal studs with power screwdrivers. They were erecting the wall along the building's bubble;

the studs were almost touching the bubble and the space between the sheetrock and the bubble was just wide enough for an insulation layer. They wired the insulation to the studs, then placed the wall over it.

Will paused to watch; they worked quickly and efficiently together as a team and clearly had a personal rapport that speeded up their collaboration. “Is this your unit, Will?” asked Zach. “There aren’t many units that need three bedrooms.”

“I don’t know. I don’t want to prejudice myself or anyone else, and we aren’t the only ones that could move into it. Three single people could move in together.”

“True. To whom are you planning to sell units?”

“We can sell units to one person, a couple, a group of individuals. . . it doesn’t matter. A person could buy a two-bedroom unit and rent out a bedroom, too.”

“How much will these units cost?” asked Thierry.

“That hasn’t been determined, yet. We’re not even sure whether to charge dollars or euros.”

“Or MCUs?” asked Zach.

Will laughed. “I hadn’t thought of that; maybe we should do that. The parts, machinery, and services were paid for in at least five currencies.”

“And we don’t know what the market will be like,” said Zach. “You could buy a unit, then be unable to sell it.”

“The Borough or the Commission will probably have to guarantee resale. I think we’ll have to end free housing; we’ll probably have to raise everyone’s salaries somewhat and charge them rent to stay if they don’t purchase a place. We can rent out space in the habitats more cheaply than in here. There’s a small army of lawyers working

on the problem, especially the tax implications of owning or renting. We may need to establish a tax system as well; most salaries will be taxed by our home nations anyway. We might as well capture some of that tax money and reinvest it."

"Interesting and controversial," said Zach. He looked around. No one was close by and could overhear the conversation. "Commander, remember I said I wanted to talk to you about housing arrangements? Maybe this is a good time. Thierry and I want to buy a condo together."

"Good. You can get your name in the pool, just like everyone else."

Thierry looked at Zach, as if to push him a bit more. "Actually, to be more exact, we'd like to be able to move into a unit together right now, even before we can buy a place together."

Will suddenly realized the implications of what they were saying. "Oh. Well, we can look at the housing allocations. There isn't any spare room to make a larger apartment, right now."

"What if we asked someone to switch?" asked Thierry. "John Hunter's room is next to mine. I think he'd be willing to move into Zach's room. Then we'd have two units side by side. We could remove the wall."

"You can ask him. Right now there isn't a lot of time for modifying existing space, but we could schedule it."

"Commander," asked Thierry. "I know you are a Bahá'í, and I know Bahá'ís do not accept homosexuality. I hope that won't impair your judgment in this case."

"Thierry, Bahá'ís do not impose their morality on others. We have our own behavioral standards. That includes no drinking alcoholic beverages. But I have not

attempted to ban alcohol even if some think it might not be a bad idea, considering how dangerous life is here."

"Homosexuality and alcohol are not the same thing!" exclaimed Thierry. Zach put a hand on his shoulder to calm him.

"I didn't say they were. I was giving an example of a Bahá'í behavioral standard that is not a Martian behavioral standard and that I have not imposed."

"So, we can live together?"

"I think so. I've already said any group of adults can buy a unit together, so it follows they can live together."

"Good. Thank you," said Thierry, calming down.

Alexandra entered the construction area and they turned toward her. She smiled. "I see the walls are going up fast. Once you've got the studs in place the sheet rock goes on rapidly." She turned to Will. "How was the launch?"

"Very smooth; no irregularities at all. The *Elysium* is now in orbit with Yevgeny, Charles, Andries, and Tina. Docking with ACV-2 should occur in about twenty-four hours."

"Good. And the weather forecast?"

"The dust storm shows no sign of restrengthening in the next ten sols, and the forecasting is now getting pretty good. They should have plenty of time to move the Mars-bound cargo from ACV-2 and ACV-3 to Embarcadero's docking ports, load their Earth-bound cargo into ACV-2's cargo hold, load the stored Earth-bound cargo into ACV-3's cargo hold, and send both automated cargo vehicles back to Earth with cargo."

"They're all itching to go to Deimos."

Will shook his head. “The forecast is iffy. I suspect they’ll be loading ACV-2’s cargo into their hold and heading back here.”

“That’s what I told Yevgeny as well.” Alexandra shrugged. “It’s a shame they had to fix the stuck manipulator arm. Dust storm season starts in three weeks.”

“There will be time for an expedition after conjunction. The weather will be better then and we’ll have to get ACV-3’s cargo anyway.”

Alexandra nodded. She pointed. “We’ll have all the walls for this entire floor finished in about a week. Take a look around while you can; it’ll be divided up pretty soon! The electrical and communications lines are in; the water and air lines go under the floors. Spackling, sanding, and painting, installing doors, laying rugs. . . there’s still a lot to do.”

“But it’s coming along nicely,” said Will. “Lisa told me earlier this sol that the rooftop gardens will be ready to plant in another week. Then it’ll take six weeks to get the dirt in here for the yard, and we’ll be able to plant it as well. We could have this place completely set up by December.”

“The swimming pool and a few other niceties will take longer,” replied Alexandra. “But the work is moving along pretty well. It’s slower than originally scheduled, yes, but we’re learning how to get faster all the time. And these will be nice housing units; no question about it.”

“Everyone wants to buy them, it seems,” agreed Will. “Demand may be so high that we won’t have to go with a housing subsidy!”

“Let’s not let the Mars Commission soak us,” objected Zach.

“The sales policies could get pretty controversial,” noted Alexandra. “Speaking of policies, I hope you didn’t feel too beat up on the other night.”

“Me? No.” Will shook his head. “Pete will make a good chair of the Borough. It may be better that the Commander not occupy an elected position as well.”

“You shouldn’t feel offended, Commander,” added Thierry. “It’s hard to explain the psychology of us Columbus 5 arrivals. We were recruited to be colonists, not personnel, so we look at Mars as a long-term investment of our energy and priorities. I think the eighteen of us all felt Pete shared that vision with us.”

“I understand,” replied Will, trying not to feel hurt about the officer elections at the borough meeting, even though he was. “Don’t worry about it. I’ve been pushing as far back as the beginning of Columbus 3 to change the recruitment policies for the residents here. The first two crews—Columbus 1 and 2—were supposed to come here for eighteen months, then mothball the Outpost for nine months and leave. Columbus 3 was the first crew that was supposed to leave someone behind. But Shinji, Ethel, and I volunteered to stay right away and threw off the plan. We loved this place and were willing to put up with the material privations of staying. So I understand how all of you feel. I’m delighted all eighteen of you want to stay at least four years. I pushed the Commission to start hiring ground support staff for Columbus 4 who could be recruited for Columbus 5, so people would come here knowing how difficult it is and willing to devote themselves to developing this world.”

“You made your own problem,” concluded Alexandra.

“And I’m glad I did,” added Will, a bit forcefully. “Aurorae Borough now has a real civil government. Who knows; it may not be long before the residents here get to

elect the Commander. After Columbus 6 arrives, our population will be pushing close to 90, depending on how many children are born here. If Columbus 7 flies up thirty more, with natural increase we'll have about 130. At some point a real civic government for this world will become a logical development."

"Sooner, rather than later," commented Thierry.

"We may have to pay our own way a lot more, first," replied Will.

The next afternoon the sky turned gray and dusty as a local dust storm swept through Aurorae. "It's a four-sol storm," Will explained to Martha Vickers that night at supper. "It was predicted. This time of year when the atmospheric pressure reaches maximum and we approach perihelion, the canyons generate a lot of local dust storms. This is not a global phenomenon."

"But I understand the seven-sol global forecast is beginning to point to a global storm," persisted Martha.

"Well, the latest forecast generated just an hour ago showed the possibility of a global storm developing a week from now. But the models are not very reliable; the seven sol forecast is still only thirty percent reliable for major changes in the weather."

"Of course, they are using a new supercomputer outside Paris to model Mars's weather," replied Martha. "Michiko told me it just started working two months ago, and it's able to digest all the weather data the satellites can feed into it, so its forecasts are regarded as sixty percent reliable."

"I think that's right," replied Will, backtracking. "I forgot about that. But this flight was approved in Houston. They saw all the data. The shuttle should be able to

return on sols five or six anyway, after the local storm has dissipated and before a global storm spreads this far."

"I hope so," replied Martha. "Will, remember I'm three months pregnant! I worry about Charles!" And tears welled up in her eyes.

"Don't worry," said Ethel, putting her arm on Martha.

Will put his arm on her shoulder. "We'll keep Charles and the rest of the crew up there safe. There should be a landing window for them in five or six sols even if the global storm develops, which is not guaranteed. And if it does develop, they can wait a month or so and come down then, after the winds have dissipated. They'll be safe; they have two ITVs to live in and enough food for years."

"I know," Martha replied, sniffling. She pulled out a handkerchief and blew her nose. "Excuse me. I'm a psychiatrist; I'm supposed to handle feelings like this."

"You're handling them the right way; sometimes a few tears are the best solution," replied Will.

"Thank you, Commander," she replied. Martha walked back to her table.

"It's a hard situation," said Ethel. "I would never have let you go up if I was three months pregnant."

"There was no problem with the forecast then."

"Never mind the forecast. There's about one chance in three or four hundred you wouldn't come back. That's not good enough, when your wife is pregnant."

"We still really don't know how safe these shuttles are," Will reflected. He pointed discretely at a nearby table. "Radha looks a bit irritated with Lal."

“Yes, she does. Well, they’re still getting to know each other, after all. They seem to be doing alright.”

“So far so good. Did you see Kevin with Kimberly?”

“Yep, and yestersol he was sitting with Christina. He seems to be looking for a new relationship, now that he’s free from Jennie.”

“That’s not good,” said Will. “I wish he’d talk to Martha more.”

“As we can see, she has enough problems of her own.”

“Not so many that she can’t help others. She’s holding this place together.” Will glanced at his watch. “Roger asked to meet with me after supper, real quick. I suppose he wants to talk about the exploration schedule.”

“The dust storm season could change all the plans.”

“Exactly. I’ll be home in time for family prayers.” Will rose, bussed his tray, and headed for his office. Roger was there when he arrived. “Looks like the first two expeditions will have to be postponed.”

“Certainly for the next four sols; after that, we’ll see, but it’s looking bad. But I didn’t ask to talk to you about that.”

“You didn’t?”

“No. Are you going to let Thierry and Zach live together?”

Will was startled by the question. At first he wasn’t sure what to say; Roger stared at him and he looked back. Then he sat down and pointed to the chair. Roger sat as well. There was a long silence as he formulated a response to his friend’s question. “Roge, you and I share many common values. I don’t approve of homosexuality. Many people here have no problem with it, and neither do any of the psychological organizations. Neither

do most western governments, either. The bottom line is that Thierry and Zach can't be told that they can't love each other. This isn't something Martha can cure. They already love each other. What do you propose to do about it?"

Roge hesitated. "Will, there have to be standards. A society can't survive without them. Earth is rotting without standards."

"I agree. We have to build a society here where there is no crime, or at least as little crime as possible; we can't afford to maintain jails and lock up people when their labor is worth millions. We have to build a society where we don't have unemployment or welfare or poverty. We can't afford them. Earth has never succeeded to make these changes. I hope we can build a society where children are born, grow up, stay, and start new families. We need as many children here as possible. But we can't order people to get married and we can't ordered married people to have children."

"What if Zach and Thierry ask whether they can get married?"

"Then the borough will have to hold a town meeting to decide what the law allows. That'll be an interesting discussion."

Roger was surprised. "Knowing the crowd here, it'd be approved, too."

"A domestic partnership arrangement could be proposed instead. But this is a pretty liberal group; I doubt they'd go for it. So I wouldn't worry about selling a condo to them, or letting them live together. They're going to have rooms next to each other; Thierry's asking John Hunter to switch rooms. They both know construction pretty well; they could demolish the wall between their two rooms on a Sunsol pretty easily, even without official permission. And anyone who is of legal age and lives here can buy anything with anyone else. You and I have the right to buy a condo together if we want."

“I suppose.”

“So I’m asking you to be polite and friendly to all your fellow residents and colonists on Mars, whether they’re Chinese or American, men or women, adults or children, gay or straight.”

“That’s a tall order, Will.”

“Aren’t you supposed to love everyone, even if you don’t like everyone?”

“Will, Jesus calls us to love everyone, but that doesn’t mean we have to support their life style.”

“I didn’t ask you to support their lifestyle, just to be civil and courteous. We have to work together to survive.” Will shook his head. “Sleep on it, okay?”

“Alright. Thanks for the time.” Roger Anderson rose and left the office.

The next morning dawned very gray. Érico, in the Bridge, called Will as soon as the forecast came in. “Pop up the weather website. The Marineris storm is spreading. It may become one of the contributors to a global dust storm.”

“Really? That’s a big change! It’s early!”

“The forecast wasn’t very accurate. There’s a real risk relying on Martian weather forecasts as if they were like Earth’s. The reliability isn’t there.”

“But they say weather here is simpler than on Earth; there’s no land-sea interface to predict.”

“There isn’t, but we have about three orders of magnitude less data about the atmospheric conditions here than the supercomputers have for the Earth’s forecasting, and this time of year the polar-tropical interface is just about as complex as the sea-land

interface. In two years we're slated to receive a new fleet of satellites—a billion bucks worth of equipment—and they'll increase our atmospheric and surface data ten fold. Meanwhile, we have to be careful."

"When can the *Elysium* return?" asked Will.

Érico laughed. "Now we're looking at a month, minimum."

"A month! That'll be a big surprise for everyone. We never should have taken the chance and launched."

"No. You'd better call them."

"Okay." Will closed the circuit and went to the website. It indeed predicted the continued growth of the Marineris storm over the next ten sols—the limit of the forecasting—and the expansion of several other storms that had started until the entire planet was enveloped. The long-term forecast was much vaguer, but it predicted one to three months of dust and high winds.

He called Yevgeny, who answered immediately. "Good sol, Will," he began. "I suppose you're calling about the weather."

"Yes. Have you seen the new forecast? The Marineris storm is predicted to grow, rather than shrink. They're now predicting a global dust storm: category 5, the biggest storm this planet makes. We've never seen one of them since humans landed here."

"I know. We could be up here until April if that happens; those kinds of storms usually last the entire five-month storm season! I looked at the weather forecast five minutes ago and then told everyone. Charles is calling Martha and she's in tears." He said the last sentence in a low voice.

“I know; she wants him home. But the shuttle can’t land in a 150 klick cross wind. Remind me of your fuel situation.”

“We have Lifters 5 and 6 here. Once they send the two ACVs on their way back to Earth and return to Embarcadero, they’ll still have twenty tonnes of liquid oxygen and methane each. We need thirty-three tonnes to deorbit and land and we have five tonnes in the shuttle’s fuel tanks already. So we have plenty. We could also use the fuel to send the shuttle to Deimos with one of the two ITVs; that would consume sixteen tonnes. Lifter 7 is sitting on Deimos with fifty-four tonnes of fuel in its tanks, so it has plenty to send the shuttle and ITV back to Embarcadero, then deorbit the shuttle and cargo.”

“How much work do you have left on the ACVs?”

“None. The work’s finished. There are some routine maintenance tasks we can do here. Between the two ACVs, we have fourteen tonnes of consumables; they’d last the four of us several years.”

“That’s what I thought. Get the ACVs on their way back to Earth with their cargo so they can come back two years from now. If the forecast hasn’t improved in four sols, you guys should decide whether to move to Deimos. Not only can you do some useful science while waiting out the storm; you can spend four sols per week in zero-gee but underground and protected from radiation, then three sols per week on the ITV where the radiation is a bit less in the moon’s shadow and where you have gravity for your bones.”

“And for showers! Not to mention washing clothes. We’re anxious to go to Deimos, Will. A month or two there would allow significant study. There are plenty of proposed sorties and projects. We’ll vote, as you say, and put in a proposal to Mission Control.”

"Okay, good. Keep in touch with me. Bye."

"Bye."

Will closed the circuit and went back to the weather website. *Category 5.* Mars had a dust storm of that size once every thirty years or so; they were not common. Insolation to the surface would be reduced by ninety percent, which meant their solar panels would make a tenth the usual power. Their solar power units would be impacted much more seriously because once the disk of the sun was obscured, the diffused sunlight could not be focused on the panels; production of energy would drop ninety-nine percent, to 1.5 kilowatts of power. The Outpost relied on four such units, but fortunately it had five nuclear reactors each able to put out 150 kilowatts of power and 650 kilowatts of heat. They could also pull heat from the ground to keep the Outpost warm; their four water wells reached about two hundred thousand tonnes of rock that had been heated by the solar power units, over many years, to 100 Centigrade. The wind turbines would put out plenty of electricity when the wind blew. They had three fully-fueled shuttles that could put out a hundred kilowatts of electricity continuously for eight months. Finally, they had spare oxygen in the underground wells and about one hundred tonnes of plant matter that had accumulated in the greenhouses; burning the latter in the former could make a hundred kilowatts of heat constantly for six or eight months, or it could be converted into methane and run through the fuel cells to make electricity.

There was no doubt: they were in excellent shape from the point of view of power and heat. But agriculture would virtually collapse; the plants would survive, but would bear almost no harvest. It would be impossible to send out any expeditions because the

nuclear reactors had to stay at the Outpost to provide power and the sunwings would be unable to take off and land, grounding their supply and rescue capacity.

Will headed out of his office to find Roger Anderson. The science plans would have to be postponed in favor of construction. They could make up for it later.

Will and Roger talked, then went to Biome 1 to talk to Alexandra. They outlined an acceleration of the construction work. Will was walking back to his office through the tunnel where the store was located during a particularly fierce phase of the storm.

"Will, it's like being in a blizzard!" exclaimed Silvio. He pointed to the side of the tunnel facing nearby Renfrew Hall. Talcum-powder-like dust was literally raining down on the tunnel, swirling on its flat upper surface, then spilling down the side. Will stopped to look.

"You're right; it does look like a blizzard! I've never seen it this fierce outside before!"

"Never?"

"No. This appears to be headed toward becoming a category 5 storm, which means it'll engulf the entire planet except the tops of the volcanoes and the north polar cap. It's probably going to last four or five months."

"Four or five! Are you sure this tunnel will be safe against the wind?"

"Sure, no problem. We're getting gusts outside up to 200 kilometers per hour, but the Martian atmosphere is a hundred times thinner than the Earth's atmosphere, so the pressure it can exert on a structure is equivalent to only a twenty kilometer per hour wind on Earth. Sand blasting is the bigger danger, but all our structures are covered with an

extra layer of plastic that can be replaced after the storm season ends. Another problem will be temperature; this tunnel will get cold. You may need extra heaters."

"I'm amazed how dark it is out!"

"It is; it's a heavy overcast right now. But we have plenty of power. The four wind generators on Boat Rock are producing an unprecedented fifty kilowatts each! That means the wind is averaging 150 kilometers per hour up there!"

"Yet if a man goes outside, he wouldn't be blown over?"

"Correct, but his suit would get sand blasted a bit and he would have to use GPS to find his way back to the airlock. Not many people will be going outside for the next few months. If you get cabin fever, go to the biome and help build it."

"That'll speed the work, at least. Say, speaking of the biome: everyone is driving me crazy with questions about the purchase of units there. I'm going to start saying nothing at all; anything I say seems to fuel rumors."

"I think that's wise, Silvio. How are the plans standing right now?"

"The conversations all point to high demand for housing in the biome and much lower demand in the old habitats and halls. Clearly, we need to set a higher price per square meter in the biome; probably double elsewhere. And now that people are used to MCUs, let's price houses in them as well!"

"I'll have to run that past Morgan. How much are we talking about?"

"If you take the cost of manufacturing and shipping the biome and building bubbles and environmental control equipment and you attribute half of it to agriculture and half to housing, then the housing costs 2,000 MCUs per square meter. I suggest we do no rental at all; everyone can buy their room or apartment. They'll get the money back

when they sell the unit, so there is no penalty against their salaries. The Commission should guarantee a base price for everything. We'll also have to charge a monthly assessment to cover services such as light, heat, water, sewage, pressurization, etc., and I propose that we raise everyone salaries equal to the average assessment. People who want to buy a larger unit will be penalized and those going for a smaller unit will come out ahead. Considering our tight quarters, such an incentive is important."

"That makes sense. So, a 75 square meter condo in Yalta will cost 150,000 MCUs? Ethel and I could pay cash for a place like that."

"Sure; you've been saving and investing for almost nine years. If we were to sell the entire three floors of the two buildings in Yalta, the Commission would gain four million MCUs or about forty million bucks, enough to build and send half a biome. That's the elegance of this scheme: the colonists themselves help pay for the development, but they don't lose anything either because when they leave they can sell the unit to someone else. The money goes round and round and this place gets bigger and bigger."

"It builds loyalty to this place and saves money."

"Our preliminary proposal allows anyone or any group of people to purchase, too. I assume that's agreeable?"

"To me, yes. Are you referring to something in particular?"

Silvio hesitated a moment. "Thierry and Zach."

"I've told them I thought they should be able to buy together, just like anyone else."

"Good." Silvio clearly was relieved.

“I’m curious; are there rumors floating around?”

“Yes. It’s hard to say how many people have heard; I don’t think it’s gotten to everyone.”

“No. I did have one person approach me, though. I told him I wanted civility among the crew, not stigmas and rumors. Please discourage rumors about the matter, alright? Thierry and Zach deserve their privacy.”

“If they want it.”

“Yes, exactly. Say, I have another matter for you as well: the Dunbar divorce. When are you expecting the result of the alimony appeal?”

“Next week. Like I said before, I think Kevin will lose. The idea of putting one fifth of the salary of each of them into a trust fund for Jake is an elegant solution to the problem of predicting the costs of raising him. Neither will promise to stay here on Mars, though no one will dare take the boy through outer space to Earth for several years at least. We don’t even know how much raising children here will cost; in five years we may have meal tickets and everyone will pay for their food.”

“We’ll probably have to institute that. Let me know.” Will looked around at the shelves. “How’s business?”

“It’s slowing down. Maybe the initial excitement of being able to shop is being replaced by the realization that it is very expensive. People have a lot of adjusting to make before we can establish the beginnings of a market economy here. The starting salary of 50,000 MCUs is five or six times the starting salary of the average professional on Earth, but we get free food, medical care, and lodging; that makes our income the equivalent of twenty times the average salary in the U.S. or Europe! But people don’t

want to spend about one hundred times as much to purchase a bottle of wine or a new shirt. They'll adjust to the new scale of everything eventually. It'll help once we can make things here."

"In good time."

"Any idea when we might be able to set up and use the cloth weaving, cutting, and sewing equipment?"

"No. The fabrication specialists are hard put to keep up with the work to prepare the materials needed by the biome. Don't worry; all in good time." Will smiled; Silvio was constantly pushing him about privatization and economic autonomy. "I've got to run, Silvio. See you at supper." He hurried through the tunnel and to his office, where there was a series of communications waiting for him. Rather than plunge back into work, he pressed the icon to hear David Alaoui's latest video message. "Hi Will," David began. "I just saw the long-term weather forecast for Mars and my heart sank. Just what you need! I'm sorry the storm season's turning nasty up there. But Father Nature is unpredictable.

"You should see our beautiful greenhouses! While you've been building, so have we. Each ITV had an inflatable greenhouse ten meters long and six meters in diameter with an attached cooling system. Each can accommodate up to 300 square meters of growth trays and holds up to ten tonnes of water. Setting them up has taken months, but now they are incredibly verdant and they can feed us completely if necessary. They completely filled the lower level of the ITVs, so that space is now available for laboratories and more living space.

"Rounding out Magellan Station is a ten meter long, six meter in diameter annex—it's really a third greenhouse unit—that extends along the station's zero-gravity

axis from the main docking unit to a secondary docking unit, where the two automated cargo vehicles are located. We use the annex for zero-gee games. Magellan's now huge, relatively speaking; it went from two hundred cubic meters on the flight out to almost 1,400 cubic meters, with the emptied ITVs and the three inflatable units! With all this volume and the great success of the greenhouses, Magellan 2 is almost certain to fly six people here. It's big enough to get lost in!

"So we're now turning more energy to exploring Venus. We have two automated rovers moving around on the surface and both of the new sunwings are flying in the atmosphere. Every day we find something new; next month one of our rovers will reach an active volcano and we hope to explore it safely but thoroughly. There seems to be a new adventure around every corner. Bye."

Will smiled at the message. He hit reply.

"Good sol, my friend. I miss you and am thrilled to hear about your successes. The greenhouses have worked out well, so far. My congratulations. I had not realized the station was so huge! I bet the video of the volcano will attract a lot of attention from the public. I suppose his will give momentum to France's next likely goal: putting a crew on Mercury. The American solid-core nuclear engine may be the key to doing it! It's really amazing to think what we might achieve by mid century, at this rate.

"I'll refrain from calling the storm an emergency or a crisis, though with improper planning either term could end up being right. The forecast's not very definitive, but in my bones I feel that this is the storm of the decade; maybe of the half century. We've got four guys stuck in Mars orbit, probably for a few months, but they can head for Deimos with an ITV in tow and will be perfectly safe, while accomplishing a vast amount of

unexpected science. Down here on the surface, we'll shift our personnel from exploration to construction; we'll need the nukes here at the Outpost to keep it lighted and heated, and the sunwings won't be flying at all. So we have a few challenges, on top of some social tests that have strained everything lately, with baby number seven coming along in a week or two as well! So you pray for us, David, and we'll pray for you. It'll be an interesting few months for everyone."

