THE MARS FRONTIER

Vol. 8

Marsians

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Hike

December 10, 2050

It was a clean whack. The golf ball soared high into the violet sky and momentarily disappeared from sight. Then it reappeared against the pinker sky closer to the horizon. It landed in a cluster of boulders to the right of the fairway.

Roger Anderson pushed the screen built into the front of his spacesuit downward into a horizontal position and waited a moment for the computer to display the result of his shot. He smiled. “Eight hundred fifteen yards; not bad.”

“Best shot of the hole,” agreed Skip Carson. “But even though I’m farther from the hole, I think I’ll have a better shot; I’m not in a nest of boulders!”

“That’s going to be a hard shot,” agreed Rosa. “I was in there once, and I bounced off of boulders twice.”

“Maybe I’m lucky to be where I am,” said Brian Stark.

“Not really; three hundred yards away and you broke our number 3!” replied Roger.

“These clubs weren’t designed for fifty below,” replied Brian.

“We have to be gentle,” replied Rosa. “Fortunately we have another one on the way.”

“Yes, but the idea was to have *two* complete sets of clubs,” pointed out Roger.

“I’ll send you a replacement. In 2052.” Brian had to chuckle at the thought of sending a replacement two years hence.

“I’ll probably send the Aurorae Golf Club a whole new set; you need the newest,” replied Skip. “Much better; you’ll see. And the expert I emailed says they’ll handle Martian climate, too.” He turned to Brian. “And I’ve got to get you some lessons how to golf. Once we’re back home, I’ll take you to Pebble Beach.”

“I’ll probably be golfing the way we do on Mars for the first six months and missing everything,” replied Brian.

“You’re missing everything here,” commented Skip.

“You’re a member of Pebble Beach?” asked Roger.

Skip nodded, though it was hard to tell in his spacesuit. “Yes, and I’ve paid my dues every year from here. By the way, I plan to remain a member of the Aurorae Golf Club. You can count on my support even after I’m on Earth.”

“The Treasurer thanks you,” replied Rosa. “Maybe Pebble Beach can adopt Aurorae; we’re the finest golf course on Mars.”

They all laughed at that; it was the only golf course on Mars, and after ten years it was still only partially complete.

They began to climb onto their buggies, small single-person all terrain vehicles they had equipped with golf club carrying bags for that sol. Just then Will Elliott, Governor of Mars Operations, and his ten year old son Marshall walked up. “Out for a hike?” asked Roger over the common frequency.

“We went to the bottom of Silcock,” replied Marshall. It was a two-hundred meter crater nearby; the sixth hole ended and the seventh hole started on its rim.

“He figured out the imbrication in the deposits,” added Will, pride in his voice.

“He’ll be a good geologist!” said Skip. “I bet you’ll see that crater a lot in the next decade.”

“Why?” asked Marshall.

“Every high school and university geology class takes a field trip there,” agreed Will, nodding. Skip smiled. Will put his arm on Marshall’s shoulder. “Let’s go, geologist.” The Elliotts headed toward the Outpost along the golf path while the foursome headed the other direction in their buggies.

“Is golf that much fun, dad?”

“It’s not bad, though it’s more fun on Earth when the weather’s nice.”

“Yeah, I’m not sure it’s the best way to spend six hours in a pressure suit.”

“I’ve played a few games here. You hit balls a lot farther because of the gravity, so you have to walk forever or ride everywhere. And it’s hard to swing a club in a suit; I don’t find that very satisfying. And there’s no nature to see. I remember one golf course I’d play on near mom’s house and I’d always see Canadian geese, deer, or something.”

“No, nothing like that out here.” Marshall was silent for a minute. “Why would you see Canadian geese in Connecticut?”

“They don’t just live in Canada.”

“Oh.”

Will felt a bit sad that his son could not know much about nature on Earth, except by watching videos. The biomes forty or fifty meters across that made up most of Aurorae Outpost were more like artificial parks and were devoid of wild animals except bees, butterflies, and a few canaries.