7

New Years

Dec. 30/31, 2044

The sheets of vinyl siding practically snapped into place. Will could align the sheet against the metal frame and push and it clicked in place, so well formed it was. Then he drove screws into precut holes using his electric screwdriver.

The piece he was working on had additional screw holes to hold ornamental window framing in place. As soon as the sheet was fully secured he grabbed the plastic, placed it, and secured it with screws. Finally, he lifted the framing and anchored it in place around the window.

He paused to peer through the three layers of plastic—two plastic sheets and a pressure membrane—making up one of the windows of building 1. It was a bedroom and he had to wonder who would be living in it in a few weeks. Eammon O'Hare was inside installing a wireless communications port. Then Will moved on to place another piece of vinyl siding. Their construction technique was indeed like Russian nested dolls, fitting tightly together but barely touching: the vinyl siding, pressure bubble, insulation layer, and the inside walls of metal studs and sheetrock.

Will continued along the second story of the building, anchoring the large, light-weight panels. Building 1 was a light blue with wide, white decorative window frames. Building 2, across the yard, was a peach color with white framing; Thierry was busy putting up its siding. As soon as Will finished the entire row of panels across the front—it took over an hour—he lowered the work platform to the ground, where Zach helped him

load up with the top row of panels. As they finished, Will's communicator buzzed. He groped for the small device under his heavy sweater and answered it.

"Hello?"

"Will, this is Silvio. I gather you don't have your video with you, right? Then I won't email you anything. We have the wording on the sale of condominiums all finalized and approved; the task force of lawyers in Houston just gave their approval."

"Excellent. You're satisfied?"

"Yes, we got most of the features we wanted. They approved using MCUs according to the valuation formula I proposed; I was surprised, but I suppose it makes sense to sell everything here in the same currency units. We'll assign units based on a lottery system weighted in favor of seniority, as proposed."

"Good. Email it to my address and I'll take a look when I get finished here. Let's make an announcement tonight."

"Okay. Take care."

"Bye." Will pushed the off button. He surveyed the biome. It was looking pretty good. By the end of the sol, the vinyl siding would be in place, including the framing around the doors. The interiors were virtually complete as well; some interiors would have to be changed depending on who bought them, but that was a minor matter of blocking a few doors. The yard was not looking as good; only the thinnest layer of fill had been placed because of the problem of heating thousands of tonnes of processed regolith during the dust storm, so there were still ramps leading up to the buildings' doors. But some trees had been moved in from Clarke Dome in their pots, and a few trays of flowers as well. The east end of the yard, termed "the patio," had a temporary plastic

floor in place and its exterior lights had been installed. Only the other end—called “the west court”—was still undeveloped, because a swimming pool was to be put there.

It was time to consider holding their meals on the patio instead of Renfrew Hall. And when better to start: it was December 31 on Earth, though because of Mars’s longer sols it was only December 30 there. Even so, it was the last day of the month; ten months on Mars were a sol shorter than their corresponding terrestrial month to compensate for the differing day length. That night was New Year’s eve.

But it was barely ten centigrade in the biome; they had kept the heat low. He punched in Lisa Kok’s number.

“Ecology, Lisa.”

“Say Lisa, this is Will. I’d like to hold supper tonight in Yalta because the buildings’ exteriors will be finished. But that means cranking up the heat, hauling in extra lights to make it bright, maybe moving in more plants, and jazzing up the menu.”

“I think a celebration is a good idea; it rewards our work and makes up for the gloom,” she agreed. “We’ve got the heat energy. We’d probably have to haul in lights from some of the greenhouses and that will slow plant growth by one or two percent.”

“Bring some of the plants along to catch the stray light; I’d rather make the yard as green as possible. What about food; any more animals you can contribute?”

“Yes, we could kill three rabbits and add them to a stew. We can increase the vegetables and salad for this meal if we decrease them slightly for the other meals over the next week.”

“I suppose that’s the best we can do. We’ve got some pretty good foods from Earth that we can pull out as well.”

"Yes; how about the wine?"

"Sure. It's New Years and no one will be working tomorrow."

"Okay, I'll take care of that right away."

They continued to work until 6 p.m., then quit an hour early. By then the siding was up; buildings 1 and 2 looked finished. The work inside was fairly extensive, but there was still a lot of finishing to do.

Will dashed to his office quickly to handle messages. Louisa Turner's message was not long, but very worrisome. "We have to turn things around in 2045, Will," she said "Interest in interviewing Mars residents has dropped precipitously over the last two months and media coverage is now forty percent as much as it was last year. The Magellan Project captured the public's attention during Columbus 5's arrival, then the dust storm prevented surface exploration and the good video it would have provided. The focus on construction of housing made you look like middle class consumers instead of heroic explorers, and the Dunbar divorce tarnished Mars's image as a family place. The gay media made a lot of Thierry and Zach's decision to buy a condo together, but in many parts of the world and for many demographics, that was very negative. The Mars currency unit hasn't helped; the utopians love it and everyone else thinks it's a joke.

"So we need a miniconference of a dozen folks—six down here and six up there—to seek solutions. Let's schedule that for January 2 or 3. Bye."

Will acknowledged the message, suggested that they make Martian architecture a theme, wished Louisa a Happy New Year, and headed back to Yalta. The round tables and chairs in Renfrew Hall had been moved to Yalta's patio and soon everyone began to

arrive for supper. The buffet line was set up just inside building 2 in what would be their future kitchen; the food had to be hauled from Renfrew, however, which was inconvenient for the cooks. The large, open space gave the evening an even more festive atmosphere than usual. Eammon and Irina brought their three-sol old baby as well; Patrick's first public appearance. Everyone crowded around to see.

"Congratulations, Eammon," exclaimed Thierry, after most of the crowd had dissipated.

"Thank you Thierry," Eammon replied, a bit stiffly.

"The rumor has it that this is the first of many," added Zach.

"God willing," replied Eammon.

Irina rolled her eyes. "We'll see," she replied.

"You can have our allotment," volunteered Zach.

Thierry poked him. "No, not necessarily; we could always adopt." The two of them smiled impishly at each other.

If they had set out to make Eammon uncomfortable, they succeeded. "Thank you, but I don't need your allotment."

"No, probably not," agreed Thierry.

"So, how's your work?" Greg asked Thierry, attempting to change the topic.

"My work? The geologists have taken it away from me because they can't get out any other way. I've become a full-time construction specialist."

"You drove half of last Wednesol," exclaimed Roger from a nearby table. His tone was impish as well, not confrontational.

“That’s true,” agreed Thierry. “Boy, you guys have been running the Prospectors ragged!”

“It’s the only way we can get around, right now,” replied Roger. “Besides, lately we’ve been cruising the trails to see how the dust has changed them. We have to tough up all the trails.”

“But it’ll be pretty fast work,” added Érico.

“Charles wants to get down here as soon as he can and help,” added Martha Vickers.

“How are they doing up there?” asked Zach. “They must have seen all of Deimos by now!”

“Pretty much,” agreed Roger. “They’ve refilled the gas tanks of their maneuvering units a dozen times and redeployed the shuttle six times.”

“Right now they’re on the ITV, though,” said Martha. “For New Year’s.”

“How are they handling the switch between gravity and weightlessness?” asked Eammon. “I think switching weekly would drive me crazy!”

“They’re doing alright,” replied Martha. “We’re monitoring them pretty closely. They aren’t having the sleep problems that often crop up when someone lives in weightlessness for several weeks or months. Their muscle tone and bone mass are holding up much better, too; they’re getting a lot of exercise on Deimos, and that helps.”

“They seem to have be adjusting faster than I’ve ever seen,” added Roger. He stood up and walked to the buffet table to get seconds, even though the relatively sedentary life of the Outpost was causing him to put on some weight. While walking back to his table he passed Tatiana, she said “Don’t listen, Roger.”

“What?” he replied.

“I was joking.”

“We’re having a debate about the colors of the two buildings,” explained Will, who was seated there as well. “Alexandra was agreeing with something Madhu said the other sol: that while peach seemed like a good Martian color for a building, light blue seemed inappropriate.”

“But I wanted the colors to represent a contrast,” replied Tatiana. “Peach does indeed represent Mars this sol; it’s a warm color, but it also echoes this world’s reds and oranges and yellows. Light blue is supposed to represent a contrast: either the water of Earth, or the water inside this biome, or the color of a dust-free sky. Those are the choices I had in mind.”

“Sounds good to me,” said Will, looking at the building in the steadily brightening artificial light, as twilight faded outside. “I like them both.”

“So, what will we work on next?” asked Roger.

“The insides aren’t finished,” reminded Tatiana. “There’s a lot to do there.”

“With this dust storm tying us down, maybe for three months more, I’d favor completion of the yard,” said Alexandra. “The swimming pool will be immensely popular.”

“Good,” agreed Roger. “But I have a simple request: the two basketball hoops. Of course, they’ll have to go about a meter higher than regulation to make up for the gravity. They can be set up in a few hours.”

“The space between them will be pretty small for basketball,” noted Will.

“We can manage, especially if the pool can be covered over quickly with a hard plastic surface, so we can run over it,” suggested Roger.

Alexandra nodded. “We’ve designed some extra-thick vinyl panels that can be quickly placed over the pool and anchored.”

“Good. But completing the interior won’t consume three months,” said Roger. “Maybe five or six weeks. What about the rest of the time?”

“Good question,” said Alexandra. “We should get started right away on the second biome: Catalina. The rangers have been excavating the hole. Next week I’ll start to divert labor to the manufacture of steel beams and rods, and sheetrock. That way when the storm clears, more people will be able to go out to explore.”

“Not many more,” replied Roger. “That’s the problem. Even once we set up the two mobilhabs, we won’t have the capacity to send out many more people. This storm will really curtail exploration for this columbiad. But a little extra construction might not be bad. I already told Will my construction suggestion.”

Will nodded. “A resort on the escarpment.”

“Made from what?” asked Alexandra.

“Catalina’s building bubble 1 or 2,” replied Roger. “One bubble is enough to accommodate Columbus 6. So I suggest we set up the other one on the edge of the escarpment; I know a place that even has the right shape. It overlooks Little Colorado as well as Valles Marineris. A beautiful spot. We could even let the bubble overhang the escarpment by a few meters, which would guarantee a great view! Inside the bubble we could set up a modest building and a small garden. We could cover it over with plastic

sheeting to protect it from sun and dust. It'd be a perfect vacation spot for two couples or one family at a time; a sort of time-share dacha for all of us."

Alexandra smiled. "What a fascinating idea! The only problem is the issue of redundancy. We need the bubble to house people if we have a failure at the Outpost."

"People could commute from the dacha to work every sol," replied Roger. "It's about an hour each way. That's *real* redundancy; two outposts near each other."

"We'll have to look into this," replied Will, obviously fascinated by the idea.

Silvio approached the table. "I think it's time," he said.

"Okay," replied Will. He had finished his supper; most people had. He rose and walked to a spot near the buffet table. Everyone, seeing the Commander stand, quieted down in anticipation.

"My, what an attentive audience!" said Will, surprised. "I wish every time I had an announcement, I got such attention! Let me start by wishing everyone a Happy New Year. Madhu has a program from 11 to 12 midnight and she says she can hold it here on the patio, so we'll stay right here. And since no one lives in here, we can make as much noise as we want.

"But I'm not standing here just to wish you Happy New Year. The Commission has approved the plan to sell condominiums. It should be on our website tonight so everyone will be able to read it and post their questions and comments on the civil forum. I hope everyone uses the forum to resolve questions, but we can hold a brief town meeting if needed.

"Here's a summary. Tonight we will hold a lottery. Every adult will draw a number; we have 47 numbers here in the pot." He pointed to Silvio, who held up a pot.

“Any couple or group of people who want to purchase a unit jointly can use the highest number drawn by someone in the group. Érico is the Borough clerk who issues title to property; Silvio is the sales agent. The two Yalta buildings will be open for walk-throughs all sol tomorrow and the website has the floor plans. People can go to the web anytime to put in their property request; the form asks for a description of what you are looking for, what you do not want, and four ranked examples. There’s even a place to list people you want as neighbors. The Yalta buildings are laid out to provide thirty-five square meters of living space per adult. If you prefer, you can put in a request for housing in one of the habitats or halls, where fifty square meters per adult will be the norm.

“A week from today Silvio, Érico, and I will go through the ranked requests and assign them based on the lottery. We have 14 adults here from Columbuses 1, 2, and 3; 15 from Columbus 4; and 18 from Columbus 5. The highest fifteen numbers, regardless of seniority, will receive their first choice. In the next fifteen selections, we will be sure to include anyone from the highest seniority group with numbers as high as 40 and anyone from the middle seniority group with numbers as high as 35. If you include the garden level apartments, Yalta is set up with six three-bedroom units, twelve two-bedroom units, and six one-bedroom units. Depending on need, however, we can rearrange the units in all sorts of ways; we could make 24 two-bedroom units, for example. Theoretically it can accommodate almost everyone.

“If someone’s four choices are taken, we’ll have to ask for further choices and start redividing units. Keep in mind that units in the habitats and halls will cost the same as in Yalta, but will be about fifty percent larger, and you should be able to negotiate even more space if you want it.

“Questions?”

“Can we stay where we are, if we want?” asked Ruhullah.

Will was surprised by the question. “Yes, no one will be evicted from their present housing. Depending on who moves out, you may even be able to double your space.”

“And if we buy, we can sell the unit back to the Borough?” asked Pete. He had a family on Earth; he was one of the few planning to head home in eleven months.

“Yes.” Will looked around. “Other questions?”

“Do you have to have seniority?” asked Greg.

“We’ve had quite a discussion on that, haven’t we?” replied Will. That had been a controversial matter. “This is a pretty weak seniority system. As most of you know, seniority is, in my opinion, an important principle in the settlement of Mars; not a central or powerful principle, but a principle, because it gives everyone an incentive to stay and advance.”

“How are the mortgages, titles, and all that going to work?” asked Radha.

“We will not require deposits; people can just start paying. Everyone here has a good credit rating. The titles to the property by definition are clear; no certification will be needed. So purchase involves signing a purchasing contract based on payments over as much as thirty years at five percent interest. The prices in Yalta are 2,400 MCU per square meter for the ground floor, 2,000 per square meter for the top floor, and 1,800 per square meter for the garden level. The price in the habitats and halls is 1,600 MCUs per square meter.”

Several people whistled or sighed at the price. “We have high salaries here,” replied Silvio. “A typical unit will consume a quarter of our salary, which is about the cost of housing on Earth, and the money comes back to you when you sell the unit. The mortgage payment will cover the cost of importing more housing and life support equipment, which means we are laying the foundation for paying for this world’s settlement. Including the interest payment, in thirty years each of you will roughly have paid for the cost of the housing and life support. In twenty or thirty years the costs of transportation will be less and it will be possible for settlers to come here and earn enough money to cover their own housing. We have to think ahead.”

“An expensive way to think ahead,” commented Érico.

“We can’t deny the presence and power of capitalism,” replied Silvio. “Perhaps it’s a bit premature to announce this, but in February the town meeting will have to discuss banking laws. We are finalizing plans to open an Aurorae branch of Manhattan Bank International. This has immense implications for everyone. Right now we are paid salaries in dollars, euros, and other currency by the Mars Commission and the money goes into banks in our home countries. We usually have to pay American income tax on the income and sometimes national income taxes as well. But the Mars Commission exists on Mars and in Houston. If we have bank accounts here, we can be paid here, and legally we will be obligated to pay Martian taxes first, not U.S. or other national taxes. Mars doesn’t have any taxes; not yet. You should be able to divide your income between our bank and any terrestrial bank. Money deposited here can be invested here, and any profits are taxable here.”

That got a lot of attention; everyone was silent a moment, trying to figure out the financial implications. “But will our units appreciate in value?” asked Roger.

“Who knows?” replied Silvio. “That’s a function of several factors: the cost of importing items for making more housing; the cost of building here; and demand for space, which is a function of our population and our personal desire for space. Imports should drop, construction costs here should drop, and demand for space should increase. Then there’s the market, which is not always completely rational.” Silvio smiled.

“So, when will we have to pay taxes?” exclaimed Kevin.

Will shrugged. “Who knows? Keep in mind that we now have eight children on Mars and one more is on the way. We have child care and schooling costs. Pretty soon, we’ll have to pay for some of our health costs. Most likely, incomes will be raised to cover the taxes, but whether the salaries will go up as much is not clear. We may have to make some choices as a community in the next few years if national government support wanes; our salaries, reinvested in this place, can be an engine for growth.”

A few people gaffawed at that, but Silvio stepped forward. “Don’t misunderstand that comment. The average adult here is paid $550,000 per year; our gross domestic product therefore is $25.85 million per year. If all of us paid twenty percent of our income in local taxes, that would amount to about $110,000 per year per person, and it would reduce the tax we owed our national governments by the same amount. Multiply that times fifty adults and twenty years: it totals 110 million dollars. Columbus 5 cost eight million dollars per person for cargo and two hundred fifty million to fly each arrival here. If those costs halve, our taxes could fly a teacher or physician here. When the Outpost doubles in size, we can fly both every columbiad.”

The lecture caused a few to giggle and a few to frown; others looked pensive. There was a pause. Will got the impression no one else had questions, but he could see that Ruhullah looked cross. “Ruhullah, it looks like you might have something to say.”

Ruhullah was startled. He looked at Will, then rose. “I did not, Commander, but since you have offered me the floor, I will graciously accept it. I apologize that I have not been following the discussion about financing our housing over the last few months. If I had, perhaps I would have spoken up sooner. Since arrival four and a half months ago, I have tried to be a hard working and loyal resident here. Like everyone, I have done two jobs; my professional work as a chemist and my duty as a construction specialist. So I am gravely concerned that after contributing so much labor to this beautiful place, the purchase of units here will be set up in a western and European manner that will force me to compromise my fundamental religious principles, or not participate at all. Many of you know that the Prophet Muhammad, peace be upon Him, was a merchant. He was very concerned about setting up a society where people could legitimately make money, but he was also concerned about the poor and about exploitation of others. For these reasons he forbade usury; that is, the charging of interest. By setting up this banking arrangement, my participation in this society has been compromised.”

He sat. There was silence. Many looked baffled; others were uncomfortable, as if they had been personally criticized. Roger turned to Madhu and said “What the heck’s he talking about?”

Will had been looking down at the floor and listening. “I believe we will be able to accommodate you,” he replied. “We looked at the portfolios of many banks when we selected which one to use, and selected Manhattan International because of its extensive

system of branches and affiliated banks around the world, as well as its wide range of services. Manhattan International has Islamic banking affiliates in the Arabian peninsula. I don't know why we couldn't arrange for the purchase of your unit through their financing system."

Ruhulllah looked surprised; Silvio looked even more surprised. "If there are no other questions, let us proceed to the selection of numbers," Will suggested. "People can come up in any order. Let's start with this table." He pointed to the nearest table. Eammon, Irina, Greg, Érico, Carmen, Roger, Madhu, and Sam rose and stepped forward. Sam was told to reach in and mix up the slips of paper, which he did. Then everyone drew a number and sat.

They went table by table and everyone drew a number, including Ruhullah, who looked at Will with a new respect as he came forward. Then Silvio and Will pulled out the last two numbers.

"I've got fourteen; what do you have?" Will said to Silvio.

"Eleven. Say, Will, do you think I should talk to Ruhullah about his concerns? Your suggestion may not be workable."

"Contact our Manhattan International representative first and see what he can do. MI is providing the entire setup of the branch here at no cost; they plan to use it in advertising. They can advertise the Islamic operation as well, so let's see whether they'll absorb the cost."

"For one person?"

"No; for Mars's many future Muslim residents. Columbus 6 may have a few, too. To send a citizen, a government must commit two hundred fifty million up front and ten

million per year for twenty years or as long as the citizen stays here, or a one-time lump-sum payment of 400 million. There are sixty nations in touch with the Commission about this way to boast about their economic and technological capabilities. A dozen of them are predominantly Muslim."

"I see. I suppose the percentage of Americans and Europeans here is bound to drop as more nations come on board. But what about the precedent? What if Érico comes to us and says he wants a bank run on socialist principles, because he's concerned about the profit motive driving Manhattan International?"

"Tell him to go to the Islamic bank; their moral and economic foundation may be more to his liking."

Silvio laughed. "Okay, I'll contact our agent sol after tomorrow."

Will headed back to his table. "What's your number?" he asked Ethel.

"Twenty-nine."

"Mine's fourteen; that should get us something decent."

"Sure you can't pull rank? I really like the first floor three bedroom unit in building 1, with the morning sunlight streaming in through the master bedroom's eastward windows."

"Sorry."

"Dad, can I stay up for New Years?" asked Marshall.

"Another year, son. You're still too young."

"I'm almost five!"

"I know; another year. I bet mom said that, didn't she?"

“Yes.” He was disappointed, on the verge of crying. Will looked sympathetically, but not too sympathetically, lest his reaction trigger a tantrum. Then he saw Ruhullah approaching.

“Thank you, Commander,” he said. “I hope my heart-felt concern was expressed appropriately.”

“Yes, I think you were very articulate. And passionate, but not in a manipulative way.”

“I hope the banking system will be able to accommodate me.”

“I hope so, too. Manhattan International does have Islamic banks; I read the portfolio very carefully. I’ve instructed Silvio to investigate.”

“Excellent; thank you.” Ruhullah smiled in gratitude.

8

Vistas

Feb. 2-20, 2045

“Be careful not to scratch the new wall!” Will warned. Roger nodded and adjusted the position of the mattress slightly. They moved it into place and stood it up against the bedroom wall.

“Such a big room,” said Roger, looking around.

“Five by six meters; you’ve got the same.”

“Yes, but right now you and I have four by three meter bedrooms! This will be really nice.”

“It’ll be great. I like the window, too, and the morning sunshine.”

“Ethel got her window. Come on, let’s get the rest of the stuff; Madhu wants me to be packing.”

Will nodded. They hurried out the door and up the stairs to the tiny lobby, then outside where a trailer was full of furniture. They picked up a fully loaded dresser—in Martian gravity, it could be moved pretty easily—hauled it through the building’s wide open airlock, then down the stairs and into the bedroom. They went back to get the other dresser, then the clothes cabinet.

“Dad, when are we going up on the roof?” asked Marshall, who had been running around the yard with Sam.

“Roger and I have to finish first.”

“But I want to go on the roof! Go on the roof! Go on the roof!”

“I know. Wait and be patient. We have one more piece to move.” Will turned away; he and Roger grabbed Marshall’s mattress—still wrapped with sheets and blankets—from the trailer and quickly carried it downstairs. “I’ll take Sam with me and start loading the trailer,” said Roger. “You can run up to the roof with Marshall quickly, then join me.”

“Okay, that’ll work. Thanks.”

They put Marshall’s bed on the floor of his bedroom—at 4 meters by 5, it was twice as big as his old room—and started out of the room when Marshall and Sam came in. “Do you like your new room?” Will asked.

“I guess,” Marshall said, reluctantly.

“Come on, Sammie, we’re going back to get another load,” said Roger, taking his son’s hand. He led the boy out of the house.

Marshall looked at his bed, then looked at his window. It was much bigger than his old window, but there was no view; a meter beyond the window was the bubble edge, then the outer wall of the biome, covered with white plastic to reflect in as much light as possible. He pointed. “There’s nothing to see!”

“No, but there’s something else. Watch.” Will grabbed the window handle, turned it, and pulled. The window, which was a meter wide and a meter and a half high—from the ceiling to his knees—opened inward. “Look, you can step out here if you want.”

“Really?”

“Sure.” Will picked up his son and put him down outside the window on the vinyl floor. Then he stepped out himself. There was barely enough room for both of them.

“I have my own porch!”

“And so does Lizzie. We can plant some flowers and vegetables out here, if you’d like.”

“That’d be fun!”

“I thought you’d like that. And I can put my roses out here—”

“No, not your roses!”

“Marshall, I have to put them somewhere.”

“Put them on Lizzie’s porch!”

“But she’s small and the roses are covered with prickers—”

“No, not here, daddy! Put them in your bedroom!”

“They won’t get enough sunlight there.”

“Well, they can’t go on my porch!”

“Alright, alright. But no shouting out here, because the people above us have balconies opening onto the light well also, and you’ll disturb them.”

“Will Sam’s bedroom be up there?”

“Yes, I think his will be right above yours.”

“Oh, good!”

“No shouting back and forth at night! Come on, you wanted to go up on the roof.” Will took his son’s hand and they walked back into his room, closed the window, then returned to the building’s lobby and went up the stairs. At the top, Will pulled out his swipe card and was pleased to see that it opened the door; he wasn’t sure it would.

They stepped into a sea of green. The metal sides of the garden squares were over Marshall’s head so Will placed him on his shoulders. Will was always amazed how light children felt on Mars; it made him wonder whether he’d be carrying Marshall when the

boy was ten. Marshall was immediately surprised to see rice on his right, with a few fish swimming underneath; the paddy covered almost half of the roof. On his left was a corn patch with corn rising way above his head. “Wow!”

“It’s really something, isn’t it?” said Will. “I’m impressed that it’s growing so well. The sunlight isn’t completely back to normal levels, with all the dust in the air.”

“I guess it’s enough,” said Marshall.

Will walked along the trail between the two gardens to the edge of the roof overlooking the yard and they looked down at the trees, grass, flowers, and vegetables growing below. Then Will walked to the left past the corn to several squares of vegetables. They didn’t look quite as vigorous; Will knew that there had been major problems with the soil microorganisms in their plots, and some of the species required full sunlight. Even so, the tomatoes were beginning to bear, and a six-legged robotic picker was striding among the vines, picking ripe tomatoes and loading them into a pouch. Father and son came to the western end of the roof and looked at squash vines climbing a trellis placed against the outer bubble. Marshall pointed. “Look, it’s the outside!”

“Of course. Up here you can see out. But our apartment windows look inward on the flowers and trees.”

“Oh, there’s the escarpment!” Marshall pointed northward and Will looked.

“You’re right! This is the first sol we’ve been able to see it in almost three months!”

“It’s good to see it again. But daddy, I liked being able to see it out my window.”

"I know. But we have a much bigger and more comfortable house, now. And you have a porch instead."

"That's true." Marshall stared. "Daddy, you said you'd take me to the escarpment some time in a ranger, remember? I want to go see it."

"I remember. Well, I suppose now that you're five we can do that. We should wait a little while longer, though. Right now there's so much dust in the air, there's nothing to see. In another month it'll be much better."

"You're right," agreed the boy. "And my party's next weekend, right?"

"Right, the party with the family. I'm sorry we had to wait, but everyone's moving right now. We want to get the house set up first."

"I know, but at least I had a party with Sam and Lizzie and Corazon the other sol. That was fun."

"Yes, that was nice," agreed Will. "Come on, we've got to get back to work. We have to get everything moved this sol, so we can sleep in the new house tonight. And then we have to help Roger and Madhu move all their things tomorrow."

Will hadn't visited the Mars Biological Facility for several months and was struck by how cramped it was. All four staffers were there to brief him: Shinji Nagatani (who was in charge), Tang Enlai, Jacques Deschanel, and Kim Irion. The twenty by six meter facility was stuffed with x-ray machines, high-powered microscopes, and chemical analysis units. One area was filled with clay models they had made of some of the organisms. Rocks littered the place and covered groaning plastic shelves. But they had

cleared their central conference table and spread out ground-penetrating radar images for Will to examine.

"This is the spot," said Shinji, pointing to a ghostly ring in one radar map. "We've named it Mendel Ring. It's a wide, shallow basin under 400 meters of oceanic sediments about forty kilometers across and 500 meters deep. Neal looked at the image and consulted with some folks at Brown University. They think Mendel was formed in the early Noachian when the Borealis Ocean was about four to five hundred meters deep at that spot. The asteroid was 2,000 meters in diameter and evaporated a vast amount of water. The steam explosion produced a big, shallow crater, rather than the standard bowl type."

"So, this is up to seven hundred meters below the surface?"

"Actually, more. Look here." Shinji pointed to a smaller ring inside the big one. "This is a fairly standard bowl crater about five kilometers across and 400 meters deep. It seems to represent a hundred-meter diameter chunk of the asteroid that broke off before impact, probably from Mars's gravity after the body passed inside Roche's limit. Apparently the crater formed within seconds of the first, before the ocean had flooded back. The bottom of this little crater is about a kilometer below the surface. That's where we'd like to drill. Not only will we penetrate a kilometer of ocean sediments, but when we get through the crater floor we'll be deep under the ocean, either drilling through the pre-oceanic crust or the earliest oceanic sediments."

"Perfect for finding the earliest Martian life," added Enlai.

Will nodded. "So, we're talking about drilling over a kilometer into Mars; maybe 1,500 meters. What did Alexandra say about that?"

“Her team can modify a driller to do it in about six weeks,” replied Shinji. “The plans for such a modification were drawn up in Moscow about three years ago. With our improved ability to make alloys and plastics, the plan needs some refinement. We’d case the shaft rather than leaving it open. Based on our known drilling rate in Boreal ocean sediments, the shaft should proceed at twenty meters per sol. In two months we could get as far as we need to go.”

“We’d need three or four people, a ranger, a buggy for back-up transportation, and a conestoga or mobilhab,” added Enlai. The mobilhabs were their new, super-large vehicles eight meters long, 4.75 meters wide, and two stories high, suitable to serve as temporary housing and work space for six to eight people for months. “This site is four hundred kilometers east of the Polar Trail, so we’ll have to clear a side route to it, the ‘Mendel Trail.’”

“Good name. I don’t think a mobilhab will be available, though. Both are committed to expeditions. Same with the conestogas. Even a ranger will be hard to obtain, but we can find that. We do have three porthabs; you could take one of them. They can be covered with vinyl sheets and buried under regolith to reduce the radiation exposure. You’ll need a nuke, right?”

“Definitely. Drilling is energy intensive,” said Enlai.

“When do you want to go?”

“If Alexandra can get the drill modified, early May,” replied Enlai. “I’ll go with Kim and Jacques, if Therese will let him go.”

“The baby will be just six months old then. Otherwise, who?”

“Qingtian is willing.”

“Okay. His geological experience would be quite valuable.”

“I’m sure Therese won’t let me go,” added Jacques.

“Michiko as well,” Shinji added, speaking of his situation. “She says I’ve been exposed to enough radiation already.”

“And she’s right,” added Will. “I’ll tell you, normally I’d say we’d have to plan this months in advance. But we’ve all been stuck here for three months and we’ll be struck here at least another month. The main construction is over and we’re now doing supplemental work. Everyone wants to get out ‘on the range,’ as it were. So I guess we will. The questions that have to be resolved are two: when can Alexandra’s team prepare the driller? And when can we schedule the ranger? We may want to coordinate the trip with another expedition as well; Érico plans to lead an expedition up the Polar Trail about that time to circle the north pole at about 45 to 50 degrees latitude, clearing the Vastitas Borealis Trail. They’ll pass in and out the polar deposits and stop at the Viking 2 landing site. They could add Mendel to the trip, help clear the trail to it and the landing strip there, then set off on their expedition. A sunwing could connect the two expeditions together and allow each to provide some backup to the other; they’d never be more than five or six thousand kilometers from you.”

“How long will the Borealis expedition last?” asked Shinji.

“Eight months; longer than you’re planning to go. But the driller could be left and run remotely, with occasional maintenance visits by sunwing. Possibly a team could drill at another location, too. I’m sure there are other possibilities.”

“Oh, definitely,” replied Shinji. “If we could find the people to run it, we could select another site.”

“Let’s talk about it.” Will looked around. “You need a bigger facility. The entire top floor of Renfrew will be empty soon, and it’d give you fifty percent more space.”

“Could we have it?” asked Shinji, surprised.

“I think so. The top floor of Joseph will be converted into an expanded machine shop. Lower Renfrew will become a crafts area. We can use the old docking units and this inflatable bio lab elsewhere on the planet. There’s talk about setting up some semipermanent facilities; maybe one in the north polar areas, maybe one in southern Hellas, maybe one in Isidis or Tharsis. We’ll see.”

“I’d favor more mobilhabs,” replied Shinji. “They’re portable.”

“We need much faster air transport, too,” added Will. “The Commission’s looking into that problem.” He sighed. “There’s so much to do. And I’ve got to run; we’re having my mother, sister, and brother in law over electronically for Marshall’s fifth birthday party.”

“Thanks, Will,” said Shinji, with a smile.

“Any time.” Will rose from his chair and headed out of the lab.

He walked through Habitat 3 on his way home and passed Martha Vickers going the other way. “How’s Charles?”

“Oh, tired of Deimos! But I think they’re all enjoying the work, in spite of the duration.”

“They have accomplished our only significant science so far, and they’ve reconfigured the drillers to make a lot more fuel for us, so it has been a successful expedition. Don’t worry; I think they’ll be landing in four to six weeks. The dust storm activity is waning.”

"I know. He'll be here for the baby, at least."

"Definitely. How are you holding up?"

"Alright. We definitely need another psychiatrist here. But I'm happy to say one couple considering marriage is in counseling and it's going well, and I think another marriage is getting off the rocks."

"That's not easy to accomplish; congratulations."

"Thank you. They're working pretty hard. As for your 'conversations' with various people; Will, keep encouraging John Hunter. He's coming out of a shell of some sort. And keep working on Ruhullah, he's beginning to make some friends here."

"I've noticed, and he's more comfortable around me as well. I'll keep up my efforts."

"You should consider counseling if you ever need a second career."

Will smiled. "Thanks." He continued on his way across the tunnel between Habitat 3 and 4, then he entered another tunnel that connected to Clarke Dome. It looked relatively bare now that many of its trees had been moved to Yalta, and the once "huge" space looked small by contrast with their first biome.

After crossing the dome he entered another short tunnel that sloped downward to the east end of Yalta biome. He crossed the patio and paused in the yard long enough to watch some of the work being done on the swimming pool. Then he entered building 1 and went down the stairs to his new apartment in the garden level.

The house was immaculately clean, nicely arranged, and full of people. In addition to Marshall's closest little friends—Sam and Corazon—a few adults had been invited: Roger, Madhu, Érico, and Carmen, who were their closest friends by default and

seniority. Michiko, Shinji's young wife, was there as well; Shinji was still on the way, since Will had just seen him at the Mars biology lab. The large screen on the living room wall had two images on it; one of Will's mother Katherine, his sister Molly, her husband Taraz Nuri, their fifteen-year old son Paul, and a five-year old neighbor of Katherine's, Jerome Case; the other was of Ethel's father James McGregor, her sister Gina, and Gina's eleven year old daughter Karie. Marshall's deferred birthday party was proceeding on two terrestrial continents and two planets.

"Where have you been?" asked Ethel. "We had to delay the cake."

"I'm very sorry, I had a meeting and it started late."

"We're really happy you liked the adventureman set, Marshall," exclaimed Katherine suddenly over the video link. "We thought you would! It seemed perfect."

Marshall walked to the videophone controls and pushed a button. He looked at the screen. "Thank you again, grandma. Sam and I are already playing with it; it's great!" He looked at his father. "We opened their present a little while ago, daddy. She gave me the whole adventureman set!"

"Oh, that sounds like fun." Will patted Marshall on the back. The boy was about to hurry back to Sam to play more when Jerome stepped up to the screen. "Marshall, I have an adventureman too! I love it! I wish we could play with it together."

Will was startled to see Marshall's response. He looked thrilled, like he was talking to an identical twin. He reached over to push the respond button. "Thanks, Jerry, I wish I could play with you, too! Maybe we can play over the video screen some time." Then Marshall headed back to Sam, seemingly a bit reluctantly.

Will turned to the video controls and pushed the respond button. “Hello, everyone. It’s good to see you; I’m glad you were able to attend Marshall’s party. Paul, you’re getting really big! You could come here to Mars in about a decade if you want; keep that in mind. Jerry, I’m so glad you’ve come to the party. Marshall needs a friend his own age; as you may know, he’s the oldest kid here on Mars. Mom, I really like your new haircut. Yes, I did notice; Ethel hasn’t said anything to me! I’m sorry I’m a bit late. I was meeting with the biologists, who are making a plan to head north to a particular site where the drill might get them some good samples. We’re also talked about rearranging the entire Outpost, because with almost everyone moved into Yalta, half the rest of the Outpost is empty! It’s kind of eerie walking through the Habitats at night when no one is working in them. We’ll end up using a lot of the space for storage and emergency backup housing if we have a problem with Yalta. Of course, work will start on Catalina pretty soon. Anyway, let me know how you all are doing. I’m looking forward to hearing.”

He pressed send; they were basically sending video mails back and forth, with cameras at all three locations continuously sending five frames a second in black and white unless someone was sending an audio message. It gave them a jerky, grainy view of each other, punctuated with sharp, high frame color transmission every minute or so.

Will turned to Marshall. “What’d you get from grandpa?”

“A new computer game; it’s the latest Dungeons and Dragons of Mordila.”

“Oh?” Will was not sure he approved of his son’s interest in such games, but software was easy to send between planets. He turned to the video controls and sent a message to Scotland. “Good sol, Grandpa James! Marshall loves that software series, as you know, so thank you very much. I see you have quite a birthday cake there. I think I’d

like your cake more than ours! We're getting out our cake now, so get ready to light your candles."

The birthday cake came out, with five candles—real candles!—on top. It was the first birthday candles used on Mars; Ethel had made a batch just last week, now that Yalta's large volume of air was available to handle the smells and pollutants. Candles were lit in Connecticut and Scotland as well, though they would not see them for another half hour. Marshall was clearly delighted and quickly blew them out. "Did you make a wish?" asked Ethel.

"That you can light them again, so that I can blow them out again!"

"Sorry, I don't have another match; we didn't make many." She did have another match, but she didn't want Marshall to keep asking to have candles lit. "What's your other wish?"

Marshall smiled. "That daddy will take me up to the top of the escarpment in a ranger!"

"You still want that birthday ride?" asked Will. "Okay. I think next Satursol the dust storm will have cleared away enough. We can go up then."

"Can I go too?" asked Sam.

Will looked at Roger, who seemed interested. "Maybe both boys and their fathers can go," he replied.

Satursol morning was rather busy, but the trip to the escarpment was scheduled for the afternoon. Right after lunch Will was running home with Marshall so the boy could use

the bathroom—he didn't want to pee in the ranger—when John Hunter saw them and waved. "Commander, have you a moment?"

Will looked at his son. "Why don't you run home to use the bathroom; you don't need my help." Marshall nodded and ran off. Will turned to John. "How have you been doing, lately? I've been meaning to ask."

"Thank you, that's kind of you. My geochemical research has been postponed somewhat by the situation; not directly because of the storm, but indirectly, because the geologists I usually would collaborate with are doing construction or are exploring by Prospector, and because the increased number of people doing construction also increases the demand for industrial chemicals. So I've been busy lately synthesizing ammonia, hydrochloric acid, polyvinyl chloride, vinyl, and a dozen other compounds. But I have made some progress studying the chemistry of Martian magmas in the upper mantle; that work is being done in collaboration with geochemists at the University of Hawaii, who have the equipment to synthesize conditions in the upper mantle."

"You've been teaching there, too."

"Yes, one course a semester by video, with videomail exchanges with the students and a lot of support provided by a capable graduate assistant. But I wanted to ask you something. Can you step into my apartment for a moment?"

"Sure, of course." Will followed John downstairs. He was their closest neighbor, sharing the other half of the garden level of building 1. John opened the door—it sensed his ear piece and unlocked automatically—and they entered his living room, a space four meters by five. It had a locally machine-woven polyester rug of his own design with a thunderbird in the middle. A couch ran along the right wall with large pillows, also

locally made; he had an easy chair as well. The wall had several large pictures of the Bad Lands and the Black Hills of South Dakota. A door in the back of the living room in the middle led to John's bedroom, bathroom, and to a second exit that took him straight to the tunnel to Joseph Hall. A window on the left side of the rear wall two meters wide ran from floor to ceiling and let in natural light, which flooded down the light well beyond and poured into the room.

"My question has to do with the light well. I love it; not only do I have this window, but the bedroom has a huge picture window onto it and the hallway to the bedroom includes a door giving access to it. As you can see, I usually leave it open." He pointed. "For me, having a place that actually includes a piece of *ground* is a blessing I never expected to have on this planet. Now, the wall opposite my bedroom is the wall of your daughter's bedroom. I don't know whether that means I should consult with you about it or not."

Will interrupted. "I am happy to hear your ideas, but I regard this light well as your property, so you can use it as you wish. Lizzie's windows face the other way, so she can't see into most of your area."

"I understand that. What I'd like to do is obtain some plastic trellises and put climbing plants in pots; morning glories, for example. No one would object to that?"

"I don't know why they would, but you can ask your neighbors above whether they'd like to look out their windows at flowers or not."

"I plan to do that. I know I can get the pots and seeds from Ecology. But I have a more delicate question. I'd like to plant a few other species in my light well. I brought seeds of traditional tobacco with me, the kind grown by my people for centuries. I also

have some gourds, beans, and maize. The gourds would enjoy climbing up the wall as well."

"Have you spoken to Lisa about this?"

John hesitated. "No. So far, I've kept the seeds in hermetically sealed pouches. If they have any microorganisms—germs—they haven't been able to escape. I know that will be her concern. Of course, the light shaft is wholly inside building 1's bubble, so nothing in my garden can get outside."

"Except on your hands. You'll be handling soil, then walking outside."

"I can always wash my hands very carefully."

"John, if the wrong species were to get loose in the biome, it could cause a cascade of problems. It could cut food production ten percent, which would cause quite a problem for us."

"I understand all that, of course. I'm just hoping we can find a way. The seeds were packed a bit over a year ago; I need to plant them pretty soon, or it'll be too late."

"I see." Will considered. "Let's you and I schedule a meeting with Lisa about this. I think she can look at the seeds under a powerful microscope and make sure we only have tobacco, and she can apply a germicide to them to kill fungi and other undesirables. We can find a way."

John smiled. "That would be marvelous, Commander."

They turned and headed back to the front door. "I'd like to ask you a question, if I may," said Will. "Is John your real name?"

“Yes and no. My parents gave me a Christian name—they’re Catholics—and a Lakota name. Depending on the situation, I use one as my first name and the other as my middle name.”

“Why don’t you use your Lakota name here?”

John was surprised. “I’ll think about that.” He opened the door.

“I had better go find Marshall. He’ll wonder where I am. See you later.” Will headed out of John’s apartment and entered his own. Marshall had obviously used the bathroom; the toilet seat was up. But the boy wasn’t there. Will checked the water closet, which had their second toilet, an essential when one had small children. No Marshall. He went back out and up the stairs. Marshall was with Roger and Sam in the courtyard.

“There you are!” Marshall exclaimed.

“Let’s go,” replied Will.

The four of them headed back inside the building and through a tunnel across it to another tunnel that took them to Joseph Hall. A ranger stood waiting for them in the garage. Will and Roger grabbed their spacesuits and took the two smallest ones on the rack; both were much too large for Marshall and Sammie, but in an emergency they’d keep the boys alive and the fathers could carry them. They loaded up the ranger with everything they needed for the trip and checked it for supplies. Then they closed the doors and began to lower the atmospheric pressure slowly, because the ranger used a pure oxygen atmosphere, rather than the Outpost’s 0.33 atmosphere, 60% oxygen and 40% nitrogen.

They drove into the airlock, then outside. The boys were sitting in the front right seat; Roger was in the middle seat; Will drove. The boys began to jump up and down

with excitement as they looked at the terrain; Roger calmed them. Will took the main route to the escarpment and the boys watched the wall of rock grow larger and higher by the minute. They stopped at a nice overlook for a few minutes, then drove toward the Little Colorado Trail. Marshall and Sam both expressed surprise when the ranger headed straight to the talus slope, then diagonally up the rock pile on a roadbed of frozen dirt. In a few minutes they were at the bottom of a canyon so narrow and deep that it was surprisingly dark. But after they drove in, it began to widen a bit and rose steadily upward. Where the canyon bottom originally had had waterfalls there were now ramps blasted into the canyon side; over the last five years the trail had been steadily improved and was now pretty wide and safe.

Will drove prudently at a reasonably slow speed; he rarely went over thirty kilometers per hour. But for boys who had never been in a vehicle before and had never been outside the Outpost before, it was incredible. Roger pointed out brightly colored layers as they went; the 1,500 meters of cliffs contained a billion years of volcanic eruptions, meteor impacts, sand storms, floods, mini-glaciations, and tectonic shifts. The boys were too young to understand, so he stuck to the colors; the canyon was one of the more spectacular areas on Mars.

After half an hour they drove up one last steep ramp and were suddenly on a rolling plateau. The boys were startled by the sudden change. Roger pointed Will toward a faint dirt track and he turned onto it. It snaked southward along the rim of Little Colorado Canyon for twenty minutes until Will slowed as they approached the top edge of the escarpment.

“Go over here,” said Roger, pointing toward a prominence sticking southward from the rest of the cliff. “I’ve walked the area; it’s solid.” Will nodded and drove toward the prominence, very slowly, until he stopped the ranger just two meters back.

“Take a look,” Will said, with a smile.

“Wooooowwwww!” exclaimed Marshall. He pressed his nose against the windshield. The dust storm had cleared fairly extensively; Roger pointed out the Outpost about twenty-five kilometers away.

“This is a great spot,” said Will.

“I’ve got to tell Jerry about this place!” said Marshall, referring to his friend in Connecticut.

“This is the place I was suggesting we put the dacha,” exclaimed Roger. “See the shape of the cliff? It’s crescent-shaped, just like our buildings. From the third floor the view of the valley would be incredible.”

“It would be.” Will looked around. “The hike along the edge would be pretty interesting.”

“It is; I’ve done it. And if you walk about a kilometer northward along Little Colorado’s rim, there’s a wide landslide scar and one can go down the cliff face pretty easily. It gives access to a series of ledges on the escarpment face.” Roger raised his voice to be heard above the boys. Then he grabbed Sammie. “Hey, calm down, and don’t shout! Just look!”

“Daddy, can we go outside in a space suit?” asked Sam.

Roger scoffed. “Get real, my boy. You have a few years to go for that!” Sammie looked crushed; Marshall looked at Will, who shook his head.

“So, we’d put one of the two bubbles here. It looks to me that the floor of the bubble would lap over the cliff in a few spots.”

“It could. I was thinking that we’d build half or two thirds of the bubble and leave part of it as a garden or an open spot. We’d want a pool, sauna, and Jacuzzi if possible.”

“That’d be nice. Let’s push this idea. I think it’s time we have a little vacation spot, and we’re not talking about an excessive amount of work. This is a spectacular choice.”

“That’s what I’ve been saying for months.”

9

Midpoint

April 1-10, 2045

Horizontal rays of the early evening sun slanted across the biome and bounced off the silvered hemisphere covering the eastern half of the bubble, reflecting a bright, midday-like sunlight onto the yard. Will paused just outside building 1's revolving door to watch Lal Shankaraman pull hard vinyl panels across the swimming pool, covering it. "Hey Will, do you want to play some basketball? I need one more on my team." Lal was wearing a tee shirt and shorts, the sort of outfit that, before the biome had been occupied, no one ever wore around the Outpost. The swimming pool, lying between the two baskets, would soon be a part of the basketball court.

"Thanks; maybe tomorrow. I've got a meeting to go to right now."

"A meeting at 7 p.m.?"

"It's 10 a.m. in Houston right now."

"Oh, of course."

Will turned and headed across the yard, then crossed the patio where a dozen residents still sat drinking coffee. The patio had become their permanent eating spot, facilitated by the relocation of the kitchen into building 1 last month. The first and garden levels of building 2 housed Silvio's new store; only five meters by six, it was small, but neat. Silvio waved as Will walked by.

A short walk put him in Clarke Dome, 32 meters in diameter. Their old "park" was now devoted to agriculture, packed with vegetables and fruit trees, with a rice paddy and tilapia pond occupying one side. The only public space was a small paved area with a

bench and flowers overlooking the pond. Lisa Kok was cleaning the pond's filter; he paused while she finished, then they walked together. "What's the topic of this meeting?" she asked.

"I'm not sure, but it sounds pretty urgent."

"They aren't complaining about the dacha, are they? That misunderstanding took you two sols to fix."

"No, they finally accepted the plan. With Yalta completed Catalina started, we have plenty of people and equipment to set up the foundations for our dacha."

"I hope it isn't the ecology here. I'm afraid the setup transition has been pretty difficult; the biome won't be functioning at full efficiency for at least a year. The buildup of nitrogen oxides in the air has been particularly tricky and I think we'll have to conduct another purge of the atmosphere in early June. It appears to be needed once every six weeks for a while."

"I saw your memo. Don't worry, I don't think ecology is the issue of this meeting. And we'll have Catalina pressurized in a few months, so we'll have plenty of time to set up its agriculture. We won't be rushed."

"Then what is the problem?"

Will shrugged. "Public relations, probably."

"It has been dismal, lately, and NASA's support hasn't been great, either." Will nodded, and he judged Lisa's comment as a bit extreme, but it was true. They had not recovered from publicity damage done by the dust storm and their more complex social life. They continued through the habitats to his office in silence.

Roger Anderson, Pete Theodoulos, and Alexandra Lescov—the other three Will had invited—were already waiting for him. Will's "kitchen cabinet" or senior staff was logically chosen: Roger was in charge of science and exploration, Pete the spaceport and all their space vehicles and was also chair of the Borough government, Alexandra their construction and manufacturing, and Lisa their environment and agriculture, or "ecology" as it was now being called.

"The conference call has already started coming in," Pete said, pointing to a red light on Will's attaché that indicated it was receiving a message.

"They're early," agreed Will. He pulled his chair out from behind his desk while Lisa grabbed a spare chair from the bridge. They arranged their chairs around half of a table in the front of Will's office, facing a large screen on Will's wall. Then Will pushed a few icons on his attaché's screen and the recorded video appeared on the screen.

A similar table in Houston appeared, with the Mars Commission's senior staff: Douglas Morgan, the Commissioner; Louisa Turner, Director of Public Relations; Ginger Petropoulos, Director of Mars Sales; their old friend from Columbus 3, Pavel Rudenkov, who was the new Director of Technological Development; and Krister Soderblom, Director of Governmental Relations.

"Good sol to all of you," began Morgan. "We're convening this meeting because over the last month a serious situation has been developing here on Earth that must be dealt with somehow. To put it simply: we're losing public interest and with it, financial support. It's not clear what we can do about it, though much of the solution probably has to come from Mars, not the Mars Commission. Louisa, you start."

"Okay, Doug. You already know about the problem in public relations, so I'll be brief. During Columbus 4 the public interest was so great, we were able to initiate the 'topic of the month' and focus interviews of crew members, especially the Commander, on that theme. That way public education about the Mars Project around the world was coordinated and reinforced itself. Columbus 4 had some flashy media events: the top of Olympus Mons and both the North and South Poles. Exploration was going somewhere. There was also the birth of quite a few babies, which made life on Mars look like a more glamorous and exciting version of middle class life on Earth.