They continued toward the Outpost; from their approach on the northeast side they could see the four original twelve-meter habitats in two rows, covered with three meters of dirt and ice for radiation protection and then shielded by white plastic, which made them look like large igloos; beyond them, after an array of a dozen cylindrical greenhouses, were a pair of forty-meter bubbles, Yalta, Catalina; beyond them another pair of forty-meter bubbles, Riviera and Shikoku; then a fifty-meter pair, Huron and agricultural Shenandoah; beyond them was the bubble of the newest biome, sixty-meter Colorado, which was inflated but only partially completed inside. They couldn't see the buried industrial facility on the north side of the biomes or the spaceport, a scattering of launching and landing pads flung among the stone fields south of the Outpost beyond Boat Rock.

"Dad, can we climb to the top of Boat Rock?" asked Marshall.

"I thought you were tired."

"I was, but I'd like to climb to the top. I love it up there."

Will considered. "Okay, but we have to watch our time; supper's soon."

They chatted about Marshall's homework—he was in fifth grade and was doing a lot with rock collections outside and insect collections inside—as they trudged along the trail, occasionally stopping and turning to see each other's faces through the helmets, otherwise contented to hear each other's voices over the radio. In fifteen minutes they reached the base of the cliff-edged mesa at its eastern end, where Face Rock, a large detached outlier of the mesa, had the profile of a man's face when looked at from the north-northwest side. They walked through Aurorae Park, a hectare of sand paintings, colorful mazes of natural materials, and wind-sculptured rocks brought from all over the

planet. They passed the Memorial where the remains of two fallen astronauts and of one infant lay, perpetually frozen, their names inscribed on a sandstone façade that could hold many more names, and probably would hold them some day. Then they set out westward along the base of Boat Rock until they reached the natural ramp on which a flagstone stair had been built. They climbed up the stairs cut in a crevasse in the bedrock until they reached the top.

Boat Rock was a mass of sedimentary rock three hundred meters long, two hundred meters wide, and one hundred meters high, with a smooth, curved top like the overturned bottom of a boat. Billions of years of wind erosion had polished the surface and blown all large loose material off. Except for one small remnant of an impact crater marring the surface, there were no natural irregularities. Marshall took the lead and headed for the crater; he wanted to compare it to what he had seen earlier that sol. The bowl was small, about thirty meters across and ten deep, irregular, and bouldery. He took a sample and asked his father, the principal author of the principal work on Martian geology, a few questions. They turned west briefly because they were near the far end of the mesa and walked to “the point,” a prominence that faced due west toward “Layercake Mesa,” a four-kilometer long continuation of Boat Rock but separated from it by a natural gap called “the Notch.” Layercake was notable for its fifteen slowly-turning wind turbines. It had room for about thirty more and they could see work being done on a new one in the distance.

Marshall looked south, toward the spaceport. The nearest Mars shuttle—a conical vehicle six meters across at the base and thirteen meters high, resting on six legs at the center of a dirt pad—was about three kilometers away. Closer to them was the three-

kilometer runway for sunwings, large gossimer-winged aircraft covered with solar panels that could carry passengers and light cargo all the way around Mars in three days.

"Dad, when do you think I'll get to fly in a shuttle?"

Will considered. "Well, I suppose when you graduate from high school, if you decide to go to university on Earth, you'll fly in one then."

"I don't want to go to Earth; I want to see Phobos." The boy turned and pointed to Mars's inner moon, which had just risen above the western horizon a few minutes earlier. Marshall had always been good at spotting Phobos and Deimos.

"I suppose if you go to Mariner Institute of Technology and take a course in the geology of Phobos, we'll fly the whole class up for a field trip."

"Really? That would be cool. I bet they don't fly lunar geology classes from the Earth to the moon."

"No, it's way too expensive."

"Dad, do you and mom want to go back to Earth?"

"Why do you ask?"

"Because whenever university comes up, you say I have to decide, but I don't want to decide if that means you and mom have to go back to Earth."

Will smiled. "Tell you what, when the time comes to decide, we'll all talk together, okay? Don't worry about your mother and me."

"Okay." Marshall looked at Phobos. "It would be nice to meet grandma. But I don't think I want to go back to Earth otherwise. I can always go to Martech."

"If you want. It doesn't offer many courses right now, but by then it'll offer a lot more, and there are thousands of distance-learning courses you could take through the

MIT-Sorbonne Consortium. And by the time you're ready to go to college, grandma will be almost 90; she may not be alive any more."

"I don't know I'd feel safe on Earth, either; there are so many murders there!"