"But the last six months—after interest in Columbus 5's successful arrival declined and the largest dust storm in thirty years descended upon Mars—have been a media disaster. We had some shots of astronauts bouncing around on Deimos, but the public bored of that pretty quickly, and the scientific exploration of Deimos did not make good t.v., at least not compared to video of erupting volcanoes on Venus! There was a flurry of interest in the new science paper that theorizes where Phobos and Deimos were physically attached to each other when they were captured by Mars, but that dissipated fast. The question of 'dawn life' has gotten old and there have been no new breakthroughs. The issues of divorce and homosexuality have not played well in many areas of the world, though in others they were unimportant. Interest in the biome has been tempered by the impression you are no longer roughing it so much. If we're going to salvage matters we need to get the focus back on exploration, especially if we are to compete with Magellan, which is still dominating space news. More human interest stories might help. Christina Csakany has been very effective on Hungarian television,

and Tina Hvitmer's video journalist skills are excellent. She made Deimos as interesting as is humanly possible." She looked at Ginger, who was scheduled to speak next.

"The decline in public interest has caused range land and fossil sales to drop," said Ginger. "Columbus 4 saw the peak in sales. Since then the price of Mars rocks has dropped by thirty percent and demand is fifty percent weaker. Range sales in the last eight months have been half as much as during the same time period during Columbus 4. As a result, we have an unanticipated $270 million deficit."

"And that's not our only deficit," added Morgan. "As you know, in January the eight-year Republican administration was replaced by a very different Democratic administration. They are very concerned the United States gave up its dominance of the Columbus Project to an international Mars Commission. For a while they considered trying to take the Mars effort back. When that proved unworkable, they asked NASA to plan a series of staffed asteroid missions, including at least one to an asteroid that goes beyond the orbit of Mars. Project Argo will involve landing on at least two, and probably three or four asteroids, staying on each two to three months to explore it thoroughly, making hydrogen and oxygen fuel from the rocks while there, then heading on to the next asteroid. The mission will last three to five years. It would also explore three or four more asteroids remotely or via flyby. The mission will test interplanetary technology for longer periods of time; Jupiter and Mercury missions may very well be in the fifteen-year planning horizon. NASA has also been commanded to put more resources into Earth orbit industrialization to help U.S. companies to fly manufacturing experiments in Earth orbit. NASA is supporting Boeing in its effort to build its own reusable shuttle like the Swift, but cheaper, if that's possible.

"The Mars and Lunar Commissions will be gradually cut loose. The moon is now doing rather well, between a billion dollars per year of tourism and a billion dollars of leases of land with ice regolith and meteoritic nickel-iron to private companies. It may be able to do some light manufacturing for export to low earth orbit. But Mars is much less able to provide for itself. We will have about a billion per year less money for developing new technology for use on Mars, and we won't be getting any more reactors. I doubt we'll get any more Mars shuttles or ITVs, either. Krister, speak about government relations."

Soderblom nodded. "My main job right now is selling our thirty positions on Columbus 6. The United States has cut back to four slots, and seems generally to feel that Mars doesn't need any more people than it has now. France won't be flying anyone, since Magellan had big cost overruns. The Europeans together will fly maybe four people. Russia will commit to four; they rightly see an opportunity to increase their position on Mars. The Chinese are also flying four. That's sixteen, leaving fourteen more. I'm afraid you won't get many couples, since the remaining countries can only afford to fly one citizen. So far, I've got ten commitments, from Australia, Chile, Canada, Indonesia, Israel, Malaysia, New Zealand, Pakistan, Palestine, and Saudi Arabia. The other four are proving hard to fill. The Mars Exploration Society may manage to fill one slot, and Muller Mining might send someone to work their holdings to export gold. We never thought selling slots would be so difficult. Many countries will be sending someone who does not have experience here in the Commission, so the new residents will not have the same characteristics." Soderblom looked at Rudenkov, who spread his hands.

“I don’t have much to add. With NASA cutting a billion a year from its Mars and lunar technology programs, we can’t expect a new generation of vehicles any time soon. The reactor development program has been suspended altogether; this administration is much greener than the last. The solid-core nuclear engines are getting used to launch personnel from low Earth orbit to Gateway, though commercial carriers are refusing to consider them because of their cost. Apparently they’ll refuse to use them even when a Swift shuttle able to launch hydrogen cheaply starts to fly. The Russian and Canadian commitment to Martian surface structures remains strong, and European commitments to ecology and medicine are unchanging so far, so we can still count on them.”

“I suppose the only good news is that the Swift Shuttle has been doing so well launching tourists to low Earth orbit,” noted Morgan. “It has already accumulated 258 launches, all safe. With experience and slightly larger payloads, the operating costs have dropped by another third. So launch costs all the way to Mars are now a third less. If Swift’s technology could be applied to a second-generation Mars shuttle, we’d have a cheaper and more reliable vehicle. But no one will make that investment for some time; we may have to have a mission failure first.

“If we extend the amortization schedule to cover the ITV and Mars shuttle costs to 26 years—12 columbiads—and cut back slightly on refurbishment costs, we can lower our costs to fly each person to Mars to about $150 million plus $10 million *per columbiad* for cargo support. This is roughly a tenth of the cost per person for Columbus 1. The rate we’ve been charging—$250 million up front and $10 million *per year* for twenty years if the person stays on Mars that long—will cover our operating costs and

leave some money for technology development. So the wolf's not at the door, not yet. But we're in a tight spot.

"We're asking you guys to help solve the problem. We don't expect answers right away; this is not a true teleconference. Let's plan to meet again in 24 hours—one day, not one sol—and see what progress was made. Maybe a daily meeting for the next week will keep us moving forward."

The image froze; the transmission had ended. Will was surprised that a response was not expected.

"We can be thankful they asked us, rather than telling us what to do," noted Pete. "They're bright and full of ideas, and they know our situation here in detail."

"Morgan's good that way," replied Will. "I'm sure everyone will compare our ideas against their mental list. We'll hear their ideas after they hear ours, I think."

"We should be able to kick-start exploration very soon," said Roger. "The global dust storm has been clearing steadily. Solar power output is up to 70% of normal, right?"

"Correct," said Lisa. "It sounds like we'll be using a lot more solar power, too!"

"Pete, what's the thinking about the *Elysium?* That they should be able to land late next week?"

"Correct. The *Apollonaris* is scheduled to launch in three sols, visit Phobos, and pick up the rest of the cargo. Then both shuttles will come down."

"Once they're back, let's get at least one expedition out," said Will. "And let's make sure we include some spectacular scenery! Roger, I know science is your department and not scenery, but plan on both."

“Aye aye, Commander.” Roger sounded a bit disappointed, but recognized the inevitable.

“’We’ve got to increase exports,” noted Pete.

“We’ve already extracted some platinum-group metals from meteoritic nickel-iron,” exclaimed Lisa. “They’re considering that process on the moon.”

Will shook his head. “Typical M-class asteroidal material is about 35 parts per million platinum-group metals. That’s 35 grams—about an ounce—per tonne. Our equipment can process maybe fifty tonnes a year, 100 per columbiad. So that’s only 3.5 kilograms of stuff, worth about $100,000.”

“I’m skeptical the lunar plans will ever materialize,” added Pete. “It isn’t clear anyone will invest the several billion bucks needed to scale up the technology a hundred fold, give the moon the electrical generation capacity it’d need, and import the large quantities of carbon the refinement process requires.”

“The most valuable thing Mars has in quantity that’s readily available is gold,” said Roger, reluctantly. “We know where a lot of it can be found, thanks to the detailed remote sensing done by sunwing and from orbit. It’s too bad the economics of gold export are so bad.”

“Bad?” asked Pete.

“The calculations were done five years ago,” said Will. “No one was sure about the Swift shuttle then, or the continuing maturation of the transportation system.”

“Things have changed!” exclaimed Pete. “Right now gold is worth $2,000 per ounce; that’s sixty million bucks per tonne on Earth! If we could export thirty tonnes, the

1.8 billion dollars would cover a fifth of the Mars Commission's costs per columbiad. The more, the better."

"Thirty tonnes?" laughed Roger. "That's impossible. Any attempt would consume most of our human resources, and the outpost isn't located near gold, either."

"On the other hand, if the thirty newcomers devoted their first two years here to gold harvesting, surely they'd pay for their entire trip," noted Alexandra. "Gold should be much cheaper to harvest here because the only deposits left on Earth are in the parts per million range."

"We don't have the equipment to pursue gold in large quantities," objected Roger.

"Something for Columbus 6 to import," replied Will.

"So much for science." Roger scowled.

"Could we use an SCN-25 to get things here?" asked Lisa.

"We probably could for a late flight of extra personnel or cargo," replied Will.

"I think we need to get everyone involved in this discussion," said Lisa. "We can trust the residents to keep it confidential."

Will considered the idea. "Let's give people the option. We'll need the morning to collect background information. Let's invite obvious people to join us, like Silvio. Others can participate if they want."

They brainstormed an hour or so, then went home to think about the problem and invite others to help. After breakfast the next morning they talked in the lounge outside the bridge in Habitat 2, then divided into smaller groups to concentrate on specific problems.

“If you want to sell more land, investors have to have confidence their asset will increase in value,” said Silvio to the exports task force. “Muller Mining has sunk 125 million bucks into mineral leases here, but Muller is an exception; he invested with a fifty-year return in mind. Most investors think in terms of ten years, and five is even better.”

“Demand for fossiliferous rocks is dropping,” added Will. “Gold seems to be the easiest, most valuable export we have.”

Silvio nodded. “We’ve detected four gold-bearing zones. We should send expeditions to all of them and learn more.”

“But we’re already planning some pretty exciting science,” replied Roger. “It would be a distraction to science to spend weeks prospecting for gold.”

“We’ll have to combine science with prospecting, just as we combine science with media coverage now,” replied Will. “This is a real world problem.”

“I know,” replied Roger, reluctantly. “We have to do what we have to do.”

“I think we can harvest quite a lot of gold with the existing equipment if we find the right lode,” exclaimed Érico. “Earth has a history of incredibly rich spots. Mars should be the same. I bet a team of six, sent to the right spot, could harvest ten tonnes.”

“I agree,” said Lal. “The deposit at Candor Vallis is rich, even if we have recovered the richest spots.”

“Remember we only have capacity to send a hundred tonnes back to Earth every columbiad,” warned Roger.

Pete shook his head. “Our system has a lot of growth potential. The automated cargo landers only have to burn off 400 meters per second of velocity to settle into a high

orbit around Earth. They're designed for the higher delta-vee required to aerobrake into Mars orbit. The 2.4 tonne aeroshields can aerobrake 24 tonnes into orbit around Earth, and if we spray on ablative compounds to thicken the shields they could haul 30 or 40 tonnnes."

"But how will we get forty tonnes to Mars orbit?" asked Roger. "It'll burn out the shuttles."

"A fully fueled shuttle is designed to lift twenty tonnes to Embarcadero, but it can put forty tonnes into low Mars orbit," replied Pete. "There, it'd rendezvous with a Lifter; fully fueled on Phobos, a Lifter can reach low Mars orbit with 48 tonnes of fuel, enough to push the cargo all the way to Earth. The Lifters are much simpler technology than the shuttles, so we should minimize the use of the shuttles and maximize the Lifters."

Will nodded. "So, you think an ACV can carry up to forty tonnes to Earth?"

"Yes. The reaction control system is rather underpowered and would need some reprogramming, but would be adequate. The navigational system doesn't care whether it's guiding ten tonnes or a thousand. Gold is dense, so it doesn't take up much volume."

"It may take some work to convince Mission Control, however," said Roger. "What's the life of the Lifters? Ten round trips before reconditioning?"

"Yes, but the big issue for us is number of years before reconditioning," replied Pete. "The Lifters were designed for ten round trips between the lunar surface and Shackleton; ten rather energetic round trips. We keep them here three columbiads—about seven years from Earth departure to Earth return—and never use even half of their flight capacity."

"We have a lot of unused capacity," agreed Will. "The shuttles can carry more than twice as much to Martian orbit, the lifters can push twice as much to Earth, and the ACVs can aerobrake twice as much into earth orbit. Pete, we need to nail this down. Roger, can you send out expeditions to the various gold deposits? A six week exploration of the upper Marineris system would get gold and great video."

Roger nodded reluctantly. "We could use the gold deposit as a base of operations. Some could explore while other run the equipment. One deposit east of Cassini Crater is near fretted terrain in Deuteronilus, an area we've wanted to visit for some time."

"Let's do it," agreed Will. "Of course, science oriented around gold digging probably won't generate great publicity."

"I think we can partially solve that problem," said Silvio slowly, thinking through his idea. "What we do is send out two teams, one for science and one for gold recovery. This is what we really will be doing, too, since one is stationary and the other mobile, and one will consist of geologists while the other will be technicians. And to underline the difference, we need to set up another department here: a department of natural resource recovery. It would be responsible for excavating all natural resources, whether it's duricrust to make duricrete or gold nuggets. It would send out the gold recovery teams."

There was a silence. "It would resolve the gray area we have right now about the responsibility for obtaining resources," commented Roger. "Right now, sometimes it falls on my people and sometimes on Alexandra's."

"That may continue," replied Will. "Because some resources are needed in bulk and are close by—like sand—while others are far away and require our exploration

equipment. But I like your idea, Silvio. If exports are to become a big part of our work here, we'll need a department of natural resource recovery."

"I think we need a department of exports, too," said Silvio. "With a head here and a head on Earth. The terrestrial functionary would sign contracts with companies to extract resources from their Martian property and export them to the Earth for the companies to sell. And the place to start is with Muller Mining, A.G. Mr. Muller had the foresight or generosity to purchase $125 million in range land with potential gold deposits. If he could send equipment, we could use it and get him a product to sell. Then more companies would be clamoring for a chance to invest here."

"That's true," said Will. "Our export costs are pretty low if you attribute the transportation costs to the Mars-bound flight and not the return. Those are excellent suggestions, Silvio."

"Thank you; sometimes it takes a businessman. But don't ask me to run exports; between the store, the bank, and inventory, I'm fully occupied!"

Everyone chuckled. Will turned to John Hunter, Enlai Tang, and Martha Vickers, who had walked up to the circle. They had been talking about science goals.

"We have a radical idea," said Martha.

"That's probably good, right now."

"Quite a few geologists and eobiologists here teach courses by video link and email on Earth. We also have a dozen people here with Master's degrees who are working on doctorates or want to work on doctorates. We've already offered tutorial courses to several of them for credit at their respective universities. So we were thinking that, with about thirty Ph.D.s here, we should establish a university."

"Well, not any sort of university; the 'Mariner Academy,' like a military academy but for space exploration," added Enlai. "Obviously, it won't amount to much right now; it'd be small and poor. But it has specialized resources, since the thirty of us have remarkable training and experience."

"But we'd have almost no students!" noted Roger, and he even laughed a little.

"That's not such a problem, with modern on-line education technology," said Martha. "We can videotape lectures and answer questions by videomail. If we have good ground support on Earth, we could have a fair number of students, and they could be located all over the Earth; the time zone would be irrelevant."

"We'd offer the courses in collaboration with other institutions, then," said Will.

"Of course, through the MIT or Sorbonne distance-education consortiums. They're already reaching millions of students," said Enlai.

"It wouldn't raise much money," noted Silvio. "But it would be good outreach."

"I don't like the image," commented Lal. "Space exploration doesn't need a Sandhurst or West Point. Perhaps 'Mariner Institute of Technology' would be better; a science and engineering oriented university based here in the Mariner Valleys."

Martha smiled. "Yes, that's the title!"

Will smiled. "So, in one sol we've founded Mars's first export firm and its first university!"

The others laughed. "Why not," said Boris Ivanov, who was a sociologist. "Just because we only have forty-seven adults here is no reason to wait. Our forty-seven people have the technology and education to accomplish as much as a small city in the past."

"I'm afraid one thing this means is that all of us will have to work harder," commented Pete. "Especially those of us who are single or who have left our families on Earth. The last month has been a peaceful and lazy time; the biome has been finished and the storm has kept us confined here. But now that has to change."

"I think so," agreed Will. He looked at Silvio. "And pretty soon we may have a few other changes, too; we may have to institute use fees for things like electricity, water, even the cafeteria. If we do that, I'll see to it that we get raises to cover the costs. If we work longer hours, that will be an easier transition."

"Why would we need use fees?" asked Érico, suspiciously.

Will spoke slowly, because the capitalism/socialism clash was a longstanding one. "We appear to be moving toward a time when not everyone living here will be working for the Mars Commission. We may have employees of mining companies living here, for example. And those of us who have lived here four or six years, possibly, could acquire the right to retire fully or partly and start our own consulting businesses or mining outfits. Or for that matter, someone might want to open a restaurant or some other small business. Under those circumstances, everything can't be free; the non-members of the Commission shouldn't get a free ride, and restaurant owners would face competition from a cafeteria that didn't have to cover its expenses."

"Ultimately, fees for products and services is the only efficient way to run an economy," agreed Silvio. "And while we're still rather small, we're just about at a point where we can say that Mars has an economy."

"Strange, to think we have an economy," said Kim Irion, who had been sitting and listening so far. "Maybe we should hoist the Mars flag above the Outpost after all!"

Just then Ethel, Lisa, and Alexandra approached. They had been off talking about construction, ecology, and fabrication. “Oh, you have results too?” asked Will.

“Each of us,” agreed Ethel. “If we run our metal carbonyl unit continuously, we can make about two kilos more platinum before Columbus 5 returns to Earth. There’s still time to import a bigger unit on Columbus 6—a ten tonne per sol processing unit—which could make 120 kilograms of platinum per year and cover its costs in one columbiad. It would lay the groundwork for an even larger unit.”

“Another task for a resource recovery department; they’d have to find and haul in three or four thousand tonnes of meteorites per year,” commented Will.

“And think of the vast quantity of nickel-steel we’d have,” added Alexandra. “The supply would be virtually unlimited and virtually free, since platinum recovery would cover its costs. We could do a lot of building with it.”

Will nodded. “What else?”

“The ecology team plans to meet before lunch,” said Lisa. “We talk briefly already. We’re determined to lick our ecological problems, even if it means working longer hours. The biome can be made to work. We can resolve problems of too many microorganisms in some soil units and too much nitrogen oxides in the air. The biological productivity can increase at least twenty percent. We’ll figure it out. So our contribution is not a new idea as much as a new determination to get our work done. Ecology is the basis on which everything here is possible. Without it, we’d have to import ten tonnes of supplies per person per columbiad. With it, we don’t have to import practically any food.”

"Not to mention the morale element," added Boris. "Our food has been very limited in variety in the last six months because of the low productivity. All of us will welcome higher productivity."

"Good," said Will, looking at Alexandra. "What can you report?"

"My people are investigating whether we can make tanks for storing liquid oxygen and methane, which are possible with abundant nickel steel. We'd add spray-on foam insulation and bury it under a dust layer. We can probably make simple heat shields, too. We're investigating whether we should request a unit to manufacture kevlar. It's a fairly complicated and expensive process, though there have been some manufacturing breakthroughs lately. If we can make our own kevlar, construction here becomes much more flexible. Finally, we're looking at the manufacture of solar cells. There has been a lot of progress in making equipment to manufacture them on the moon, but the lack of certain key materials there has hampered the production of the really efficient cells. Maybe we can do better here."

"How many people are you talking about?" asked Silvio.

"Two or three times the number we have in fabrication and construction now," replied Alexandra, without blinking.

"We're all thinking along very similar lines," said Will. "We'll resolve the staffing issues later."

The discussions continued for ten sols, with everyone in the Outpost contributing ideas. It was conjunction, the usual time for a review of their goals anyway, and the dust storm season was ending. The media learned about the review and covered it, ironically solving

their media problem temporarily. The Mars Exploration Society involved its members in long term planning, vetting a few good ideas from the thousands proposed. Land owners were asked to comment about the future direction of Mars exploration as well. Each evening Will and his team met with Morgan and his team for an exchange of progress reports. One evening a town meeting reviewed the entire situation.

The process reached a culmination on April 10, when the crosswinds dropped enough to let both shuttles land on Mars. The *Elysium* came down first, making a perfect landing on pad number 4. The crew received a joyful welcome.

"You're finally here!" Martha said to Charles. There were tears in her eyes.

"I'm sorry, honey," Charles replied. He reached to embrace her, but her big belly—she was eight months pregnant—made it difficult. He held her gingerly and kissed. "At least I'm here for the baby."

"Yes." And she began to cry. He just held her, with tears welling up in his eyes as well.

Yevgeny came out next, and Alexandra hugged and kissed him as well. He smiled and hugged her; they had missed each other and were delighted to be together again. Andries and Tina came out of the ranger next; Lal, Roger, Érico, and Will were there to shake their hands and welcome them.

"Five months on Deimos," said Will. "At least it wasn't the entire dust storm season! Is there any part of the moon you haven't seen?"

"I don't think so!" replied Tina, with a laugh. "When you fly over the moon now, you see footprints every hundred meters or so."

“We walked all over it,” agreed Andries. “Deimos ain’t so small when you’re walking on it; a couple hundred square kilometers. Pole to pole is fifteen klicks. You could get lost on it!”

“But there’s probably no science left to do there for a long time!” added Tina. “It’ll be four years before anyone can think of a new question to ask about the place for which data is missing! We’ve mapped every fracture inside the moon.”

“Phobos is almost as well explored,” noted Will. “I’m glad you brought the shelter down; we’ll need it here.”

“We ate so much from the supplies!” laughed Andries. “It was a funny diet; filet mignon, exotic frozen vegetables, chocolate, but no fresh vegetables and not much starch! It pushed up my cholesterol.”

“Oh, your cholesterol’s fine,” scowled Tina. “I’ve been monitoring everyone. Our health up there was really good; we figured out how to use the artificial gravity of the ITVs a few sols a week to counteract the zero-gee when we were exploring Deimos. I’m walking almost normally; no wobbles at all.”

“You all look very healthy,” agreed Will. “And I gather there’s a bit of romance that bloomed up there. . .?”

“Oh, Commander, there are some things you always like to stick your nose into,” said Tina, with a smile.

“Well, I hope we’re building something different from western civilization; something with a better balance between the individual and the community than we’ve achieved in the past.”

“People joke it’s a romance made in heaven, and then I remind them Deimos means ‘terror.’” quipped Andries.

Tina poked him in the ribs. “It’s getting to be an old joke; he’s said it a dozen times.”

“Well, part of romance is getting used to each other’s bad jokes. But seriously, I need to talk to both of you privately.” Will looked around. “Let’s go into Renfrew.” He took Tina’s dufflebag for her and she helped Andries with his; it was heavier than they thought. They walked through the airlock and into the old great room, which was now partially subdivided into offices.

“Wow; it looks so strange,” said Tina.

“I can’t wait to see Yalta; the virtual reality walkthrough just isn’t the same,” said Andries.

“That’s right; both of you participated in the lottery, one of you got a unit in Yalta, and neither of you have seen it! I’ll be quick.” He looked at Tina. “We need to open a press office here in the Outpost to work with the press office in Houston. Can you do it? It’ll be half time.”

She was surprised. “Sure. Of course. That’s my training.”

“Excellent. You and I will meet with Louisa Turner and Doug Morgan by video in the next sol or two. Andries, we need to set up a Department of Natural Resources; it’ll be responsible for exploiting Martian resources, everything from the water wells and hauling sand here for construction to copper and gold mining. Do you want to direct it?”

“Is this a full time thing?”

“Not yet, but it may grow to be full time. If we want Mars to grow, we have to export more.”

“So, am I in charge of exports?”

“No; last night Yevgeny and I talked and he agreed to do it. The Commission is appointing someone on Earth as well, and you and I will meet with Morgan and that person at some point. You’ll have a complicated job; we don’t have enough resources to do all the exploration, construction, and exports that we want.”

“From the discussion of the last ten sols, it sounds like we’re going to have a complicated and busy nine months.”

10

Dacha

late May, 2045

Phobos was high overhead, half full, and racing eastward when Will walked through the biome on his way home. He stopped long enough to contemplate the little worldlet, about a tenth as bright as the Earth's moon but bright enough to throw shadows when full. In the biome, however, electric lights made the shadows invisible. Only the brightest stars were visible through the slightly frosted dome.

Will pushed through the revolving door and opened the pressure door inside, then turned left and went down the stairs. When he came to the apartment's front door he said "open please" and waited for it to unlock, then pushed open the door.

The living room was dark, except for a nightlight and a little light coming in from the high windows. The television screen glowed slightly as well with an image of wooded hills in moonlight; some of the Connecticut hills near Will's boyhood home, which would show sunrise when the time for dawn came. The children's bedrooms were on the right; the doors were ajar. They were followed by a blank wall where they'd eventually put cabinets, an electric oven, a two-burner stove, and a small refrigerator; it would be a while before they could be imported or made. The kitchenette area only had a sink. Past it was the master bedroom. He opened the door; Ethel was asleep. She stirred when he entered.

"What time is it? After midnight!" Ethel was surprised. "I wish you had called! Marshall was wondering where you were and wouldn't go to sleep without you. I called you a few times and you didn't answer!"

"I'm sorry. I think all our communicators were going off."

"Well, call! He didn't go to bed until almost 10 p.m.!"

"Oh, God, he'll never get up in the morning. I'm sorry."

"I was absolutely fried trying to get him to sleep. I fell asleep first; when I woke up, he was finally asleep. And then I was so exhausted I just went to bed."

"I can imagine. I'm sorry." He leaned over and kissed her. "This was the worst head of staff meeting I've ever attended. Morgan's getting desperate to close the budget gap; we don't have the money to fly Columbus 6, pay the staff, and cover all the various contracts we've signed. NASA's downright hostile and won't help. Morgan's been calling his Senator friends in Washington and they say the assistance has to be channeled through NASA."

"It sounds like NASA is trying to destroy the Commission."

"Or even the Mars project. It won't be the first time politics has overridden common sense or the common good." Will sighed. "It makes all my heads of staff anti-American, which is another test. And it makes everyone fight to increase their department's share of the pie on the grounds that it will solve our problem. Morgan and Dvorkin—he's the new Director of Exports in Houston—want us to dig 600 million dollars of gold by Columbus 5's departure on December 4."

Ethel was startled. "That's five months! That's impossible!"

"Well, some people think we can do it if we send ten people to Candor right away."

"Ten! Where would they stay!"

"In the Phobos and Deimos habitats and in Biome 2's second building bubble. The latter would be big enough for them; the moonlet habitats would provide redundancy."

Ethel shook her head. "We'd have to send ten more to build their housing, and that means four or five rangers; that's half the operation!"

Will nodded. "And anything less would not be safe. When you calculate the number of sunwing flights and cargo trailers hauled by ranger that would be needed, it boggles the mind. And there's no really safe landing site near the Candor gold deposits; the middle of the canyon, far from the downslope winds, is a two hour drive. The alternative is driving everything, which would wear out vehicles and probably would require widening the Marineris Trail. Alexandra's furious with the idea; constructing housing for up to twenty people three thousand kilometers from here would be a logistical nightmare. They'd basically have to camp in tents inside the bubble. The plan's not practical. I think Morgan's leaning against it."

Will sighed. "But it gets worse. In retaliation, Dvorkin's attacking Alexandra—criticizing is too polite a description—for wasting time building the dacha on top of the escarpment. He even said she was doing it to justify her department, now that the biomes are complete. Of course, the dacha was started several weeks before the big meeting that marked the beginning of this crisis. Petropoulos says the dacha has already raised land values on top of the escarpment; we had to buy back two square kilometers of land from owners at double their purchase price, so now everyone realizes their land might really have resale value. Soderblom and Roger Anderson say we should concentrate instead on strong exploration, a strong media campaign, and stronger governmental relations. We

might be able to borrow or gain a grant from someone, after all. Morgan points out the most likely source of a loan or grant is China and that would further alienate the United States. Soderblom thinks a Saudi grant may be possible, but that raises the issue of Arab influence up here and you can imagine how that would play in the west." Will shook his head.

"Sounds like a mess. Candor's not the only gold source, though. I thought Dawes and Cassini both look richer."

"They probably are, but we won't be sure until we visit them. Dawes is on the equator, but is too high for the sunwings to carry a lot, so we'd have to drill a well, fly a shuttle there with cargo and a reactor, and it'd have to sit there and wait to refuel. It'd take three weeks to bulldoze through to it from the Circumnavigational Trail. Cassini's lower and may have more mineral potential, but is fairly far north, so one can't launch gold into equatorial orbit from there. It's not too far from an area that could be explored, but otherwise it's a long way down a trail we haven't built yet, which means no gold recovery for about two months."

"So, is Morgan going to break the deadlock?"

"He's still gathering information."

"You all have gathered information for almost two months. It's time to move. Otherwise, it'll be too late to do anything before December."

Will considered. "I agree. Maybe the Assistant Commissioner on Mars and the Commander for Mars Operations should cut the gordian knot."

"I think so." Ethel glanced at the clock. "Let's get to sleep; the kids will be up pretty early. Will, if you have to work so many hours, you'll have to sleep less. You have to save 7 to 9 p.m. for family time. No exceptions."

"None?"

"None."

"Okay, but I'll have to make exceptions when Morgan calls."

Will didn't sleep well that night. The next morning he rose early and went up on the roof, among the gardens, to say his morning prayers; he often went up there for solitude. The relative peace helped inspire a set of decisions. As he returned to the staircase, he was surprised to see John Hunter coming up the stairs with a bundle in his hand.

"Good morning."

"Good morning, Commander. It's a beautiful sol, isn't it?"

"Yes; no wind at all, an almost blue sky. The sunwings definitely can fly now. Enjoy the peace up here."

"Thank you, it's really essential. It's as close as I can get to a feel for the land."

"It's almost nature, up here. Have a good sol, John." Will hurried down the stairs and dashed to the patio to grab breakfast for the family. They had a fairly routine, though surprisingly long, breakfast. When Will went to his attaché to send an email to the heads of staff, Marshall was right behind him. "Dad, I want to send a videomessage to Jerry."

"Who?"

"Jerry Case, in Connecticut."

“Oh, yes. He was at your birthday party. Alright.” Will switched his attaché to Marshall’s account. Marshall knew what to do right away. Jerry had sent him a message; he asked the computer to display it and laughed as Jerry talked to him for about five minutes. Then he offered an equally rambling and silly reply. Will began to look at his watch.

“Give him a chance,” said Ethel. “This is very important to him. Jerry’s his age; he has no real peers here.”

“I know, but I’m afraid I’ll miss some heads of staff.”

“They’ll get your message, don’t worry.”

Marshall finally finished; Will got to send his videomessage to the heads of staff and Silvio, asking them to meet him at 8:30 a.m. at his office. When he reached his office at 8:35, almost everyone was there, and Will’s videophone was ringing. He headed to it first.

“Hello.”

Alexandra’s face appeared. “Good sol, Will. I just got your email, and I’m afraid I’m already at the dacha. A group of us got a really early start. It’ll take me another hour to get there, I’m afraid. Can the meeting be postponed?”

“Ah, no, but that’s okay. I’ll drive up to fill you in later; I’ve been meaning to get up there to see the construction.”

“Oh.” From the tone of her voice, clearly she was surprised. “Okay. Let me know when you plan to arrive.”

“I’ll do that. I may be able to come up with the later work crew; when are they going up?”

“They leave the Outpost at 10. They have two hours of geology work to do.”

“I’ll come up with them, but have someone drive an extra ranger up, or maybe I’ll drive it myself. Bye.”

“Bye.”

Will closed the communications circuit. Just then, Yevgeny hurried up. “Alexandra left for the Dacha an hour ago; she won’t be back in time for this meeting.”

“I know, we just talked. That’s alright, I can talk to her later. Let’s all sit down. I have a sort of plan.”

That raised the tension in the air noticeably. Everyone sat quickly. “Okay,” Will began. “For the last six weeks we’ve been re-opening the trails that were partly drifted over with dust. But now it’s time to act. We’ve got to make up our minds together and present the result to Morgan. I’m sure he’ll approve it under those circumstances. Andries, how quickly can we get two shuttles ready to fly a reactor, a portahab, two rangers, gold excavation equipment, a drill, and six people to Cassini?”

Andries thought a moment. “We could be there in a week. But we don’t have permission to fly shuttles from one spot on Mars to another, and it would take a long time to refuel the shuttles for the return flight.”

“I don’t think we’ll have trouble getting permission to fly two shuttles to Cassini. We’ve been flying them for ten years and know their capabilities. Refueling one shuttle enough to fly it back to the Outpost empty will take one reactor, seven tonnes of water, and about a month. Between Cassini and Dawes, which would you favor?”

“Cassini’s a bit better, I think; mineralogically more diverse. But they both have huge potential; they both may be of the scale of the Witwatersrand complex back home.”

"I gather. I want gold production to start as soon as possible, and the shuttles are the way to do it; besides, flying them this way will be interesting to the media, and we need that, too. Roger, how long to travel out the Circumnavigational, then quickly drive due south a thousand kilometers to Cassini?"

"No geology stops? Two or three weeks. But that's not the way we planned to go to Cassini. It's slated to be on the Virgo Trail. We had planned to move Virgo farther north in that area to follow the highland/lowland dichotomy, but instead we could just extend it to Cassini—"

Will raised his hand. "I know. From Cassini, you can extend the new trail north to the dichotomy and build Virgo in any direction you want. So make getting to Cassini your priority. The way to do that is to go via the Circumnavigational. Besides, if Cassini doesn't pan out, you can then quickly drive back to the equator and press northward a thousand kilometers to Dawes. And if Cassini does work out, you can use it as a base of operations to explore the dichotomy, which is spectacular north of there. If there's any extra time, we will have made it relatively easy to explore the Dawes area as well. It's a question of killing two birds with one stone."

"But Will, the Commission needs at least 10 tonnes of gold—$600 million—and this plan might not generate any," exclaimed Yevgeny.

"Let's look longer term than December, Yevgeny. Let's prove that gold reserves are ample in Cassini and/or Dawes, establish solid infrastructure to recovery it, and begin some production. Silvio, would that mean the Commission could get loans?"

"Sure, or land sales to mining partners."

"But if we sell mineral rights, we don't get as much profit," said Yevgeny.

"And if we have to recover 10 tonnes of gold in less than six months, we won't get anything else done," persisted Will. "Let's put ourselves in the position to sell several hundred million dollars or more of mineral rights; the income will fuel the expansion that will produce the gold. We can't be doing this amateurishly and we can't rush it."

"And exploration?" asked Roger.

"Send four rangers, two Conestogas, two reactors, the two mobilhabs, a trailer, and twelve people to Cassini overland, set up a landing strip, and make sure the gold recovery is proceeding. After that, some can head north to the dichotomy and others can head east or west to clear Virgo Trail. We can run three expeditions from the same spot at once. People who get tired of exploring can run the gold equipment, and vice versa."

"Exploration and mineral extraction." Roger nodded. "That's the best we can do."

"I'd focus on loans and sale of mineral rights," agreed Silvio. "Sometimes you're better off borrowing against the future."

"Let's count on it," said Will. "Let's say we can get the infrastructure in place to extract fifty tonnes of gold per columbiad—that's $3 billion in sales. Let's say we keep half and half goes to a mining company; that's $1.5 billion for the company. Over ten columbiads, that's $15 billion, and with the obvious implication that during that time a lot more equipment can be flown here and production can increase, and every columbiad transportation costs will drop. How much would a company be willing to spend for land?"

"Billions; maybe even ten billion, if future options are included," said Silvio. "Maybe half that, if they have to fly out the crew and buy the additional ACVs and shuttles."

"Either way, we get money and a bigger Mars," replied Will.

"But why Cassini instead of Dawes?" asked Yevgeny.

"It's a flip of a coin," replied Will. "But Cassini's closer to an area we need to explore, so we'll go there for the science."

"Then let's do it," agreed Roger.

"Andries, you talk to Érico about what we have to do to fly two shuttles to Cassini. Yevgeny and Silvio, you write up a memo about the export and financial side. Roger, you write a memo summarizing the science we can do from Cassini throughout the northern highlands and along the dichotomy, and I suppose into the Vastitas Borealis area as well. I'll put together a cover memo summarizing everything. Houston's asleep right now; I'd like to have this ready to go to Morgan this afternoon. Meanwhile, I'll drive down to the dacha to brief Alexandra."

Everyone nodded; the meeting broke up. Will had just enough time to check his messages. David wrote from Magellan about the latest results from their Samandar-3 Sunwing in the Venus atmosphere and how one of its Phoenix fuel cell-powered airplanes had flown down to an old, dead rover on the surface, snagged its sample canister, and brought the rocks back to the Samandar, where a fairly sophisticated computer-controlled laboratory was busily analyzing them. It was their first successful science.

He had no time to reply; that would wait. He ran down to Joseph Hall and jumped into the ranger that was about to head to the dacha. When he was finished he could drive it back to the Outpost himself and the ranger could be set to drive itself back to the dacha

at ten kilometers per hour, a speed where the computer would not have any trouble with the steep inclines and sharp turns.

On board were Ruhullah, Greg, John, Zach, and Thierry; Thierry was driving. “What is this, the Prospector drivers and geologists are still doing construction?” said Will, surprised.

“The Prospectors are mostly in suspension right now,” replied Zach. “Some of us are still busy with construction, the geologists are busy proposing explorations, and the sunwings are all back here for maintenance.”

“That’s true.” Three sunwings had been caught in the air when the Outpost’s runway had to close, and they managed to stay aloft five months, but now all three were on the ground for extensive maintenance. “Well, the sunwings are going back up pretty soon, so the Prospectors can get back to work.”

“Good,” said Greg. “I’m not in geology or Prospectors, of course, but lately I’ve found that I can get the robot cleaners and the laundry machines started in the morning, go up to the Dacha for four or five hours of work, then return. My nursing skills are sometimes needed up there.”

“Like last week,” commented Ruhullah. Greg nodded. Enrique had cut himself rather badly on some equipment and had missed three sols of work; Greg had stopped the bleeding.

“Any idea when we’ll be going out on the range?” John asked.

“I think in a week, but I’ll be sure tomorrow. Morgan has to approve the plan.”

“Finally!” exclaimed Thierry.

“Commander, is there any truth to the rumor that NASA has decided to get out of Mars exploration?” asked Greg.

“Get out? No, that’s not true. But it appears the administration is scaling back on Mars in favor of asteroid missions, low orbit industrialization, and technological development.”

“So, will Columbus 6 use the solid core nuclear engines?” asked Ruhullah.

Will shook his head. “Probably not. The fuel costs will be almost as much as the current system and the lease of the two SCN-25s will be several hundred million bucks. I’m afraid if NASA isn’t going to support exploration here much, we’re not going to rent the nukes.”

“So, families are stuck here?”

“For another two years, anyway. None of the kids are old enough to be trained for space flight, anyway.”

“That’s true,” said Greg.

About an hour after leaving the Outpost, the ranger approached the bubble. It was quite strange to see a transparent structure perched on the edge of the cliff and be able to look inside at what looked like a fairly ordinary building by terrestrial standards. The building occupied the center of the crescent-shaped bubble and was roughly twelve meters square and three stories high; its exterior of vinyl siding and large plexiglass windows was complete. To the left of the building was a partially completed patio of duricrete; a metal vehicle airlock extended from the bubble. To the right of the building was the untouched plastic floor of the bubble, an area slated for future construction.

Thierry drove the ranger straight into the airlock and pushed a button, closing the airlock's exterior door. Once it was closed, a pump began to fill the airlock with compressed Martian air. In a minute or two a green light came on and the inner door opened. Thierry drove the ranger into the bubble. The airlock door closed behind them and they opened the ranger door to get out.

Alexandra was waiting for Will. "It's been a long time since you've come up here."

"Yes; well over a month. I see the main building's now complete."

"On the outside; we still have a week or two of work to do inside. Do you want a tour?"

"Sure." He followed Alexandra southward across the bubble to the very edge of the escarpment; the building had actually been built a bit past the edge of the cliff!—then inside. They entered a room that ran across the entire cliff-facing front of the building, and was nine meters deep. "The dining room. The kitchen and life support controls are in the back. We can fit eight round tables with eight each in this space, or half that many with a dance floor, though I suppose we'll dance outside." She pointed to the patio where the two rangers were parked. After they looked around the room to admire it, she led Will to the stairway in the back of the building.

They went up to the second floor. A corridor ran along the back wall, which was a plexiglass sheet covering the bubble, giving a beautiful view of the rolling highlands north of the escarpment. There were four doors. "Four rooms, each three meters wide and eleven deep. The same on the third floor." She pointed up, so they went up to the top level. She led him into the first room; the door was open and the unit was mostly

finished. “All the rooms have a large bathroom in the back and each will have a Jacuzzi, though we can only install two Jacuzzis right now; the others will have to await parts imported from Earth. Each room will have a king-sized bed, too. Come see the view.” She led him to the window.

“Wow,” said Will, and for a moment he had nothing to add. The room extended against the southern side of the bubble and looked out over the entire Aurorae Chaos, a vast rolling stony plain 1.5 kilometers below that stretched to the southern horizon, a land of browns, reds, yellows, and grays, all under a pinkish sky. The Outpost was plainly visible, 25 kilometers away. “Incredible. There’s nothing like this on Earth.”

“Nothing. Maybe tourists will flock here some day; meanwhile, we’ll have a nice vacation getaway.”

“So we can accommodate sixteen.”

“More if there are three or four to a room, which would be true if a family came here. If you and Ethel come, reserve the room next door for the kids.” She pointed to an interconnecting door. “It can be locked from either side, of course.”

“And building two will occupy the right side of the bubble?”

She nodded. “It’ll be a bit smaller; three rooms per floor, but will use all three floors. So altogether we’ll have seventeen rooms up here. The left side of the bubble will eventually be occupied by a parking garage that can accommodate four rangers. Above the parking area will be a swimming pool ten meters long and up to eight meters wide; a floor can be rolled over it to form a space for dancing or tennis, just like in Yalta.”

“Assuming we can manage to haul all that water up here!”

“There isn’t any up here, that’s for sure.”

“It’s quite a plan. And we’re going to enjoy this place quite a lot.”

“But when will we be finishing it? I suppose that’s what you’ve come here to tell me.”

Will nodded. “We can finish building one. It sounds like it’ll be done in another week or two. But building two will have to wait until at least early next year, maybe longer. I’m proposing to Morgan that we fly two shuttles to Cassini right away—in a week or so—to start looking for gold. The data from the sunwing reconnaissance of the area is that extensive placer gold deposits have formed in the area. Until we actually explore the region, we won’t know what’s there. If the deposits aren’t rich enough we’ll check out Dawes instead.”

“Why not return to Candor?”

“Maybe we will, but we have exhausted the really rich placer deposits there and the recovery levels we need would require too many people and machines. We’re going for the quick wealth right now. After we’ve imported a hundred million dollar machine for digging and separating gold, we’ll head for lower grade deposits. We need to find deposits that are a hundred times richer than the ones being dug on Earth, or it isn’t worth our time and effort.”

“They say those deposits should be here, because Earth had them once upon a time.”

“Exactly. In a hundred years when transportation between Earth and Mars and faster and cheaper and there are ten thousand folks up here, we’ll be able to afford mining deposits that are merely three or four times richer than on Earth. Right now we have to find the super-rich deposits, and we’ve got the ability to do it by combining our very

sophisticated remote sensing data with surface exploration by foot. I'm sending six people to Cassini in the shuttles, and Roger's sending an expedition with six vehicles and twelve more people overland. Once they map the gold areas, we'll have to plan what sort of infrastructure to build. I need your people to focus on that, rather than on building the dacha."

"It'll be plenty big enough with building 1. In fact, building 1 could house half of Columbus 6. I assume we'll continue working on Catalina?"

"Yes, set up the outer biome bubble and the bubble for building 2. When Columbus 6 arrives, we'll have to have building 2 finished and ready for them. I think we should have the entire outer shell of building one finished as well, complete with the agriculture on the roof; we'll inflate the bubble for building one inside and build it, and we should have all the building materials ready so the structure can go up fast. But you don't understand how important Cassini could be. If we find the rich gold deposits we think we can find, even with our existing equipment we might recover twenty or thirty tonnes of gold per year; that's over a billion dollars of gold exports per columbiad. That could set off a gold rush of sorts, with companies buying billions of dollars of mineral rights and shipping the personnel and equipment to recover their gold. A half billion dollar investment can get four workers and sophisticated equipment here, and those workers could excavate a billion dollars of gold per columbiad. Dawes may be mined next. So Mars may see new outposts springing up; mining outposts. That's what you have to think about."

"Other outposts." She nodded. "It's a shame we can't grow this one."

“Oh, we will. Maybe all that’s needed is two to four people to maintain equipment, and it can be operated from here. Or maybe companies will want their own outposts. We don’t know yet. But if there will be other outposts on Mars, they’ll be based on one of the most important forces in human society: money.”

“I understand. When will you know about this plan?”

“I hope we’ll get it to Morgan later this sol and we’ll hear right away. Time’s passing fast.”

“Okay. Just let me know and we’ll get started. The dacha needs another week for building 1, and we’ll be able to declare it complete.”

11

Vision Quest

late July, 2045

Will put the tray, loaded with the dishes, cups, and silverware of himself and his two children, in the dishwashing unit. The unit, fortunately, was able to separate items and move them into a washing section. He headed for the revolving door of building 1 some twenty meters away, leaving the chatter of the patio, where half the Outpost was still eating brunch.

The kids were way ahead of him; Marshall was now strong enough to turn the revolving door and had helped Lizzie to pass through. By the time Will entered the building, the kids were already down the stairs and yelling at the front door of the apartment, telling it to unlock. As Will entered, he passed Greg coming down from the second floor and heading out.

“I really enjoyed your sermon on community and morality this morning,” he said to the former priest. “I agree with your effort to define a balance; sometimes we have to keep our morality private to some extent, and sometimes we have to stand and insist that a certain moral principle is essential for building true community. Of course, how one decides when a moral principle falls in which position is the problem.”

“Oh, I agree with you. But that’s part of our community here. As a Catholic, I have to speak up about matters of personal morality even if it makes others uncomfortable; however, I have to speak up in a way that is courteous.”

“Exactly! And that’s hard enough with 47 adults; I don’t know how we’ll maintain that standard when we have 47,000 or 47 million people here. We can’t create a

society where police have to use tear gas to break up demonstrations that have gotten out of hand. We don't have the air for it."

"Well, maybe that fact will help maintain our civility." Greg smiled. "I get a lot more feedback on my sermons here than I ever got in a parish church, where hundreds would hear me! Thank you for coming, Will. And let me apologize again for offering you communion. I had forgotten you had previously told me you wouldn't take it when I gave you the cup. Thanks for passing it along."

"Oh, don't worry about it; you were concentrating on your actions. I wasn't offended in the least. I'll try to make it to more masses; I think with such a small population, we need to support each other's worship programs."

"And I'll attend the next interfaith service as well. I think they're important. Religious people *have* to pray together. Let's build a community of faithful people who trust each other, so as Mars grows, the trust is preserved."

"We can be a model for Earth! I agree. Greg, come visit us out in the yard some time this afternoon. The kids will be playing, we'll be chatting, and there will be a volleyball game at 4 p.m."

"I will! I'm on my way to sick bay right now, but I'll be back later." Greg nodded and headed out the door.

Will hurried down the stairs to his home. The door was open, so he walked right in. He changed out of his nice clothes and put on a teeshirt and shorts; one of only two he had, since no one had had the place to wear them until the biome had been completed. Ethel had just finished changing as well. When he came out he found Marshall listening to a videomail from his friend Jerome on Will's attaché; the boy had gotten good at

navigating to his own message area. “Dad, I want to send Jerry a video message, so I’ll be outside later, okay?”

“Okay,” replied Will. He headed out the door. John Hunter was coming out of his unit as well. “Good sol. Are you joining us in the yard?”

“Yes, for a while. I’m bringing my attaché; I want to catch up with some newspapers.”

“How does your tobacco grow?”

“Very well. Do you want to see?”

“Sure!”

John opened his door and they walked in. His court was verdant with all sorts of plants. “Where did you get all the pots?”

“Ethel made them; there’s a small supply available!” John led him out his door to his two by five meter courtyard. “I’m so glad Lisa was able to check every seed in the pouches and ‘weed out’ the weeds.”

“And she kept them, too; you never know when we’ll need them! My, the tobacco is growing well. It likes something.”

“The light, I think. Some kinds of tobacco are shade lovers, and the light down here is indirect. The gourds need sun lamps.” He pointed. “Lisa was tending them while I’m away. She knows plants really well. They’re doing so well partly because of her.”

“She’s good. I’ve had to turn my roses over to her; they almost died in my apartment, Marshall wouldn’t let me put them on his patio and Lizzie almost destroyed them when they were on hers.”

“I hope they survive; I like roses.”

“So, you’re back from Cassini for a week. How was it?”

“Fascinating geology; the hydrothermal complexes and igneous intrusions are all over the place, interpenetrating, melting and transforming each other, then the whole area was rained and snowed on, flooded with lakes, drained and eroded by catastrophic floods, and all the time it was bombarded like crazy by planetesimals, smashed to pieces, soaked by groundwater, fused back together by magma, dissolved and redeposited by volcanically heated water. . . really amazing. We found three new mineral types, and new minerals aren’t found that easily any more.”

“And a lot of gold, but not much that’s high grade. Gold recovery’s been going pretty slowly. But there’s still hope.”

“Andries has good instincts, the sunwings are still gathering detailed data, and we’ve got three mining companies pouring over every byte of data. As a geochemist, I can see a hundred doctoral dissertations that need to be written. We’ve studied the combination of water and oxygen in the Earth’s crust under terrestrial temperature and pressures, but not water and carbon dioxide in Martian crustal temperatures and pressures.”

“Your research will lay the foundation for those dissertations. I want to get down to Cassini some time, but administration keeps me pretty busy.”

“Go down; you’ll have a better feel for the place.”

“Did you get a ‘feel for the land’ there?”

John paused to reflect. “Some. Father Mars is different from Mother Earth. That reminds me. I want to go up to the dacha some time this week, but I want to go up alone.

I know the rule says we have to go with at least someone else. But I can't do what I want to do with someone else around."

"Hum." Will considered. "I suppose we can make an exception. No one's up there most of the time on the weeksols. Sure; do it."

John smiled. "Thank you very, very much."

They headed out of the apartment. Ethel and Madhu were standing outside the Andersons' apartment, which was directly above the Elliotts'. Will stopped. "Did Marshall come by, yet? He was sending a video to Jerry."

Ethel shook her head. "No, he must still be taping something. Yestersol he taped every joke he knew and laughed at all of them. But Jerry did the same, so I guess they're having fun."

"But he's playing with Sam less, and Sam's jealous," noted Madhu. "He's looking forward to playing with Marshall this afternoon."

"We've told him to play with Sam more," said Ethel. "I hope you understand; Marshall's got no one who's really his age, and he misses it. But in a few years they'll be closer developmentally and they'll play more."