"Yes, but remember there are billions of people and the few murders get a lot of attention. It's not that dangerous." Will had to admit to himself, though, that he worried about a naïve kid from Mars trying to negotiate the vast array of choices and dangers of urban life. Not to mention the exposure to dozens of germs his system had never experienced before, and dealing with almost three times as much gravity as his body was used to.

"But if I went to Earth, would I go to the U.S., or Scotland, or even somewhere else in Europe?"

"You could go to either; you're a citizen of both the U.S. and the E.U."

"I know." Marshall seemed lost in thought, reflecting on these places that he knew about only from television.

"Are you wondering whether you're an American, or a European?"

"I guess. I'm wondering about being a citizen of Mars."

"Well, you could think of yourself as a citizen of Mars. We really don't have citizenship. What we have is 'residency.'"

"What's the difference?"

"It's hard to explain. Mars isn't a nation; it's too small. Citizenship comes with being a nation. But we live here and we participate in society here, so we're residents."

"I see." But he seemed dissatisfied with that answer. Will put an arm on his shoulder. "Ten years ago when you were born here, I would have said you were a dual

citizen of the United States and European Union and left it at that. Five years ago I would have said you were partly from Mars, partly from the U.S., and partly from Europe. But now I guess we're Marsian, whether we have some other citizenship or not."

Marshall nodded. "I don't know what it feels like to be American or European. I feel Marsian."

"Of course. You wear a pressure suit when you go outside and you don't shop in a mall. We have to live in a very different way; we have a different culture. We're all Marsians here, now."

Will found the term 'Marsian' strange on his lips. They had been using it for less than a year, since he had made a speech as Governor of Mars Operations and the President of the United States had reacted by laughingly called them all 'Martians' in public comments. The residents of the Red Planet had adopted the term of derision with pride, though they had started to spell it with an "s" and pronouncing it "Mar-zi-an."

"Dad, do you think Mars will ever be a nation of its own?"

"Yes, and you may live to see it. We need more people up here, that's all. But even though there are only 150 of us right now, we've had to develop our own way of doing things and working together; our own culture. So we're Marsians anyway, nation or not." Will glanced at the sun. "Come on, we better get home. It's getting late."

2

Aerobraking

December 15, 2050

Three astronauts huddled around the stuck cable winch attached to Annex 5's aerobrake, repairing the mechanism while the background stars wheeled slowly in a circle. Commander Seiji Takada watched the scene intently on a screen in front of him, but kept an eye on the clock and several monitors as well. No one had thought three astronauts would take four hours on a simple winch mechanism.

"How about annex three?" he asked Clara Forsyth, the day officer on the bridge.

"It'll be secured in another twenty minutes. The plumbing won't drain on the third level."

"These annexes are more trouble than they're worth," Seiji growled. "Vent the leftover in thirty minutes; we can't delay separation much longer."

"It's the sewer line. If they vent it, the remaining sewage will dry out and it'll be very difficult to remove."

"It's that, or let the entire structure burn up."

There was a crackle over the radio. "We got it!" announced Robert Wairimu. "Prepare to activate the winch!"

"Acknowledged; on your word, Robert," replied Seiji, suddenly alert. He watched the three astronauts slowly back away from winch. Since they were standing on top of the aerobrake, Columbus 8's rotation pushed them downward against it, so they were able to walk slowly away from the stuck equipment.

"Okay, give her a rip," said Robert.

Seiji pushed some buttons and the winch sprung alive. The annex, ten meters in diameter and ten meters high, its top three floors deflated and airless, began to compress slowly against the first floor.

"It's working!" exclaimed Seiji. "You did it, guys! Congratulations!"

"It's looking good," agreed Robert.

They all watched the six winches slowly turning, pulling the top of the annex downward into the shadow of the fourteen-meter aerobrake, millimeter by millimeter. After fifteen minutes the winches finished their work. Seiji pushed some on-screen icons and the winches locked.

"We have full lock," exclaimed Seiji. "Thanks, guys; come on inside. Well done."

"Thanks, Commander," the three astronauts chorused, and they turned toward the airlock. Seiji turned to Clara. "Annex five is secured."

"Three will be, don't worry," she replied.

Seiji's attaché—a combination computer and communicator—beeped with an incoming connection. Governor Will Elliott himself was calling. "Toru, activate the call," he said to the attaché. The screen flashed alive with Elliott's face.