"I know. Sam's lucky to have Corazon and Marshall." Madhu looked at Will. "Do you want to see my design for the space between Yalta, Clarke, Renfrew, and Joseph?"

"Sure."

She turned and led him into the apartment; Ethel trailed behind. The Andersons had a three-bedroom unit, with Sam's bedroom right above Marshall's; they had had to order the boys to stop talking to each other via the balconies at night. The bedroom above Lizzie's was Madhu's art studio; it was small and crammed with shelves of rock and

mineral samples, unusually shaped or colored rocks, several large sacks of clays of different colors, a potter's wheel, and a bunch of plaster of Paris sculptures. "On, Muse," she ordered, and the large screen on the wall responded by glowing. She had named her attaché "muse," a fairly common moniker for the attachés of artists. "Project Labyrinth 1 design onto the screen, please; view only," she added. A complex pattern of colors appeared. "This space is eighteen meters wide and between twenty and forty meters long, and complex in shape because it has two rectangles bordering the southern and western sides, but two circles on the eastern and northern sides, all connected by pressure tunnels. No one will don a pressure suit and walk in it; it's a piece of Mars that's cut off from everything. It's our largest piece of dead space inside the Outpost. But it has windows facing it on all sides, some on second stories. So I plan to lay out a big labyrinth pattern in yellow sandstone and black basalt, with three 'destinations'; a spring of water, a crater, and a mesa."

"But no one will be able to walk on it."

"You explore it with your eyes! It's quite complex; people can spend fifteen minutes looking at it one sol, and five minutes the next. It will have a meditative quality; in the Middle Ages labyrinths were used for meditation. One reason people like to go outside, or look outside, is to see things that are complex and changing. Labyrinths fill the bill. And they can be very Martian; they're geometrical but can have Martian images in them, which we can change periodically."

"Even a labyrinth?"

"This is designed so that if we change a few bends and connections, we change the path in the labyrinth drastically. It'll take an hour to make the changes."

Will studied it and nodded. “This is fantastic, Madhu!”

“I hope people like it. If so, I’ll design labyrinths for all the shut-off spaces within the Outpost, and maybe a few outside as well where people can walk, with Martian wind sculptures for them to look at.”

“I think people will love it. I suppose this will take a week or two of work to make, and we’ll have to blow the dust off periodically, but it’ll be worth all the work we do.”

“Thank you.”

“I told her the same thing,” said Ethel. “She showed this to me while you were talking to John.”

The three of them headed out of the apartment. “How’s your health, by the way?” Will asked.

Madhu shrugged. “The spot on my lung had disappeared, then it reappeared, then it was shrinking, and now it seems to be growing. Columbus 6 will include an oncologist and she’s bringing equipment to biopy the spot, so we can figure out what it is.”

“We may need oncologists here, anyway.”

“I’m afraid that’s true.” Madhu sighed. “I’ve lived with this for four years, now. It’ll be good to get it resolved.”

They went out through the revolving door. About half the Outpost was sitting in chairs, usually in semi-circles under the buildings’ overhangs where there was shade and protection from cosmic and solar radiation. Some chairs faced the swimming pool; others faced a game of petanque, a game similar to bowling that several were playing. Small children ran on the grassy areas under the fruit and nut trees and sometimes trampled

flowers or vegetables. Ethel and Will headed toward a group of chairs. Martha, Charles, Irina, and Eammon were already seated there. “Ethel, we need chaise-longes,” said Martha, as they approached.

“I know; it’s on my list, and I suppose some day we’ll get around to making them,” Ethel replied. She sat. Caitlin, age five months, was nursing at Martha’s breast. “How’s the little one?”

Martha smiled. “Oh, she’s coming along quite well. Growing and growing.” She pointed at Patrick O’Hare. “Look at him, crawling all over the place!”

“And he’s just eight months!” added Irina, standing to grab her son and pull him back. “Eammon says he walked at nine months.”

“So I’m told,” added Eammon.

“It runs in the family,” agreed Will. He looked at Charles. “So, you’ve been back from Deimos five months now; any chance your wife will let you go out on the range?” He smiled and winked.

“Can’t I have him for another month?” asked Martha.

“Yes, but Roger’s trying to figure out how to rotate people and it’s hard when some have to stay at the Outpost.”

“Next month,” replied Charles. “I’m anxious to get out, too, but for only four or five weeks, please. I want to make relatively short field trips until Caitlin’s a year old.”

“That’ll help,” agreed Will. “Martha, it’s great that you can spend as much time as you have in the office. We really appreciate it.”

“Well, Charles wanted part of the family leave, and I wanted him to have part of it. And the infant care here is good; it seems to be good for Caitlin to be around other

kids. So we're managing pretty well. I'm sorry Enlai and I haven't been able to press forward with the MarTech plans."

"MarTech?"

"Sorry; we're calling the Mariner Institute of Technology 'MarTech,' on analogy to 'CalTech.' Enlai and I have had no time to do much more than brain storm."

"It'll happen, and right now we've got practically everyone working sixty hours a week on other things anyway."

"I know. But I'll have a report about mental health in another week or two."

"Really?"

She nodded. "The faster pace is putting us under a lot of stress, but levels of depression are okay, and overall we're doing better than the average in developed societies. Of course, we aren't a random selection of citizens, either."

"Not as long as we do extensive psychological screening. I'm glad to hear that the quality of life is reasonably good."

"I didn't say that! There's a difference between mental health—the level of depression, for example—and quality of life! But our quality of life ain't bad, I suppose."

"Better than many people in poverty on Earth," agreed Ethel. "It has its disadvantages, certainly."

"Like risky pregnancy," agreed Irina, sighing. "This one is not proceeding as well as the first one, I'm afraid."

"What's wrong?" asked Will, alarmed.

"I'm really tired, this time; exhausted! Eve's still not sure why. She plans to do an ultrasound in a few sols and see whether the baby's developing right."

"You'll be fine," said Eammon, leaning over.

Will looked around. Marshall and Lizzie were playing with Sammie and Corazon. The smaller ones were running around or were with their parents. "We've been on Mars nine and a half years and we've got nine children; and Shinji and Michiko will have number ten in a few weeks. And you've got another one in the oven, and at least three other couples are contemplating parenthood. . . . life really moves on."

"Not particularly profound, Will," said Martha.

"I suppose it's an emotional point, not an intellectual one," replied Will. "I feel blessed. We come from different cultures, we speak different languages, but we've become friends and we support each other's families. We have community in spite of our disagreements. And that's more important than whether we have access to fifty thousand possible consumer items or whether our chance of dying of cancer over our lifetime is 28% instead of 21%."

"Here, here," agreed Martha.

It was Monsol afternoon about 1 p.m. when John Hunter stepped into ranger 5—one of the three left at the Outpost—loaded an overnight pack, some special gear, and his pressure suit inside, and drove out of the airlock of Joseph Hall, heading for the Dacha. Soon he was driving up Little Colorado Canyon, steadily up and up, 1,500 meters vertically in six kilometers of road. The ranger reached the top, then he turned and drove it southward, back to the edge of the escarpment. It entered the tunnel-like metal airlock of the Dacha. He drove inside the air bubble, opened the door, and stepped out.

He moved his overnight bag into room 1, though he doubted he would actually stay there. He walked into several rooms and took their small electric hotplates. He pulled out a large metal container filled with plastic and other materials he had brought and walked around the enclosure, between the building and the western end, to find a good spot. He chose an area in the middle.

John emptied the metal container, placed it on top of the four hotplates, connected them to the building's outdoor plug, and turned them on. He scrounged around the enclosure and filled it with spare rocks; Madhu had brought in rocks to make some artistic designs, but had not yet started on them. While the rocks heated up, John built a frame of metal rods and tape that he had brought, then he draped the plastic sheeting over it and folded it under to make a floor. He had a sweat lodge.

It was close to 4 p.m. when the sweat lodge was ready and the rocks were hot. He returned to his room and changed into a breachcloth—one of the few traditional items he had with him—then carried the container of hot rocks into his makeshift sweat lodge, placing it on a large flat rock to elevate it off the floor. First he threw some sage that he had brought from Earth on the stones—it smoked and released its special aroma, the aroma he associated with the sweat. He prayed to Tunkašila Wakantanka, the great mystery, the father of all, in the traditional way that his father had taught him. It felt strange performing a sweat by himself, but he had no one to assist him, so he had to make do. He pulled out his pipe, filled it with tobacco, prayed, then smoked it. Finally he threw water on the hot stones to make steam, and prayed. Steam condensed on the plastic sides and trickled onto the floor, making sweat-like beads of water there. And still he prayed.

Finally, he opened the sides of the sweat lodge and stepped outside. He walked to the rounded western end of the crescent shaped bubble, which covered a prominence that stuck out from the top of the cliff and projected over the precipice. There he was as far from the ranger, the building, and the patio as possible, on bare kevlar bubble stretching over father Mars just a millimeter below. The sun was setting.

He sat facing the waning sun and pulled his blanket tightly around him against the evening chill that was already invading the dacha. Scarcely looking at the mind-boggling expanse of cliff falling away to vast stonescapes stretching a hundred kilometers before him, yet intensely aware of father Mars all around him, he prayed to the spirits of the place; to the spirit of Paul Renfrew still walking the world; to the spirit of the unborn Joseph Stroger, hovering over Joseph Hall; to the spirit of Ethel MacGregor's mother that partially inhered to the stone gazebo built in her honor on top of Boat Rock; to the spirits of the future born and of the future dead; to the spirits of *Spheruloides Gangii* and the quadrillions of life forms, arrayed in at least fifty known species, arranged into at least four known phyla, that had once considered this world their home. Mars, indeed, was alive with spirits.

The sun was gone and a myriad of intense stars popped into the sky. Venus rode high in the west; Jupiter glowed low in the east with Saturn. Cygnus, the northern cross of Mars, which pointed steadfastly north just as the outer two stars of the Big Dipper did on Earth, floated low in the northern sky, Deneb pointing downward. And John prayed. After an hour he pulled out his sacred pipe, filled it with tobacco again, and lit it, raising it to the six directions—north, south, east, west, up, and down—repeating the words his father had taught him. Finished, he sat and, as his people would say, cried for a vision.

He waited, in silence, crosslegged, blanket pulled around him. Time seemed to hang in suspension. The stars slowly wheeled in the sky. Then a light in the west disturbed him. He looked up, surprised, and at first he saw a yellow face hovering just above the horizon, its light glinting off of thousands of rock surfaces to the distant horizon. It was Phobos, which had just risen; and yet it was also a face, so easy and plain to see as he looked at the yellow apparition. A woman's face. Phobos was a female. In the myriad reflections off the rolling land below he saw her coming toward him; or perhaps she was leaving, returning to the Great Sacred that sent her, just as the White Buffalo Calf woman had brought the sacred pipe to Hehlokecha Najin, then took the form of a red and brown buffalo calf and trotted away, then laid in the grass and rolled around and rose as a white buffalo, then walked, rolled in the grass, and rose as a black buffalo, then bowed to the four directions and disappeared over a hill.

And then a light in the east disturbed him as well. He turned; it was small, intense, yellow, another miniature female face. Deimos. The child of Mother Phobos and Father Mars. A face yearning for reunion, anxious, yet unable to come to her mother; and her mother raced toward her and was already almost overhead, half way to union with her child.

As John looked up in wonder, he moved his head side to side as he prayed, and he suddenly saw hundreds, thousands of stars moving across the heavens, in and among the other, fixed stars. The spirits were there. He could hear them whooshing through the heavens as he swayed and he suddenly felt terrified. He clutched his pipe and prayed as he swayed, and as he swayed the spirits moved and whooshed, yet none came to hurt him. The land groaned and heaved slightly beneath him as he swayed.

Phobos came across the sky to her child and for a brief moment they embraced. He heard her utter a name: Wicahpi-luta, Red Star, Mars. But who was Wicahpi-luta? Himself? It was common to receive a new name under such circumstances. Or perhaps a child, for that was what he saw. He had no time to ponder; he had to watch.

Then they separated and mother Phobos fled on east, and soon she dropped to the eastern horizon. Where she touched it, the land glowed, and John realized there was a place of sacred power there to the east, and not all that far away. He would have to look for it some time.

Then the mother dropped below the horizon and was gone. John grieved at her loss. He sat crosslegged, lit his pipe again, and prayed, and the stars wheeled. He could feel spirits, of little round ones, of two-leggeds, of clouds, but it seemed there were no spirits of four-leggeds, for Mars had never had any four-leggeds.

The eastern horizon glowed, a halo of light appeared, then suddenly the sun was there. It shook him from his state. He looked around, glanced up at the frost flecks clinging to the dome above him, stared at the rolling terrain suddenly visible outside the dome. The entire night had passed. And he had had the vision he had cried for. But what did it mean? That would require meditation.

He heated up the container of stones again, went back into the sweat lodge and prayed again, thanking the Great Spirit for the vision he had received. He smoked his pipe and reflected. Then he took down the sweat lodge, threw the stones back on the pile where he had taken them, changed into his normal clothes, and drove back to the Outpost.

Will walked to his office on Tuesol morning past the sickbay in habitat 2 and was surprised to see Shinji and Michiko there, sitting and waiting. He stopped. “Is it time?”

“It seems to be!” exclaimed Shinji, an unnatural excitement in his voice.

“Contractions every half an hour,” added Michiko, sounding more anxious.

Let me kiss you in congratulations.” Will walked over and kissed Michiko on both cheeks, then embraced his old friend Shinji. “I’ll keep you in my thoughts all day.”

“And all night,” added Michiko, worried.

Eve Gilmartin’s examining room door opened. Irina and Eammon came out, and they looked excited. “We know why I’ve been so tired!” she announced. “Twins!”

“Twins! I have to kiss you, too, then.” Will came over and kissed her on both cheeks. “Congratulations and felicitations.” He took Eammon’s hand and gave it a vigorous shake.

“That’s all the women expecting babies I plan to see this sol,” said Eve. “It is a joyful sol. Come in, Michiko. So, you’re going to have a baby. . .” She led Shinji and Michiko inside and closed the door. They nodded a good bye to Will.

He whistled as he walked the last twenty meters to his office in Habitat 1; babies on Mars always put him in a very good mood. He commanded his attaché to awake and switch to the message center. He was surprised to find a videomessage from Sebastian Langlais, commander of Columbus 2, who had been the Primary Commander of Shackleton Station for four years and Vice Commissioner of the Lunar Commission for two. He and Sebastian had exchanged messages on and off since Columbus 2 had ended, though they had not been in touch for the last six months.

“Good sol, Will,” he began. “I thought you’d like to hear some news I just got a few hours ago. Shackleton has permission to build a space vehicle ‘dry dock.’ It’ll be a kevlar reinforced cylinder based on the technology that produces your biomes, thirty meters high and fifteen in diameter. We’ll be able to roll in a Lifter, a Mars shuttle, an interplanetary hab, anything that fits in the space, close the door, pressurize the space, and work on the vehicle without spacesuits. The dry dock will be protected from micrometeoroids by a metal shell we’ll build here.

“I’m sure you can imagine the advantages of this facility. One sixth gee is just about ideal for this sort of work; equipment is easier to move than on Earth and stays put better than in weightlessness. We’ve needed something like this for decades, but it was too expensive. Repairing Lifters outside in space suits has always been very difficult and dangerous; refurbishing Mars shuttles at Gateway has been difficult and expensive. Costs will be dropping a bit more for everyone, and Shackleton will make money. We need it too, as I’m sure you can imagine! Good luck with your quest for gold deposits. I’ve been following the news closely. Bye.”

Will hit reply. “Thanks for the news, Sebastian. Congratulations! A dry dock will be immensely valuable for everyone, and I suppose it means you’ll have more staff permanently up there. I’m thrilled for you! You’ve been doing very well in the last year, between the expansion in tourism and the interest in mining lunar ice and meteoritic nickel-iron. I’m envious.

“Gold prospecting is going slowly, but we’re confident that we’ll find some good deposits. This world appears to be as mineralogically rich and diverse as the archaean era on Earth, and as you know, that’s when a lot of the mineral deposits formed there.

Everyone says if we're patient, we'll find plenty of ores. It looks like with the decline in transportation costs, that's the way we'll go in the next few years.

"Anyway, keep in touch. Bye."

Will sent the message and reflected about the moon's position. Shackleton had expanded further since David's visit. It now had ten tourists almost continuously, almost two hundred per year; it had four support staff for them; about twenty geologists, technicians, and Prospector drivers; six astronomers; a dozen engineers and construction personnel; and twelve support staff of various sorts, for a total of sixty personnel. The Chinese national station and the European station at LeMonnier had a dozen more each, and the Japanese station at Grimaldi had six, giving the moon a population of one hundred when the tourists were included. It had twice the population of Mars, and the dry dock would push it forward even more. It would be some time before Mars, so far away, would catch up, if ever. He was a bit envious.

He pushed a button to listen to a message from Louisa Turner that had arrived in the middle of the night. "Good sol, Will. I thought I'd give you a progress report. Tina's a real hit on several networks, and Boris is doing pretty well as a videojournalist. Tina's training is paying off. I'm sorry you've had to switch two people to full time media work, but it's effective, and the public support will translate into funding that exceeds their salaries. We need to find a few more people who can do science and reporting well; there are still some slots on Columbus 6 to fill.

"As for the message, the gold prospecting is getting old, but the human interest side of their reporting is still strong. Roger's expedition will reach the fretted terrain along the dichotomy later this week and the video will be interesting. That should boost

our ratings. Magellan's been quiet lately and the public is not so interested watching people in orbit drive small tank-like rovers around in smog. The moon will steal some headlines tomorrow—did you hear about the dry dock?—but we're doing pretty well right now. Bye."

Will hit reply. "Thanks, Louisa, I'm glad the report's good. Tina and Boris have both testified to your lengthy quizzing of them about sol to sol life and the diaries you are requiring them to send to you, so you can get back to them about human interest stories to pursue. So I think it isn't just Tina training Boris; you're training both of them! We're extremely grateful. I wish we could sit down and have a coffee together, face to face. Maybe we should try something virtual at opposition. Bye."

Will sent the message and glanced at his watch: noontime already. He had to get lunch. But then he saw that a new message had come in; an email with a video attachment. It was sent by John Hunter, which surprised him, since his staff could call or visit; they rarely send video messages. With a bit of trepidation he opened the message.

The email was simple: *Will, I just taped this description of last night for Big Toe, my great uncle back home, and I thought you should know about it as well. This is private, of course; not for anyone else. Thanks. John.*

Intrigued, Will clicked on the video attachment. He sat entranced, watching John describe his experience of the night before; the entire night before, which had seemed to flash by for him. When it ended he sat there, thinking about the remarkable vision his Lakota colleague had had.

"What did you think?"

He turned, startled. John was standing in the door. “I hope you don’t mind that I sent it to you. I just felt that I had to share it with someone here, and you were the only one I could think of. Greg would be a possibility, but he’s too. . . Catholic.”

“I feel very privileged. Thank you.”

John closed the door and came in. He sat. Will was tempted to get up from behind the desk, but for some reason the desk seemed irrelevant. They looked at each other. John continued. “I suppose there are all sorts of logical explanations. You can see a face in just about anything. But I have looked at Deimos since I came back to the Outpost and I can’t see a face in her. And all the moving spirits that I saw in the sky, the swaying stars? . . . I suppose they were ice crystals on the dome, reflecting the Phobos light.”

Will shrugged. “Maybe they were ice crystals and spirits.”

John was startled by the suggestion. “Perhaps my science background is intruding.”

“I think you are blessed with multiple insights. The scientific is one; the spiritual is another.”

John bowed his head slightly. “Thank you. Phobos will be up again this afternoon, and I’ll take a close look. I don’t remember seeing a face in her before, either.”

“I haven’t. I’m intrigued by the glowing patch on the eastern horizon. There is a special spot on the escarpment east and a bit north of the dacha; a natural bridge. It was formed when flowing water ate out a tunnel under a lava flow.”

“Really? I’ll have to see whether that was in the right spot.”

The attaché rang; a videophone message was coming in. Will ignored it. “So, what do you think it means?”

"I don't know. Especially Wicahpi-luta; I don't know who he is. I've asked Big Toe for his opinion." There was a long pause. The silence was broken only by the beeping videophone, which neither heard. "Mars is alive. This world is filled with *wakan.* Wakan means the unknowable, incomprehensible dimension of things; you could translate it as the sacred in something, or even the spirit of something. It isn't just Paul and Joseph, or your mother in law. It isn't just the ghosts of the various spheruloides species that have been catalogued. It's the rocks that blasted the craters; their spirits are here, the shattered remnants of ancient worlds. It's the rocks themselves. It's the particles of pulverized dust coating everything. Wakan fills this world. It's *lela wakan,* very sacred. I think that's what I learned."

"And what does that mean to you?"

John looked at him. "You ask difficult questions! It means I am in relationship with this world, just as I was on our home world, on my home land. It means this can be my home land as well. It means we have to learn to respect this world, just as we have to respect the Earth. It means the sacred is here; that Wakan Tanka, the Great Incomprehensible, is here."

"I agree," said Will. "Because I pray. I hope, some day, it will be possible for you to share this experience with others. That is up to you, of course. Many people are not ready for it. There will always be people who will dismiss this; psychiatrists who will attribute it to mania or sleep deprivation; humanists who will smile and say they appreciate the myth you've brought to Mars. But there will be people of faith who will appreciate what you've experienced. I hope it will be possible for them to learn from this."

The videophone began to ring again, and this time the tone was faster. Will looked at the attaché's screen; it was from Andries Underwood and the message description included an exclamation mark. "I'm sorry, John, this seems to be urgent," Will said. John nodded and left the office. Will reached over and opened the call.

"Good sol, Will! I called a minute ago and you didn't answer!"

"I was having a private conversation. What's the situation? There are no warning bells on the bridge."

"No, this is not an emergency; this is victory! Will, we've found gold, lots of it!"

"Where?"

"About twenty-three klicks northeast of the landing strip! Very close; we've been searching as much as one hundred kilometers from here! We've been looking in the loose, most recent gravel bars and other placer deposits. We haven't done badly; we've recovered two tonnes of gold that way. But we started looking at the older alluvial deposits last week, and bullseye, we found a boulder conglomerate full of nuggets!"

"Lithified?"

"Yes; hard as rock! It's Noachian, the remains of a catastrophic flood, possibly triggered by the Cassini impact event, then lithified by silica. We just pried a gold and quartz block out of the conglomerate that weighs thirty kilos, and the mass is half gold! It's incredible! There are a lot of smaller nuggets, too! But we'll need all the explosives you can send, the two drills, and at least one more ranger if you can spare it. That probably means three or four more people, too."

"Okay." Will paused to think. "We need an evaluation of the deposit; its dimensions and potential for gold recovery—"

“Will, we’re talking about a deposit two thousand meters long, a hundred meters wide, and an average of fifty meters thick. . .ten million cubic meters of rock, say twenty-five million tonnes, and it’s assaying at 25 grams per tonne!”

“Write it up. Make the preliminary report as accurate and thorough as you can. We can get started here with the resupply without the report. But we need the exact details because the mining companies are fascinated.”

“I understand. Can you send a shuttle? That’s the fastest and even the safest way to get things to us. You can’t fly the equipment down by sunwing and driving it down would take two weeks.”

“We’ll probably use a shuttle. You’ve got the *Hadriaca* and the *Apollinaris* refueled, right?”

“They each have thirty-five tonnes of fuel; enough for a one-way flight anywhere on the planet for both and a two-way flight anywhere between Cassini and the Outpost for one of them. That’s the requirement to fly another shuttle from the Outpost.”

“Okay. I’ll get Érico started planning a shuttle flight down. Get us a good report in the next twenty-four hours.”

12

Cassini Outpost

late July 2045

Nearly two sols passed before the shuttle could fly to Cassini. Selecting the necessary cargo and loading it on board was complete by mid afternoon Wednesol, but by then the sun had set at Cassini, five time zones to the east of the Outpost. Launch had to wait until after sunrise the next morning. It was just as well; Will was able to be present when Shinji and Michiko presented their newborn son, Toru, to the community.

Will hadn't flown on a shuttle for a decade; it was a strange and even a frightening experience for him. The launch and acceleration to a suborbital trajectory took only three minutes. Half an hour of weightlessness was followed by the return of weight as the shuttle fell back into the Martian atmosphere, heat shield down. For twelve minutes the shuttle plummeted downward and across Mars, the hypersonic passage through the atmosphere being used to steer the shuttle farther to the northeast. Then the engines roared back to life and after a minute and a half of leaden weight, the shuttle settled onto pad number 3, a dozen kilometers inside of Cassini's battered and pocked western crater rim.

They stepped out onto a rolling, gray-orange landscape. The Cassini highlands were ancient; they had seen meteors and asteroids, rain and snow, volcanism, sand-blasting dust storms, and floods since the beginning of time. Two rangers drove up and people got out in pressure suits.

"Welcome, Commander," said Andries, extending his right hand. "We're delighted you flew up here."

They shook hands. “I’m delighted, too. We’ve got your stuff; let’s unload now and talk later.”

Andries nodded. Érico—who had piloted the shuttle—opened the side of the cargo bay, which was located below the fuel tanks and just above the landing legs. The crew deployed the cargo ramps and began to unload the new ranger, the two drills, the additional nuke—which had three tonnes of ice blocks packed around it for radiation shielding—and boxes of supplies, including dynamite. Meanwhile, Érico connected the shuttle to the spaceport’s power line and moved several ice blocks to the fuel synthesizer unit, which could convert the water, in the presence of atmospheric carbon dioxide, into methane and oxygen. Kevin Dunbar, who was running Cassini’s other nuke, towed the new reactor to a sandbagged pad enclosure near the other one and, using the remote manipulator arms installed on the ranger, connected it to the power grid. By then everything was ready to go. The three rangers set out.

“Will, I’ll need to interview you about this find,” said Tina, sitting up front between him and Andries as they headed down “Pretoria Trail,” as they had dubbed the route from the spaceport to the gold field.

“Okay, but not now. We can do that later.”

“Keep in mind it’s early morning in Europe right now. In about four hours it’ll be time for the producers to plan their evening news programs, and the United States will be six hours behind.”

“Okay.” Will watched the terrain roll by. “Everyone’s extremely excited. I could feel it while we were unloading the shuttle.”

“Immensely,” agreed Andries. “Rather than run the centrifugal separation equipment, we’ve been spreading out and walking the gravel bar in pairs, picking up nuggets as we go, weighing them and entering their GPS coordinates into the computer. We call it ‘gold archaeology.’ The six of us have picked up 900 kilos of nuggets in three sols.”

“Nine hundred kilograms?!”

Andries nodded. “It’s the fastest way. We’ve walked upstream of the gravel bar, too. The hydrothermal complex that the flood tore apart is just one kilometer upstream of the gravel bar. We found nuggets all the way up, and we found them in situ in the bedrock outcrops in the flood channel. So we know where the gold is coming from.”

“How about other metals?”

“The lag deposit is enriched in nickel-iron meteorite fragments. There’s scattered silver; enough for our internal needs and some for export to the moon and low earth orbit. Copper, too, but that’s downstream twenty kilometers; a fairly large body of malachite-altered dune sandstone sitting under a basalt flow. The gold and silver ores are in and above a lower Noachian intrusion from the base of the crust.”

“Water?”

“It’s everywhere once you drill down fifty meters. It isn’t quite as available as at Aurorae because the megaregolith has lower porosity than sandstones and arkoses, but there’s plenty for our purposes.”

They drove on in silence, looking at the terrain roll by. In half an hour the road topped a rise; a battered gap in the crater rim. They rode down the ejecta blanket and soon stopped at the edge of a valley. Before descending into it, Andries stopped and

turned the ranger so they could see out the front. “This is the vallis with the deposit. It’s five kilometers wide and two hundred meters deep, but as you can see, time has nearly erased it as a geologic feature. Those cliffs you see on the other side were formed by a later, smaller flood coursing down the old valley in middle Hesperian times. Do you see the break in the canyon profile upstream?”

Will nodded.

“That’s the location of the hydrothermal complex that the flood breached, which contains the gold. We’ve named it ‘Joberg,’ the common nickname for Johannesburg. The long feature here—” Andries pointed. “That’s the gravel bar formed from the canyon sediment, where the vallis widened out and the current slowed. Two kilometers of lithified boulder conglomerate with gold nuggets and some scattered native silver. We’re calling it ‘Pretoria.’”

“Fascinating. Let’s go see.”

They drove down the gentle incline to the floor of the flood plain where, an unimaginably long time ago, an unimaginably huge amount of water had raced through, underwater tornadoes cutting through solid rock like a knife through butter. At the northern—downstream—end of the Pretoria conglomerate, a Mobilhab was parked. As they pulled up to it, Will noted the dust all over it; it was surprisingly dirty. Two Mobilhabs had arrived on Columbus 5. Like Mars’s buildings, the Mobilhabs were vehicles made of a series of layers: an inner barrier of Mars-made vinyl that the crew walked on and wore down; a middle layer of airtight, transparent kevlar-reinforced tefzel and nomex imported from Earth; and an protective outer shell of Martian nickel-steel, interrupted by frequent plexiglass windows. Above the vehicle was a hinged solar array

capable of making sixty kilowatt-hours of power per sol, enough to keep its life support systems operating. The vehicle was 2.4 meters wide at the floor, 4.75 meters wide at the ceiling and at the floor level of the second floor, 4.75 meters high, and eight meters long. Each of its two floors had two rooms and complete bath facilities, allowing the vehicle to house up to eight personnel manageably. It had eight independently powered wheels. It could not be used for road clearing and could not travel as fast as a ranger or a Conestoga, but it supplemented rangers extremely well; an expedition of two rangers and a Mobilhab, with eight crew, could clear roads 14 or 15 hours per sol.

"Commander, shall we step out?" asked Andries.

"Yes." Will stood and moved to the ranger's rear area, where he put on his life support pack and helmet. The three of them were ready to egress in a few minutes. They depressurized the main cabin and opened the driver's side hatch.

Right outside the Mobilhab was a pile of gold nuggets, so they stopped to admire them. They headed up the hill, stopping at every spot where bedrock poked above the ground. Most of the bedrock was boulder conglomerate consisting of big blocks of grayish igneous rock with smaller, shiny chunks of nickel-iron in between. Will bent close to the ground to look with his built-in magnifier; even on a randomly chosen outcrop he could see a golden fleck or two, usually in the matrix between the cobbles.

"This is amazing."

"It really is," agreed Andries. "I feel like I understand the excitement at Sutters Mill, California, in 1848; or in Deadwood, Klondike, Transvaal, or Victoria! The largest nugget ever found on Earth was something like seventy kilos of gold! So far the largest one we've found is fifteen."

“That’s worth how much?” Will did a mental calculation. “About $900,000.”

“It boggles the mind,” said Tina.

They walked to the top of the ancient gravel bar, then down its steeper far side. At one point, Will spotted a loose fleck. He reached down and picked it up.

“About ten grams, I suppose.”

“Let’s weigh it and enter the data,” reminded Andries. He pulled out a tiny scale and put it down on the rock. The nugget was 11.8 grams. It went into a sample pouch, and Andries dictated the coordinates into his computer. “Another datapoint.” he noted. “Some spots are richer than others.”

They turned south and walked along the deposit. Others joined them, holding up nuggets that were as much as a kilogram in weight. Finally, after two hours, with the sun setting, they went inside the Mobilhab for a hearty supper. They swapped stories about what they had found that sol.

“Commander, is there any possibility we might be able to keep a little of the gold?” asked Kevin Dunbar. “It’s a pretty special souvenir.”

Will considered the request. “We’re here to guarantee a future for Mars, but that doesn’t mean we can’t keep mementos. But let’s keep the mementos small, and for our bookshelves, not our bank accounts.”

“Fair enough,” said Kevin.

Will’s attaché beeped. He had attached it to his spacesuit for the sol’s excursions. He glanced at the screen, intending to see who was calling so that he could ignore the message until later. But he saw that the sender was Mich Dvorkin, Director of Exports,

and the message had been forwarded to him via Yevgeny, their local director of exports. He excused himself and entered the mobilhab's driver's cabin to view it privately.

"Yevgeny, I just received a message from Consolidated Mining," exclaimed Dvorkin, a note of excitement in his voice. "Their geological team has just finished analyzing the data sent back from Cassini. They're estimating the total gold reserve in the 'Pretoria Conglomerate' at six hundred tonnes, which at the current price of $60 million per tonne is worth 36 billion dollars. The Joberg hydrothermal complex may have ten times as much. They say that the local geology suggests an estimated reserve within one hundred kilometers of up to one hundred times as much as Pretoria; comparable to the Witwatersrand complex in South Africa. Their estimated recovery and transport cost for the first 500 tonnes of the gold in the Cassini region—the easiest part to extract—is $5 million per tonne. The next 2,000 tonnes will cost $10 million per tonne. No one will guess after that; recovery costs per tonne will go up but experience and innovation may drive them down. Consolidated is willing to bid twice as much as Muller Mining for the recovery contract; a billion down right away, a billion to cover the transportation of four crew and their mining equipment to Mars, and half the profits. Our contribution to the deal is four more personnel and the life support and transportation infrastructure for everyone. They'll even pay the shipping insurance to cover the cargo coming back to Earth. I'm contacting Muller Mining, A. G., for a counter offer. I expect that we'll get offers from several other companies as well. Please ask Commander Elliott for any comments about the terms. Bye."

Will had to laugh when he watched the message fade on his screen. It was a laugh of joy. He couldn't talk to anyone on the Mobilhab about it, so he called Yevgeny.

“I knew you’d call when you saw whom the videomail was from,” Yevgeny said, his face popping onto the screen.

“This is incredible. Absolutely amazing!”

“I did some calculations. The roughly 6,000 tonnes of gold in Pretoria and Joberg, if mined over twenty years, will bring in eighteen billion per year, half to the Commission. That covers half of our current expenses. Since governmental allotments will continue, it will allow development of cheaper, faster transportation between the planets. Since Mars has a lot more gold—they say ten times as much in the Cassini region alone—we can predict that more will be found, more mining efforts will be established, and more revenue will come in.”

“I agree! Yevgeny, we’re in the money!”

“I think so. This discovery means Mars has a chance to become financially self sufficient.”

“It’s amazing.” Will laughed at the thought.

“It’s unbelievable, it really is. And since the demand for gold on Earth is several thousand tonnes per year, we won’t be in danger of flooding the market. All this money can be used to import more people and more equipment, giving us more capabilities.”

“We had better talk to Morgan and plan another meeting of the two cabinets.”

“This certainly changes the plans for Columbus 6.”

Will laughed. “Opposition is in less than nine months. Columbus 5 has to leave for Earth in a bit over three; Columbus 6 launches in six, unless they use the solid core nuclear engines, in which case it could launch in eight. There’s a backup interplanetary hab and a backup Mars shuttle in reserve at Gateway. We may see both of them come this

way. There's a backup ACV. It'd be possible to fly 36 here instead of 30 if the mining companies pay for them. We'll need special mining equipment. It'll have to handle Martian cold, it'll have to be extremely energy efficient, and it'll have to be ready to fly here in six months! We'll need a lot more power. We'll need at least one biome for Cassini, maybe two for the Outpost. It's going to be dizzying."

"How's it possible to have mining equipment ready?"

Will shrugged. "You know the expression: *quality, speed, cost: pick two.* We need the equipment fast, which means it'll be expensive and reasonably good, or cheap and shoddy."

"Training the crew will have to occur during the flight or after they arrive."

"There's another long-term implication to consider. Mars will have two outposts. We won't be able to call Aurorae 'the Outpost' any more."

"Aurorae's wealth will be dependent on Cassini."

"That's right. Maybe Cassini will consist of repair personnel only; maybe the equipment can be run telerobotically from Aurorae. If that's not practical, though, Cassini may become Mars's future metropolis, not Aurorae."

David Alaoui took time away from the controls of the rover rolling across the hilly, baked wastes of Maxwell Montes to look at Venus through the window. Twice every twenty-four hour elliptical orbit there was a brief half hour period, right after they had swept into sunrise or were approaching sunset, when the planet was a thin crescent, but the sun was not yet shining in the window. At that time Venus was a beautiful thing, not too bright to

hurt the eyes, with hints of sunrise or sunset along the limb, and even a sense of the fuzzy, smoggy nature of the cloud deck. He got up and stared for about five minutes.

"She's beautiful, isn't she?" exclaimed Juliette to him. They spoke in French, the standard language on Magellan.

"She really is," he agreed. "Beautiful and deadly. I wish we could walk on her."

"Me, too. I wish we could get out of this station!" exclaimed Juliette. "Virtual exploration just isn't enough. Even a space walk would help right now."

"I know what you mean. The greenhouse helps; the plants are always changing. It's going to be hard to go home in just the little *Amazonis.* But the next expedition will have that much more space, with the *Guinevere* waiting here for them."

"They'll need it. I'd like to see the next expedition deliver a big module of some sort; call it a gym."

"That would be good." David turned back to the rover controls. "I hope this rover lasts another month. The science objectives are getting interesting."

"How's the video holding up?"

"It's blind in one eye and looks like it has a cataract in the other, in spite of computer enhancement. The heat is seeping in; there's something wrong with the air conditioning in that area of the rover."

"The same flaw that killed the last one. At least we were able to recover its radioactive electric generator." She tapped on the screen in front of her. "The RTG really sped up the Samandar's fuel manufacturing."

"How much water have we been able to recover from the atmosphere so far?"

“That dip into the sulfuric acid cloud last week pushed the total to 300 kilos! We’ve already converted it into over half the liquid oxygen and methane we need for the sample return.”

“We better send the Phoenix down to recover samples from Maxwell Montes soon. It looks like we’ll be able to refuel the sample return vehicle before we have to head back to Earth. We need some time for analysis in the Samandar’s lab before loading the samples into the return capsule.”

John Hunter’s research kept him quite busy at the Outpost for a week after his vision quest. He was anxious to look for the place of spiritual energy he had seen in his quest, but it was hard to get to the Dacha, especially alone. Finally, Enrique had to go up to do some routine maintenance, so John volunteered to accompany him. Then on the excuse he wanted to check for geological samples, he suited up and walked east-northeast from the Dacha, looking for the sacred place he was sure existed.

The escarpment edge of Little Colorado Canyon was farther away than he thought; three kilometers, a long way to walk by oneself outside. He was nervous about being so far from the Dacha; it was a big violation of the rules, rules that admittedly people bent all the time. He approached the cliff edge cautiously, his astronaut training battling with his cultural training.

He looked down into Little Colorado Canyon. It was nearly a kilometer deep at that point. The lower slopes were so steep he couldn’t even see the bottom where the road was, except for a few spots. He gazed along the rim, both to the north and the south, and noted a notch in it 500 meters to the north, so he walked toward it.

When he got to the notch he saw that it was the top of a ravine that extended about a hundred meters east from the cliff edge. Eons ago a spring had undermined the cliff, causing it to retreat. Looking down into the canyon, he spotted the natural bridge that Will had mentioned; the canyon cut through a lava flow in the strata, and at one point the water of the spring had opened up a natural crack in the rock and worked its way under the lava flow, leaving a piece of it to form a roof. He had never seen a phenomenon like that on Mars before.

There were boot prints descending the rim not too far away; Elliott had descended into the ravine with someone else. Knowing that there was a route down and back, John followed their trail. It was easy to spot even though it was months or years old; even the worst dust storm would obscure it very slowly, and the men had been careful on their way down to mark the trail to make their return easy, quick, and safe. Whenever they had tried a path down that had failed, they had clearly scratched it out so that they wouldn't be confused on their way back up.

The first cliff was the hardest to climb down; after that the men had followed a natural ledge until they reached a breach in the next cliff. It took John fifteen minutes to follow a path that probably had taken forty minutes to establish. He approached the arch with caution; it was an impressive structure, twenty meters above the ravine floor, fifteen meters long and ten wide. The ground underneath was littered with stones that had fallen off it, sometimes in big heaps. Surprisingly, the last flow of water had broken through most of the debris, establishing a creek bed under the arch.

As he stood just under the edge of the arch, he noticed something else as well; the debris had fallen to form two semicircles, one on each side of the creek bed. Together

they formed a rough circle of stones. That really surprised John. “This is a very sacred spot,” he said to himself. He sat on a boulder and prayed thanks to Wakan Tanka for leading him to this place.

He had just finished when his communicator buzzed. He opened the line. “Hey, John, where are you? I’m finished with the work on the electrical system.”

“I’m at the escarpment edge looking into Little Colorado. I just got my samples.” He looked around and picked up two pieces that had fallen off the arch.

“Acknowledged. You’re a long way from here. Shall I suit up and drive over?”

“Ah. . . sure, I’ll walk over to the dirt track leading to the Dacha, and I’ll make my GPS position public so you can home in on me. That’ll save a lot of time.”

“Yeah, and maybe your skin; you’re a long way away.”

“I know. I’ll tell you about it on the way back.”

13

Contracts

Aug. 2045

For the next week, Will spent eight hours of every sol outside with the other eight personnel at Cassini. Some ran the drill and prepared explosives; every other sol they set off a series of blasts that tore a great hole in the Pretoria conglomerate and exposed hundreds of tonnes of rocks to examination. Others scoured Pretoria for loose nuggets, or nuggets that could be pried loose in an hour or so. Yet others set out in rangers and rode north or south along the ancient vallis, sampling the sediments and searching for other rich gold deposits. Finally, a team set out across the highlands to follow the exposures of the Joburg intrusion, sampling the regolith and the ejecta from craters for gold. They, too, found scattered nuggets, and one spot where rotten igneous rock could be blasted apart with explosives to free up in situ gold. They collected another tonne of nuggets. It was an exciting, rewarding period.

Each sol, for the late afternoon and half the night, Will retreated to the Mobilhab's driver's cab to receive and send emails, voicemails, and videomails. Negotiations had started with a third company as well, the Sibir Resources Company in Moscow, know as Sibireco. Each offered a special bonus for an exclusive contract, which Morgan vetoed after Dvorkin came close to closing a deal with Consolidated. After that, it became a question of how many companies would get a deal and who would offer the most. The bidding forced the Commission to raise its contribution somewhat as well.

"It looks like Sibireco's dropping out," Yevgeny told Will one night. "They thought their strength was their experience operating during the Siberian winter, but now

that they've looked at the situation more closely, it appears that Siberia is not a very useful training ground. Consolidated has immense experience all over the Earth and vast resources. Muller Mining is in the running because they love Mars, their expertise is robotic mining, and they're willing to risk the entire company."

"Muller owns most of it, right?"

"He and his daughters. The other stock holders are furious; their stock is dropping in value. Muller doesn't care. Consolidated's worried as well; their stock has dropped a few percent."

"But that must be a coincidence," replied Will. "I understand the price of gold has dropped ten percent, to $1890 per ounce, and the analysts are saying it's because of the speculation about Martian gold entering the market!"

"Uncertainty, Will," replied Yevgeny. "That's what's driving prices down. If we succeed very, very big, it's remotely possible we could increase the supply enough to affect the price. Everyone says that'll be decades away; we'd have to export something like 300 tonnes of gold per year to depress the market price! But the possibility of big success causes uncertainty. And the possibility of a big failure causes uncertainty about Muller A.G.'s stock price, pushing it down."

"Ah, I see, there is a connection. How's Mich Dvorkin holding up?"

"He looks utterly exhausted. Morgan's interfering in an area he doesn't know and Dvorkin's always afraid he'll get undermined by the Commissioner. The outside consultants Morgan called in to make sure the Commission doesn't get a raw deal have messed up the chemistry, too; the other negotiators trusted Dvorkin and now they feel they can't make a good faith offer without worrying about a lowball response. So the

negotiations are a mess. And everyone's under immense time pressure; Mars and Earth are moving inexorably towards opposition on April 17, 2046. I told Mich he had to talk to Morgan about the problem, and if he couldn't he had to talk to Louisa to talk to Morgan for him. That's a conversation we can't have with the Commissioner."

"I agree; it requires spontaneity, not video soundbites. Urge him to talk to Morgan directly. We can't get this messed up. What are the offers up to, Yevgeny?"

"The gold recovery estimates are holding up and Sibireco, Consolidated, and Muller all came up with roughly the same figures; they'll invest $1 billion to fly four people here, plus develop the mining equipment, plus fly it and some consumables here over three columbiads. But the result will be five hundred tonnes of gold exports, worth $30 billion on earth. If we export it over six years, we'll be humanity's ninth or tenth largest gold producer. The Commission's costs will be substantial but less. We don't have to develop and build the mining equipment, just the biomes, roads, sunwings, shuttles, and other things we already have. The negotiations now say the Commission will get $2 billion up front for the lease plus half the profits, which would be $15 billion. If we split the contract between two companies, we'd get about half from each."

"Add that to the income from national governments, and the Commission will be able to expand this place significantly. We'll have to send a team to Dawes in a few months and we'll have to reexamine the Candor deposits. There's a new paper published on the web that identifies two other possible gold recovery districts, too."

"Terrestrial companies mine 2,000 tonnes of gold per year from a few dozen localities, and Mars has about the same amount of dry land." Yevgeny sighed. "I suspect

this will be wrapped up in another week. A decision has to be made now, or it'll be too late to get ready. What are your plans?"

"I'll be here another week at least; I'm going out on a gold prospecting expedition. I haven't been in the field a long time, and once I'm away from the kids, God bless them, I might as well make it last a while! We're trying to define the geology of Cassini Borough better. Then, if I can, I'll head north and see Deuteronilus Mensae for a few sols, then come back here and fly home."

"That sounds fascinating. Roger has me on the list to rotate down in another month, so I guess I'll be running the export department from the front of a portahab."

"I'm using the front of the Mobilhab. I'd better run; thanks for the update."

"Sure. Talk to you tomorrow. Bye."

"Bye." Will closed the line and turned to various reports. Lisa was perpetually updating him about the woes of running the ecology of Yalta; finally the agricultural productivity was climbing to where it should be and the crops were more diverse, with more space for spices and slow-growing species. Alexandra sent a report about Catalina; the space into which the new biome would be inflated was now enclosed by duricrete walls and a floor, and the metal tunnel and airlock connecting it to Yalta was finished. Madhu sent a report about the completion of her first labyrinth art design. Enlai and Martha sent him a report about the plans for MarTech; a team of lawyers in Houston were now drawing up the institution's charter.

Finished, Will opened the door—the driver's cab was its own airtight cabin—and walked into the main area. Kevin Dunbar was playing a card game and flirting with Kimberly Irion, who was enjoying the game and ignoring the interest. Four other

crewmembers were already upstairs. Andries and Tina were sitting at the other table downstairs finishing cups of tea.

"How's everything?" Andries asked.

Will nodded. "Negotiations are progressing. It sounds like we could be exporting almost as much gold as South Africa in a few years."

"Oh, I think so. Our Joberg-Pretoria deposit has a huge amount of gold. And the hydrothermal body we were looking at this sol has a lot of potential; I'm calling it 'Klondike.' We might as well use names from the old gold rushes on earth. I don't see any placer deposits associated with it, but the intrusion has a lot of gold in it."

"Write it up. The more gold we're sure of, the better."

"We're going back tomorrow morning," added Tina. "And a sunwing is scheduled to conduct very low-altitude sensing flights; the reflection spectra can be scanned for gold signatures."

"They can be now; no one had programmed the software to look for it before!" agreed Will.

Andries rose. "Well, I think I'm retiring. Dawn comes pretty early."

"Good idea." Tina stood up also.

Will nodded. "Good night; rest well." The two of them headed into the Mobilhab's airlock, which led to the docking unit and then to the portahab, the small wheeled inflatable habitation they were staying in. Will turned to the Mobilhab's stairs. He headed up to his cubicle.

After ten sols of gold prospecting, Will, Kevin, and Qingtian took a ranger up the Cassini Trail—so called because it ran from the Virgo Trail to the Circumnavigational Trail, with Cassini in between—to the northeastern expedition. Roger Anderson, a Mobilhab, two rangers, and five other crewmembers had pushed Virgo eastward five hundred kilometers through Deuteronilus Mensae, the mesa-like erosional remnants left from the retreat of the edge of the highlands. A billion years of floods, groundwater sapping, and wave erosion had cut back the highlands several hundred kilometers. The two-sol drive was a fascinating tour of Martian geology. Anderson's Mobilhab was parked in a channel between two mensae with spectacular sedimentary strata exposed on their sides, on the edge of a dune field. Right after the big dinner that marked their arrival, Morgan sent a videomail. Will retreated into the driver's cab to listen.

"Will, it's now official. The negotiations have taken much longer than expected, but Mich engineered a breakthrough last night, based on the companys' relative strengths that neither wanted to admit to. Muller Mining, A.G., gets an exclusive lease of the Joberg intrusion. Their strength is not placer mining, but robotic digging and use of the cyanide process to extract gold from the crushed rock. Consolidated gets an exclusive contract on the Pretoria conglomerate; their expertise is placer mining, and they designed the liquid carbon dioxide centrifuge you all tried out on Candor two years ago, which worked pretty well. Both companies are buying ten-year options on other areas as well: Muller's taking Klondike and Consolidated is taking the entire vallis for fifty kilometers downstream of Pretoria, where gold has been found. Since they're working on different deposits, the total gold yield we expect is higher than either company individually. We're looking at up to 1,500 tonnes over a fifteen-year period, or 90 billion dollars. Both

companies will fly four workers here and we'll provide four more to each for support and maintenance services. Both are flying about twenty tonnes of equipment on Columbus 6, and may fly a similar quantity on future missions. Both are paying us $750 million over the next year as a down payment and we're splitting the subsequent profit in both cases. We get to keep all the profits on gold mining until their crews reach Mars.

"Congratulations on all your work determining the extent of the gold reserve and your hard work to extract gold for the Columbus 5 return flight. The news of the contracts will be released momentarily—though not the financials—so you can inform your crew of our success. Goodbye."

Will sent Morgan a quick acknowledgement thanking him for the effort, then taped a very simple video message and sent it to the crew. When he stepped out of the driver's cabin, he found everyone watching his announcement on the room's big screen. When it finished everyone cheered and applauded. Will smiled.

"That didn't take long!"

"But what does it mean?" asked Roger. "Will Cassini become the new capital and largest settlement on Mars, or will it remain a mining camp?"

"Telerobotics will allow us to do a lot," noted Kevin. "Cassini could be just a repair and maintenance facility."

"I doubt Muller and Consolidated will want that," replied Will. "We'll have to wait and see."

"How long before miners outnumber the rest of us?" speculated Roger.

"That's a very good question, and we don't know the answer to that, either. The mining operation will require sixteen personnel altogether."

"And we can fly thirty, right?" asked Lal.