"Hi, Seiji, just thought I'd check to make sure all is well. We're ready for your arrival; five shuttles are already in orbit and the sixth one goes up right after aerobraking is complete."

"Thanks for calling, Will. It's nice to be so close that we can have an ordinary conversation! Annexes 3 and 5 were giving us some trouble, but five is now stowed for arrival and three will be shortly. The other four annexes are stowed and ready. Except for

the repair people and the pilots, everyone is out of the annexes and in the interplanetary transit vehicles. Separation is scheduled for . . . twenty-six minutes."

"Annex three is now stowed," reported Clara.

"I heard that," said Will. "I'm glad everything's ready. I was getting worried! The annexes do not stow easily; we cut corners developing them. Thanks for all your work. Please convey my gratitude to your team."

"I will. We'll get all six of them to you, don't worry."

"Good. You'll be in our thoughts and prayers, Commander."

"Thank you, Governor."

"Goodbye."

"Goodbye." Takada closed the circuit and turned back to the work at hand. The bridge now had five people; two had arrived during the call. Clara started to call the other five ITVs or Interplanetary Transit Vehicles—the Sabaeus, Hellas, Ausonia, Gangis, Coprates, and Tithonium—and to the two Mars shuttles—the *Apollonaris* and the *Ascraeus*—to verify the readiness of each to take control of their own life support systems. As each replied affirmatively, Clara set each free of central control.

Right on time, Seiji gave the despin command. Columbus 8 had already been slowed to 1 revolution per minute from its usual 5 revolutions, which had decreased its gravity to a maximum of about eight percent of earth's; just enough to create a sense of up and down and to make the bathrooms work. It took about fifteen minutes for gravity to ebb away. That accomplished, Seiji began to give each ITV and shuttle permission to undock; the annexes undocked next, leaving the central cylinder, which was their zero-gravity gymnasium, naked. Clara purged it of its air and activated its winches. They

watched the central cylinder compress down to a safe length behind its aerobrake. Three hours after they started the separation maneuver, Columbus 8 was no more; it was replaced by sixteen separate vehicles, each with a pilot and copilot. Everyone else was in the seven ITVs, which provided tight but comfortable accommodation for two days.

Each of the vehicles—including the Syrtis, the ITV in which Seiji and his control crew were located—fired its engines over the next few hours to execute its own flight plan. Each had to hit the Martian atmosphere at the same angle, but they had to be at least twenty kilometers apart. Aurorae Outpost provided radar, Doppler, and GPS data that confirmed the position and velocity of each vehicle and audited the entire procedure to make sure everything was done exactly right.

Twenty hours of relative calm followed while teams on Mars and in shuttles orbiting the planet reviewed emergency plans. Twenty hours of zero gravity, drinking water and eating food in tubes and washing with wet cloths, and patiently waiting.

Just after dawn, the first vehicles began to encounter the Martian atmosphere several hundred kilometers west and slightly north of Aurorae Outpost. For those who rose early enough, the streaks of light crossing the sky from west to east were fascinating to see, but worrisome. Sparks sometimes rolled off the aerobrakes and the smoke contrail occasionally wavered. At closest approach, the glowing aerobrake could be clearly made out with the naked eye through the slightly opaque bubbles the Marsians lived in; the vehicles dove to within ten kilometers of the surface to encounter air thick enough to slow them, and the closest point was just twenty kilometers north of the Outpost, where a collection of surface vehicles stood ready to race to any wreckage that might result. The personnel on Columbus 8 briefly experienced decelerations as high as three gees. Then

the vehicles, in their straight line through the curve of air, began to rise away from the surface, and in less than a minute they were in space again. The two-minute encounter had slowed them from almost 8 kilometers per second to 5 kilometers per second, putting the vehicles in a one-sol (Martian day) elliptical orbit with the low point just west of Aurorae Outpost. Embarcadero, their interplanetary arrival and departure facility, awaited in that orbit with spare ITVs, an ion engine, remote manipulator arms, fuel tanks, and three Lifters—unmanned fuel tugs based at Phobos and Deimos, and the shuttles *Ascreus* and *Apollonaris*.

"Marshall, Lizzie, you won't see a lot of me for the next few days," Will reminded his kids over a quick lunch at "the Patio," their cafeteria in Yalta Biome.