Will shook his head. "The public interest in Mars has increased and it appears more countries will respond to the Commission's invitation. They'll send six ITVs and three shuttles, but they'll be accompanied by an 'interplanetary transit axial module,' popularly known as the 'middeck,' thirty meters long and six in diameter. It'll be big, roomy, and zero-gee; everything else will dock to it. The ITVs are receiving new, more robust life support systems that recycle the wastes of six people easily and eight in an emergency. As a result, Columbus 6 could accommodate thirty-nine or even forty."

"They're going to pack them in like sardines!" exclaimed Roger.

"No, it shouldn't be that bad. The middeck has a volume equal to about two ITVs. It's a clever addition to the mission; it'll have its own heatshield and a small engine, so its uses are flexible."

"We could have used it on Columbus 5," commented Radha. "Columbus 6 will have greenhouses, too, to recycle waste and provide even more space."

"Interplanetary transportation is improving and should get cheaper," added Will. "There's an article on the web you all may have seen. It says we can guess safely that Mars's population will increase by at least forty per columbiad from now on; even though some personnel return home, others start families. Just that fact will increase our population to about five hundred by 2060. And it projects that the cost will drop to a third of the current level in twelve columbiads, which would make transportation about fifty million per person. Furthermore, it suggests the current investment in Mars will stay at least the same as it is now, in which case, twelve columbiads from now we'll be flying one hundred twenty people to Mars each opposition. It further notes that if spending on

Mars grows at two percent per year—the same as earth's rate of economic expansion—in twelve columbiads or twenty-six years spending will be about sixty percent more, which means we could be flying two hundred people here per columbiad. You can figure out the implications. Within our lifetimes, this world could have over a thousand people on it. Mars may be sending out its own missions to asteroids. So we have to work hard and safely, because we have an opportunity most people lack: the chance to build something really tangible, to watch real progress before our eyes because of our own sweat and dedication."

Will used his ten sols along the dichotomy well. After five sols with Roger's eastwardly progressing expedition, he took a sunwing flight with Kevin to Peter Theodoulos's westward progressing expedition, so that he could see what they were finding and get a sense of the terrain; Kevin had to do some routine maintenance on the nuke they had. Five sols later, the two of them flew back to Cassini in time for the shuttle flight back to Aurorae Outpost; in the meantime, Érico had driven back in a ranger. A sunwing had already landed at Cassini with three new crewmembers, so the total number of personnel in the northern hemisphere remained at sixteen. Will, Érico, and Kevin boarded the shuttle for the forty-five minute hop back to Aurorae Outpost.

"I suppose I should get used to zero gee," Kevin said to Will after the shuttle engines shut off.

"Why, are you planning to fly back to Earth?"

“I think so. I hate to leave, especially since Jake’s here and I won’t see him. But Will, Jennie’s making any contact with Jake difficult. And I’m not someone who can live alone; I love to love women, Will. The pool here is really small.”

“True, but why not give Mars a little more time. A lot of new people will be coming; there will be women to meet. Aurorae Outpost will be that much bigger; we’ll have Catalina Biome finished. You won’t have to be so close. And we’ll have Cassini, so you won’t have to live in the same outpost any more. Maybe in the next two years your reasons for leaving will be resolved. And obviously, Jake needs you.”

“Maybe,” said Kevin. “I don’t know what to do, Will. This has been a very difficult two years.” A tear formed in one eye, the only hint of the emotional impact he had felt.

“I’m sure it’s been rough on Jennie and Jake, too. But sometimes fine people are unable to live with each other.”

“I know; Martha’s told that to me alone and to both Jennie and me together.” He shrugged. “I can’t promise anything, but I’ll think about it.”

“Okay. Let me know if there’s anything more I can do.”

“Thanks. I’m glad we’ve had the last week or so together; we haven’t talked that much, but you have been a help.”

Will nodded and smiled. He unstrapped from his seat and floated over to the window facing “downward” toward Mars, so he could watch his beautiful adopted world roll by underneath.

Soon they had to strap in again. The shuttle reentered the Martian atmosphere at hypersonic speeds and Érico watched the computer as it steered the vehicle steadily

toward the landing pad. Finally, three engines came alive to burn off their last 5,400 kilometers per hour—half their velocity when the engines shut down after launch—and the shuttle settled down onto pad 6. Half an hour later, they were back inside the Outpost.

Will spent the rest of the morning with Ethel and the kids. That evening—as was traditional whenever a shuttle returned safely to the Outpost—there was a grand dinner. "Welcome back," exclaimed Greg to Will, while the latter was sitting at his usual table with his family. "We missed you over the last month. The services weren't quite the same."

"My 'sermon' can always be rescheduled. From the sound of things, everything went just fine."

"Yes, we managed alright. I hear you flew over the so-called 'Face of Mars.'"

"Not just flew over; Roger stopped his expedition at it and we did a live broadcast over the web, followed by live broadcast of the geological excursions in the area. I hope we have set the rumors to rest. All of us were making a lot of jokes about them."

"I heard a little of that, live. I suppose there will always be people who maintain it was a coverup," said Greg with a smile. "What can you do? I understand there are still a few folks who insist no one has walked on the moon or Mars. How is everyone doing, up there in the northern highlands?"

"Pretty well. Lal and Radha are doing very well together, from what I could see. They said to me that the first year, they now realize, was actually difficult, and it is now getting easier! Andries and Tina have decided to get married in December just before Columbus 5 leaves. The Mobilhabs are improving morale; they provide so much more room for living on the move."

“So I hear. Roger has me scheduled to go down for three months right after Columbus 5 leaves; I’m looking forward to it. Good to have you back.” Greg waved goodbye and headed back to his table.

“It’s good to see Greg,” said Will to Ethel, and she nodded back.

“I’m afraid I’m feeling a bit uncomfortable around Greg, right now,” said Enrique, who was eating with them that evening. “Every time I see him, I think he’s wondering why I’m not going to mass!”

“You are free to decide yourself; there is no compulsion in religion on Mars.”

“I know.”

“I hope we can start the study circle up, now that I’m back. There are new materials from the Wilmette Institute about several Bahá'í scriptures that we can review.”

Enrique looked at Will, surprised. “We never stopped the study circle while you were away! We finished the course on the Bahá'í concept of unity and started studying Ruhi book 35.”

“Really? I didn’t realize.”

“Enrique really wanted the course, so we completed it without you,” said Ethel. “That’s a consequence of going away a month.”

“It really was excellent,” agreed Enrique. “That’s the main reason I feel funny around Greg. I feel I am now ready to become a Bahá'í.”

“Really?” Will was surprised. He smiled. “You believe?”

“I do; I believe in Bahá'u'lláh as a divine messenger. I can’t say why I believe; I can’t even say when I started to believe. But I do believe.”

“Then you are a Bahá'í.” Ethel leaned over and gave him a kiss. “Welcome to the Bahá'í family, Enrique.”

“Thank you. Is there anything I should do?”

“The two of us can enroll you in the Faith,” replied Will. “Let’s sit down and review the basic beliefs of a Bahá'í some time, just to make sure there’s nothing that will surprise you. Then we’ll continue the study circle, except all three of us will be Bahá'ís.”

“Maybe I can give some Bahá'í classes to Marshall,” suggested Enrique. “He’s old enough for basic classes, it’d help me get a better grasp of things if I taught him, and he probably needs to hear from someone other than his parents.”

“Great idea!” said Ethel. “There’s a lot of curricular materials on the web.”

“There may be other kids interested in coming, too,” added Will. “This is marvelous, Enrique. It’ll be good to have you in our little community.”

They continued chatting on various matters. Lisa stopped by and asked Will if he had enjoyed the beef; it was the first time they had slaughtered a cow raised on Mars, for they now had enough plant waste to feed cattle. Alexandra stopped by to schedule an inspection tour of Catalina; the outer bubble had been inflated just two sols before and was ready for interior construction and planting. Irina and Eammon stopped by to say hello and assure Will that the pregnancy with the twins was now going much better. Martha stopped by to tell Will that she and Enlai would have a charter for MarTech ready for debate by the town meeting in early September.

People began to drift out of the patio, heading to the store—which was always open after meals—or to their flats. Seeing that people were leaving, Érico walked to the stage and stood on it. “Can I have everyone’s attention quickly!” he shouted. “Please, can

I have your attention!" He had to strain his voice a bit; in the one third atmosphere, sound did not travel as well as on Earth.

Conversations stopped and people turned to him. "I think this special evening deserves one further formality," he said. "As we all know, this has been the strangest columbiad ever seen on Mars. First we were stuck inside for much of the dust storm season, then had an acute crisis of direction and financing, then resolved the crisis in a bold and decisive fashion. I think we all owe someone thanks for the resolution of the crisis: Commander Will Elliott. Could we all acknowledge our Commander with a round of applause."

Everyone started clapping; many cheered as well. Will smiled and nodded, then stood and nodded, and quickly sat. But several began to shout "Speech! Speech!" and Érico responded by beckoning Will up to the stage, so he rose from his seat again and walked to the stage.

"Thank you, everyone. I'm not good at speeches, especially when they are spontaneous, so I'll keep this one short. As Érico noted, we've never had a columbiad like this one. But consider our remarkable achievements. First, look at this magnificent place we reside in, with open space, trees, and comfortable, light-filled flats; we have indeed graduated from horticulture to ecology. Second, we now know both of this world's moons intimately. Third, we now have a dacha for relaxing and getting away from it all. All of these accomplishments were made possible by the storm. Fourth, we are exploring the last major area of the planet that was heretofore unknown: the northern highlands. Fifth, we now have historic, signed contracts with two very capable private firms to begin exports of gold from Mars, something that will launch us into the top ten

of gold exporting ‘countries’ and will move us substantially toward financial self sufficiency. This is a development no one would have anticipated would occur only ten years into human settlement of the Red Planet; if anyone had guessed, most would have said such a development would await the turn of the next century. Sixth, Mars now moves from having one outpost and one borough to two.

“If there is any way to summarize our achievement during this columbiad, it is this: we have moved from outpost to colony. We are no longer a group of scientists and engineers discovering how human beings can live on Mars. We have figured out how to do that. We are now a colony of Mars residents laboring to establish an economy, society, and culture on this world. That task will take many decades; it started this year.”

14

Launch

Nov. 2045

"This is as high as she's going to get, David," exclaimed Juliette. She was sitting in front of the controls of the Samandar 3B Sunwing.

David Alaoui looked at the control screen. The 3B was at 64,400 meters, where Venus's atmosphere was only a tenth as dense as the Earth's and the air temperature was –20 Centigrade; conditions more Martian than Venusian. Its three propellers were spinning at their maximum; not only was the sunwing using all of the 60 kilowatts of power the solar panels covering the tops and bottoms of its wings could generate, but it was using 40 kilowatts of power beamed over by microwave from the nearby Samandar 3A. The latter was broadcasting a picture of the 3B and David glanced at it as well. The Samandar had a wingspan of almost twenty meters; the fuselage was six meters long and one meter in diameter and David focused in particular on it. The front meter was a science lab with a trap door in the top where miniature Phoenix airplanes could land, anchor themselves, and deposit rock samples from the roasting surface far below. The rear meter had the sunwing's control module, fuel cells, energy storage system, and communications. The four meters of fuselage in between was a rocket, now fully fueled with 3 tonnes of liquid methane and oxygen, ready for a drop launch.

"Everything's nominal?" he asked.

"Affirmative," replied Juliette.

"We're actually 1,500 meters higher than planned," added Ludwig. "That gives us some extra delta-v."

“Good. Let’s initiate the drop launch sequence.”

“Laying it in,” replied Juliette.

“The timing is perfect for the launch window,” added David. He watched the screen. A countdown began. No one spoke; they watched it silently count down through the last thirty seconds, as systems activated themselves or checked themselves for the launch.

At zero, they all focused on the television screen. Suddenly, the middle section of the fuselage separated and dropped like a rock. The sunwing, suddenly 3,000 kilograms lighter, immediately shot upward. Juliette switched to a camera in the belly of the 3B. The rocket fell away, then suddenly its three engines came alive, blasting out an immense flame behind it. The rocket began to turn and rise into the blue sky, accelerating rapidly.

“Beautiful,” exclaimed Juliette.

“And the thrust is perfect,” added Ludwig. “The engines are performing very well.”

The rocket shrank to a bright point within ten seconds. It was accelerating at an immense rate, powerful engines using up the methane and oxygen fuel as fast as possible in order to reduce losses due to gravity. A mere eighty seconds into the flight there was a pause, a flare was visible, then the spot faded in brightness. “Staging has proceeded normally,” noted Juliette. “The first stage is on its way to the surface of Venus.”

“To become a puddle of aluminum,” remarked David wryly.

The spot continued to glow on the screen, but there was no detail to see. They all turned to the telemetry screens where thrust, remaining fuel, altitude, and delta-v were all charted, along with data from hundreds of temperature, pressure, and other sensors. The

rocket was now rising into the thin wisps of upper atmosphere where the air had very little impact on it. The flight computer leaned the rocket over so that it was flying more horizontally, gaining speed rather than altitude.

About 300 seconds after it separated from the sunwing, at an altitude of 250 kilometers, the second stage engine shut down. “It’s in orbit,” said Juliette, with a smile. “We can start planning the orbital circularization maneuver right away. We’ve got the fuel to move the orbit up thirty kilometers.”

“It’ll make the job of the recovery rocket much easier,” replied Ludwig. The recovery rocket would dock to the sample capsule and bring it back to Magellan in two weeks time.

“Congratulations!” David said. “The first samples ever recovered from the surface of Venus are on their way up!” He looked at his three teammates, including Sally Greenleaf, who had no role in the launch but who was present nevertheless.

“We should have a toast, even if our French commander doesn’t drink French champagne!” exclaimed Ludwig. He rose and got out a bottle from the cabinet and filled three glasses. Meanwhile David, who was reasonably observant as a Muslim, filled a glass with water.

They raised their glasses. “To Venus; may she continue to yield her secrets to us,” exclaimed Ludwig.

“And to the sunwings and their rockets; may they continue to serve us,” added Juliette.

"And to the future," concluded David. "To deuterium recovery from the Venusian atmosphere, and reusable shuttles that can fly down to sunwings and back, and rovers that won't melt, and all sorts of other innovations that are promised to later Magellans."

"Here, here!" exclaimed Sally. And they all drank.

Will Elliott ceremonially rang Aurorae Outpost's bell once, twice, three times. Then the wedding march began and everyone turned to watch Andries Underwood and Tina Hvitmer walk in, preceded by Lizzie Elliott and Corazon Lopes, both three years old, sprinkling flowers as they went.

A smile graced every face as the couple reached the front of the patio and stood under an arbor, decorated with flowers for the occasion. Gregory Harris joined them and welcomed everyone on behalf of the couple.

The wedding ceremony was brief; a few readings from scripture, words from the chaplain and the couple, a song, the exchange of vows, and then the signing of the marriage license. When it ended everyone broke out into applause for Mars's newest married couple. Everyone lined up to shake hands or embrace them while Lisa and her crew quickly rolled out tables, rearranged the chairs, and set up the buffet lunch. Others stopped at the two videophones and attached projection screens to greet the family of bride and groom, who were participating with their friends in Johannesburg and Copenhagen, respectively. The couple walked to the head table while recorded music blared from loudspeakers. Immediately everyone banged on their glasses to get the couple to kiss.

“A custom I wish we could abolish,” said Ethel to Will. “They’ll never get a chance to eat!”

“Don’t worry,” replied Will. “What a glorious sol.”

“Let’s see; we still have ten folks who plan to stay here who are unmarried. I hope some of them can be convinced soon.”

“Maybe Columbus 6 will bring the right man or woman. Selecting a mate when the choices are relatively few is not very easy. Though we did alright.”

“Yes, I guess we did,” conceded Ethel.

“Well, let’s get in line for the food.” Will rose and Marshall almost jumped from his chair, he was so hungry. They ended up in line right behind Pete Theodoulos and Yasuo Matsuzawa.

“How are plans for liftoff?” Will asked them. The *Olympus* was scheduled to carry both of them and Taehun Kim to the ITVs on November 10, just three sols away.

“Quite good,” replied Pete. “We just ran a second set of complete tests on the systems and everything is fine. The *Hadriaca’s* ready for launch tomorrow. The spaceport crew finished loading the gold and fossils on board yestersol.”

“So I heard. We have to congratulate Andries for a greatly successful effort there; who’d have thought we’d recover nine tonnes of gold in five months?”

“There’s no doubt; Pretoria and Joburg are among the greatest gold concentrations ever found my humanity,” replied Pete. “Will, I really regret leaving. These seventeen months have been incredible. I’ll never forget the terrain we explored. But I have a wife and two kids who want me back.”

“And I know exactly what that means, Pete. Don’t feel bad about the situation. Frankly, if this arrangement with the Commission works out well, you can do a great deal of good there. We don’t have any astronauts who have walked on Mars in high positions in the Commission’s Houston headquarters. They really can’t completely understand our situation up here without someone who can explain it to them.”

“I’ll do my best,” agreed Pete. “I think the job is ideal for me. My boy is starting high school and needs me around for a few years. I’m not sure how the family will respond to a move from Toronto to Houston, but they’re willing to give it a try.”

“Good. And maybe you and your wife—or even the grown up kids—can come later.”

“Commander, I am saddened to leave as well,” exclaimed Yasuo. “But as you know, it really has not worked out so well for me, up here.”

“Yes, I know Yasuo, and that’s alright. If you weren’t going back, I’m not sure Pete could go back as well! There will be just three of you on two ITVs and two shuttles; a big, rambling space to be in. If only two were going, the Commission would have scrubbed the flyby of asteroid 2017PL6. With three, that’s feasible.”

“And I’m really glad we’re doing it,” added Pete. “It’s good science and provides yet another datapoint, especially if the *Hadriaca* can land and scoop up samples as planned. Don’t worry, Yasuo, as soon as we spin up the Columbus 5 station, we’ll switch to an exactly 24 hour day, and I’m sure your chronic sleep problems will go away.”

“That’s what the doctors say,” said Yasuo, nodding. “I hope future residents with this problem can get relief with medication.”

“They’re working on it,” replied Will. “I worry about my kids; they were raised here with a 24.6 hour circadian rhythm programmed into them. I wonder whether they can adjust to living comfortably on Earth!”

“I’d worry more about the gravity,” replied Pete. “Even with a gradual increase in spin and artificial gee during the flight, several people have had long-term adjustment problems on Earth.”

“It may not be a problem anyway,” said Will. “At the moment we have no reason to leave, and at the present rate, by the time Marshall’s an adult, Aurorae may be a small town anyway. Who knows, maybe he’ll be on the first mission to Ceres.”

“Maybe,” said Marshall, piping in.

They reached the food and went through the buffet line. Marshall loaded his plate; Will was more restrained, because the improvement in diet was causing him and everyone else to put on a bit of weight. He walked back to his table via the bride and groom.

“Congratulations again,” he said. “I owe both of you a debt of gratitude, too. Andries, without your energy and focus, we wouldn’t be exporting nine tonnes of gold. Tina, without your journalistic skills, we wouldn’t be in as good a position as we are where public relations is concerned. I heard from Morgan this sol we now have forty signed up for Columbus 6, and both of you are responsible for the turnaround.”

“Forty!” exclaimed Andries. “I’m amazed they can pack that many into the ITVs and shuttles! It strikes me as risky.”

“It shouldn’t be risky at all. The equipment is good.”

“So that means Mars will just about hit one hundred people,” commented Tina. “That’s a milestone to publicize as well.”

“Correct. After Columbus 5 leaves, we’ll have forty-four adults and ten children, with two more kids on the way. When Columbus 6 arrives we’ll have a population of ninety-six, most likely. I think it’s pretty likely we’ll have four more children born in the next two years.”

“We’ll probably make our contribution to the population explosion,” noted Tina. “With the biological clock ticking and radiation damage a constant worry, there’s no reason to wait very long.”

“But meanwhile, we’d like to be assigned to Cassini again,” said Andries. “We’re enjoying the work there, and Tina has found plenty of journalism to do from there.”

“Excellent; I’ll look at the schedule. But right now focus on the wedding and starting your life together. You’ll be the first couple to honeymoon at the dacha.”

“Yes; that should be fun,” agreed Tina. “But since we’ll be the only people there, we may find food preparation and other tasks to be too demanding! We may prefer to be here where we can get our meals easily.”

“That makes sense, and I bet someone will even deliver them. Enjoy the rest of the sol.”

November 10, 2045, dawned bright and cold, as it always did at Aurorae Outpost. Pete Theodoulos, Yasuo Matsuzawa, and Taehun Kim ate a big breakfast on the patio of Yalta with many of their friends, then after a round of hugs and hand shakes, they headed for the garage in Joseph Hall. Their personal possessions were all packed in airtight suitcases

in the ranger. They donned their pressure suits quickly, then Will himself drove them to the *Olympus* and helped them walk to the shuttle's entrance ramp. They walked up the ramp, waved, and entered the airlock. A few minutes later the ramp rose and folded into place against the side of the shuttle.

Inside, they stowed their suitcases, strapped in, and began to run through the two-hour launch checkout procedure. The *Olympus* was poised and ready, 155 tonnes of oxygen and methane in its tanks, enough to hurl the ship to the high elliptical orbit followed by Embarcadero Station. The ITVs *Cimmerium* and *Ophir* awaited them with the shuttle *Hadriaca*, which had arrived safely two sols earlier. Its cargo bay, in addition to a section for the crew, had two sections containing half of the gold, three tonnes of rock samples destined for laboratories on Earth, and four tonnes of fossiliferous shale for sale to the public. Altogether, Columbus 5 was returning with almost $1 billion of exports.

The final countdown began as the ITVs and the other shuttle raced into the place they were destined to be at launch. Finally the count reached zero and the *Olympus's* engines came alive, belching out a small initial flame, then rapidly increasing to full throttle. The shuttle rose for pad 6, at first slowly, then with increasing speed and confidence as it blasted skyward on its homeward journey to Earth.

Will visits building 1 and talks to Thierry and Zach about condo sales. They make it clear they want to move in together right away, as well as buy a unit together, and ask Will whether his religious convictions will lead him to oppose them. He says it will not. Alexandra asks him about the weather forecast, as it could delay the shuttle landing. Pete has been elected Borough Chair; they commiserate with Will. Roger wants Will to oppose housing for the gay couple; Will says no. Silvio pushes for more commerce.
Date: early Dec. 2044

7. New Years 98
On the last day of December, the outsides of buildings 1 and 2 are finished and the financing plan finalized. Will moves the dinner and New Year's celebration to the patio. At the dinner the financial plan is announced and discussed and the lottery held. Ruhullah expresses concern and Will says they'll offer Islamic banking as well. Taxation is discussed.
Date: Dec. 30-31, 2044

8. Vistas 115
Will and Roger move their families into Yalta and talk. Will takes Marshall up to the roof and he asks to go see the escarpment. Will talks to the exobiologists about their plan to drill a buried crater under the northern ocean sediments and to move the lab into Renfrew Hall. Will talks to Martha about encouraging Ruhullah and John. He attends Marshall's birthday party. Will and Roger take the boys to the top of the escarpment and see the perfect spot for the dacha.
Date: Feb. 2-20, 2045

9.Midpoint 135
Will and his team meet with Morgan and his team and learn that support for Mars has seriously declined on Earth. They brainstorm solutions and everyone expresses a willingness to work more hours. On April 10 the *Elysium* finally lands. Will appoints Directors of Public Relations (Hvitmer), Exports (Underwood), and Natural Resources Recovery (Yevgeny).
Date: April 1-10, 2045

10. Dacha 157
Will returns home late at night, despairing over the disunity in his team about the next step. Ethel encourages him to pull it together. The next morning Marshall calls Jerry. Will lays out a bold plan to start gold exploration and recovery in Cassini. The team approves the idea. Will goes to the dacha to get Alexandra on board and stop the work on the dacha once building 1 is complete.
Date: late May, 2045

11. Vision Quest 174
On Sunsol, Will sees Greg and discusses morality and interfaith relations. He sees John and his tobacco; John asks to go to the Dacha alone and Will approves. He sees Radha's labyrinth design. They all go outside and visit with Martha and her baby, Irina and Eammon, and Will comments on how wonderful life is. John goes to the Dacha and has a

vision. The next morning Will sees Shinji and Michiko having a baby; Irina is going to have twins; Sebastian calls to tell him about the dry dock; Louisa is happy about the improved media work; John comes to talk to him about the vision quest; Andries calls to report a major gold find in Cassini.
Date: late July, 2045

12 Cassini Outpost 196
Shinji and Michiko have their baby. Will flies to Cassini by shuttle with additional equipment and tours the gold find. Consolidated Mining offers a big cash deal and a long-term profit sharing arrangement. He and Yevgeny discuss the implications.
Date: late July 2045

13 Contracts 209
While Will visits Cassini, Yevgeny reports slow progress on the negotiations and various problems. When Will visits Roger Anderson's expedition, the contract is finally signed with two separate companies for both to come work on Mars. Will, Roger, Lal, and others discuss the ramifications, which are difficult to predict. On the flight back to Aurorae, Kevin says he wants to leave Mars and Will talks him into staying. Back at Aurorae, a celebratory dinner is held. Enrique announces he is a Bahá'í to Will and Ethel. Will gives a speech saying Mars is now a colony.
Date: Aug. 2045

14 Launch 224
The Magellan 1 crew launch a sample return rocket from Samandar 3B to Venus orbit, where it arrives with 100 kilos of samples. Andries and Tina get married three days before Columbus 5 leaves. Pete, Yasuo express regrets that they are leaving. Andries and Tina ask to be assigned to Cassini after their honeymoon. On Nov. 4, the *Olympus* blasts into orbit.
Date: early Nov. 2045

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