"Dad, you already told us!" said Lizzie rolling her eyes. Ethel put her hand on her daughter to reminder her to listen.

"We'll have some people down here by sunset, right dad?" asked Marshall.

"Yes; the five tourists and four special visitors are coming down in the *Apollonaris* in about three hours. We just cleared them for landing before I came here for lunch."

"So, everything went well this morning?"

"Perfectly. The new aerobrakes on the annexes performed as expected. All sixteen vehicles were right on target."

"When will we have the annexes? I want to see one of them, they sound cool."

Will chuckled. "The technology's cool, but they may look ugly. The first step is to bring the pieces of Columbus 8 to Embarcadero; they're still hundreds of kilometers apart. The central cylinder will be added to Embarcadero in about twelve hours and the

ITVs will dock to it, which will give everyone space to walk or float around in. Embarcadero will spin to 1 revolution per minute, which will generate enough gee for toilets and showers—"

"But how will people come and go?"

"Embarcadero will stop rotating twice a sol for about an hour, for docking and undocking. Mars shuttles will bring half the crew here right away, while the other half disassembles the annexes—"

"And that's complicated!"

"Well, we hope it won't be. Each annex has a flexible 4.5 tonne meteoroid shell outside and a triple-thick, 4.5 tonne pressure shell inside. We have to squeeze down the pressure shell inside the meteoroid shell to certain dimensions, secure it, unzip the meteoroid shell, pull the pressure shell out, and transfer it to the cargo bay of a Mars shuttle. Not an easy task to accomplish on a pressure shell that's originally ten meters in diameter, but it is a flexible plastic fabric and we'll have the rigid outer meteoroid shell to push against. If we can't accomplish that task using the designated equipment, we can fly the annex to Deimos, where the moon's slight gravity should make the task easier."

"It'd be a waste of fuel, though," said Ethel.

"And time. Each time a shuttle lands here with an annex, it'll go back up with cargo for Earth: gold, argon, nitrogen mostly. The remaining crew at Embarcadero will put the cargo inside the meteoroid shell and anchor it. Once everything's ready a lifter will push the shell, its aerobrake, and maneuvering system on a trajectory that will take them back to Earth in eighteen months."

"Why so long?" asked Marshall.

“Mars and Earth are no longer aligned right for a quick flight. It’ll be two years before a direct flight will be possible again.”

“It’s really amazing we can do something this complex,” said Ethel. “This is not like anything we’ve attempted before.”

“It’s an order of magnitude more complicated than Columbus 7,” agreed Will. “But we’ve developed fifteen years of experience with the Mars shuttles; we know what they can do. Embarcadero has more equipment than ever before. And we have people here who are incredibly good with orbital rendezvous and cargo transfer. Let’s hope we don’t have any trouble or accidents.”

“There’s always an element of luck in these things,” agreed Ethel. “The big danger is a collision between vehicles; there are a lot of them in a small area. And I suppose the untried part of the plan is the annexes, since they’re new.”

“If they prove too difficult to pack into the shuttles, we can always fly them down here with landing engines and parachutes,” replied Will.

“Say Will, where do you think this will lead?” asked Skip, who was seated at the next table.

“You mean, Columbus 9 or Columbus 10?” He shrugged. “This approach is getting pretty complicated. We have eight shuttles here on Mars and in the next six weeks they have to fly two missions each. We can’t afford any accidents. We have to develop a good, reliable landing system to bring the annexes down without using the shuttles or build a new, bigger shuttle. But between politics and the depression, I can’t see us getting money for either.”

"No, that's not in the cards," agreed Skip. "Could the current system double in size?"

"Maybe, if might split the arriving fleet into two complexes, space their arrival out, and send the annex aerobrakes back to Earth over a longer period of time. That would spread out the workload on the shuttles. Maybe we can improve the shuttles' reliability enough to fly them more often between repairs. And Embarcadero would have to get bigger to accommodate larger missions and their possibly larger emergencies."

"The more people we can fly here each time, the cheaper it'll be," added Ethel. "If this world's going to grow, we need a breakthrough in propulsion and in the cost of transportation."

"That's for sure," agreed Skip.

Will turned to his lunch; he had to eat quickly and get back to the control area. He kept one ear on the conversation about Lizzie's subtraction homework and Ethel's explanation to Marshall about how she was making plastic chairs for the arrivals. At the next table, Skip and Brian engaged in their usual political exchange, Skip attacking the White House for its import restrictions and the consequent trade war with the rest of the world and Brian insisting that nothing else could protect an economy massively damaged by the terrorist computer virus attack and the nuclear explosion over Houston. Érico Lopes, their left-wing Brazilian, occasionally offered light-hearted support to Skip, though he was more interested in helping his almost three year old son with his lunch. Roger occasionally encouraged Brian, though he was sitting with his family as well and was no longer fired up to argue politics. Others sat and listened; about fifty of the hundred people in the outpost were seated at their usual spots on the patio.

Before heading back to Mars Control, Will turned to Érico. “Any news about Fuel Plant number 2?”

“Eliseo says they’ll have it fixed by tomorrow. It was one of those trivial mechanical breakdowns that people can fix easily, but robots can’t fix in ten years.”

“So I gathered. But since no one will be back to Phobos for nine months after December, I wanted to be sure it’s fixed.”

“Understandable. I’m glad we’re getting a third unit; both units are acting up. They’re too old.”

“Same with the units on Deimos. Let’s hope they make it until Columbus 9.” Will turned back to his family. He apologized that he had to go and took his tray to the return area. Then he headed across the patio to the table with Alexandra and Yevgeny Lescov on his way to Mars Control. The two of them looked a bit sad, but Will didn’t make anything of it. “Yevgeny, any developments with the gold shipments?”

“No. We’ve still got fifteen extra people running equipment, and that’ll continue until the end of next month. Cassini Outpost has a shipment scheduled to arrive here November 29.”

“The last sol before the last launch. How much?”

“They hope it’ll have sixteen tonnes.”

“Sixteen!” Will was surprised. “And the total for the columbiad will be?”

“Two hundred eighty-eight tonnes.”

“Wow.”

“The value of gold fell a bit this sol, but it was still $20,000 an ounce.”

“But the dollar’s now worth a twentieth as much as it was in 2000. I find it easier to think in redbacks: a thousand redbacks per ounce. So that’s eight and a half billion redbacks: impressive revenues.”

“That’s why the stock of Muller Mining, Consolidated, and Siberco has gone through the ceiling,” said Yevgeny. “Thank God we put half of our savings in their stock several years ago. Our net value has increased about ten times.”

“Ours, too. Their stocks are almost the only ones going up. I suspect a stock bubble. I may sell a lot soon.” He turned to Alexandra. “And Colorado?”

“Oh, it’ll be ready.” She didn’t sound very enthusiastic. “We’ll be cutting the rye-38 crop tomorrow and plowing under the roots. The soil tests indicate the rye-38 has reduced the lead below serious levels. We’ll plant fruit trees and vegetables next week.”

“And the foundations for the housing?”

“The work left is minor. As soon as the annex pressure shells arrive, we can start to set them up. We’ll keep up with the arrival rate just fine.”

“Good.” Will looked at her closer. “Are you feeling well?”

“No, I’ve been under the weather lately. I took off this morning, but I’m feeling better now. Eve saw me this morning; don’t worry.”

“A virus?”

“Something like that.” Alexandra waved her hand dismissively and Will wasn’t sure whether she was dismissing the virus or him.

“Okay, get better. Let me know if there are any developments.”

“Oh, don’t worry.”

Will waved goodbye. He headed across the biome to the airlock leading toward Riviera and Colorado. Yevgeny turned to Alexandra. “Maybe we should tell Will. He can give good advice.”

“No, I don’t think I want his advice. I know what it’ll be.”

“Well, so do I.”

“Yevgeny, it’s my body!”

“Dear, I know, but it’s our decision.”

3.

Welcomes

January 10, 2051

Later the same afternoon—December 18, 2050—the shuttle *Apollonaris* descended from orbit with five tourists, four visiting workers, and three permanent arrivals. Meanwhile, in orbit intense activity was occurring as the ITVs and annexes docked to Embarcadero. Astronauts bled off any air left in the annexes, then injected air into the space between their outer radiation shell and the inner pressure shell to compress the latter into a cylinder five meters in diameter and 2.2 meters high so that it could be deorbited inside a Mars shuttle. It was a slow, difficult, and delicate process, for the shells had to be folded just right. Once on Mars, the triple-thick pressure shells could be separated into three separate bubbles, providing comfortable housing and work space for twelve people.

Every time one of the six annexes was packed and transferred to a shuttle, with a load of cargo, it headed for Aurorae, followed by a shuttle with twelve arrivals. The first pair descended from Embarcadero on the 23d and 24th and returned two sols later with gold, argon, nitrogen, and fossiliferous Mars rocks. Subsequently a pair descended every few sols through January 10th. At that point all the expeditions to the moons were over, Embarcadero was mothballed, and all the cargo was on its way to Earth.

The safe arrival of everyone on the Martian surface, as always, was cause for celebration. The ritual that had evolved involved a reception, dinner, and a cultural program. Flights from Dawes and Cassini Stations were full for the three days before, because everyone wanted to be at Aurorae for the dinner and the shopping that the arrival

of new goods made possible. As a result, the evening saw 200 of Mars's 224 people gathered in one spot.

Greg Harris arrived at the pre-dinner reception early in order to look for the new beautician. He spotted a woman with perfectly quaffed hair, impeccable makeup, and—the true giveaway—beautifully smooth, hairless legs. He walked over. "Tatiana Petrovna, I presume?"

"Yes; and you are Father Greg Harris, I presume?"

"Exactly. I'm delighted you've arrived. Have you seen the salon?"

"Over there?" Tatiana pointed to the "Mariner Beauty Salon" sign. "I didn't go in, but I looked in the window. Very nice."

"Thank you, and the new equipment you're bringing will make it much nicer. I'm glad to be turning the salon over to a proper professional beautician. I've done my best for six years; I didn't have a lot of training when I arrived and I got a lot of tips by video from some experts on Earth."

"I've heard you got pretty good!" replied Tatiana. "Many people have complemented your work to me."

"Oh; thank you. I arrived to be a jack of all trades for Mars; a 'mission generalist' I used to say. Four years ago I turned the cleaning operation over largely to robotic vacuuming and floor washing machines. Two years ago I was able to turn the laundry operation over to robotic clothes washers, driers, and pressers; they could even do repairs! And now I can turn over the beauticians' work, though to a real person."

"I'm flattered." Tatiana smiled. "It's hard to believe the work is now almost full time."

“That’s the survey we did. Men need an hour every two months for haircuts and women need an hour a month for haircuts and other services; with our current population, that’s three weeks of work a month out of four. So you will have a reasonably free schedule for the next two years. You saw the price schedule?”

“Yes. It’s unbelievable, but I guess I’ll get used to it.”

“A meal here in the cafeteria costs about 40 redbacks per person and a simple haircut runs 75 redbacks. Believe me, it won’t be enough, either.”

“Oh, I believe you! I’ve been shocked by the prices in the store already. Yet all the women want a waxing appointment!”

Greg smiled. “Just about! That’s something I didn’t study, so I never offered hair removal, and it seems that practically every woman on Mars is dissatisfied with her legs. I think you’ll find there’s plenty of demand. Oh, honey!” He interrupted their conversation to stop a woman walking by. “Honey, come meet Tatiana.”

Anna Racan turned and walked over. In spite of the thick radiation vest she wore, it was obvious to Tatiana that Anna was pregnant, which startled her considerably.

“Pleased to meet you,” said Anna. “Greg’s been looking forward to getting out of the beautician’s business and back into counseling.”

“And I’m glad to be taking over as the aesthetician.” Tatiana looked at Greg. “Please excuse me, Father—or, Mr. Harris—I was under the impression that you were a Catholic priest—”

“Yes, that’s correct, I was a priest in Texas before coming to Mars. Here I’ve been a nurse and jack of all trades, and the Vatican asked me to resume my priestly role as the Catholic community grew. Since I had never given up my ordination, I was pleased

to serve as priest as well. Anna arrived last columbiad and is an ex-nun. We decided to get married and the Vatican has allowed me to continue my priestly duties on an interim basis until another priest arrives. So here I am, about to become a father—in the physical sense—in about six weeks, and I am serving as a father to a flock as well!" He smiled and shrugged. "Life takes unexpected turns."

"I guess so! What do the Catholics here think, may I ask? I am Orthodox by cultural background and I am really nothing in practice, but I am curious."

Greg looked at Anna. "Most Catholics here have no problem, I'd say."

"Half are only semi-active in the church, and they don't care. The liberals are delighted to have a married priest, and the conservatives are relieved they still have access to a priest!" added Anna. "Greg also plays an important role in the interfaith community here. There are at least twenty-five religions here on Mars and they meet in interfaith services twice a month. The Catholics are in the position to take a leading role."

"I'm surprised there are religions here at all," said Tatiana.

"Will Elliott has something to do with that," replied Greg. "It helps when the man in charge is religious and encourages others to be religious, as long as they are tolerant and mutually supportive. This place isn't as religious as the United States, but it's more religious than Europe. You should come to services. We have something every Sunsol at 11 a.m. in Clarke Dome. A Christian service is held the first and third Sunsols of the month—sometimes it's Catholic, sometimes one type of Protestant or another—interfaith services are on the second and fourth Sunsols, and when there's a fifth Sunsol we have something else. Catholic mass is held every Satursol evening at 7:30 p.m. and there's a Muslim juma prayer every Frisol at noon. The Protestants have a Bible study every

Wednesol evening at 7 p.m. and the Bahá'ís have a devotional program and study Frisols at 7 p.m. The Jews meet some Satursols, the Buddhists and Hindus whenever there's a holy day."

"That's a lot, but I suppose they're small."

"Of course. The Sunsol morning services get twenty or twenty-five, and everyone is welcome."

"I'm sure." Tatiana was tiring of the subject. "Greg, I'll open the shop on Tuesol morning. I gather over the weekend we'll be doing informal things, and Monsol is devoted to safety training."

Greg nodded. Tatiana headed to the refreshment table to grab another cup of punch. There she stopped to talk to Yevgeny and Alexandra Lescov in Russian, a language with which she was more comfortable than English. Tatiana's husband, Dimitri Lyubinin, joined them.

"It's good to see the two of you; I haven't seen you at all since we landed," he said to the Lescovs.

"We've been occupied," replied Yevgeny apologetically. "You arrived yestersol, right?"

"Yes, I went to Phobos to see the structures we already have there and get a feel for the minigravity. It's a distinct environment; you're virtually weightless, but you do have a sense of up and down," said Dimitri.

"I tried to drink a glass of water on Deimos once," said Alexandra. "It was an experiment. The water stayed in the open glass just fine and I raised it to my lips very,

very slowly, but when it reached my lips the water splashed out all over my face anyway."

"Yes, the gravity is useless," agreed Dimitri. "But it gave me some design ideas. We've still got one annex pressure shell in orbit and we can pull it apart to make three separate pressure shells. Buried under three meters of regolith for micrometeoroid protection, they can easily be deployed on Phobos or Deimos. I'm hoping Elliott will approve."

"He's in favor of more pressurized space in orbit; we'll need it if there's an accident during arrival or departure," said Alexandra.

"How are you enjoying the outpost, so far?" asked Yevgeny.

"Oh, quite well! Of course, I already knew every square centimeter, in terms of viewing the blueprints and experiencing it in the virtual reality. But walking around the place, the *feel* is different. The texture is richer; even virtual reality doesn't capture the canaries, the butterflies, the bees, the colors of the flowers, and the smell of the trees. And I walked around outside this afternoon for several hours and climbed up on top of Boat Rock to look down into the biomes."

"New design ideas?" asked Yevgeny. He knew Alexandra couldn't ask; her design ideas and Dimitri's had clashed for several years.

Dimitri glanced at Alexandra briefly, nervously. "Yes, I think I've been inspired. I also have a better appreciation for Alexandra's insights; after all, now I'm experiencing the same environment in the same way."

Alexandra didn't look convinced. Dimitri smiled again. "The one feeling about the place is crowding. The virtual reality doesn't capture the sense that people are everywhere. Our population density is incredibly high. We need a lot more space."

"And how will we do that?" asked Yevgeny.

"I'm not sure which option is best; a lot of proposals have been made." He nodded to Alexandra. "Well, I'll see you in the office on Tuesol. Shall we get another cream puff?" Dimitri asked Tatiana. She nodded, so Tatiana and Dimitri walked away.

"He's pleasant," said Yevgeny.

"Oh, he's never been impolite. His ideas are radical, though."

"My dear, so have your ideas."

"But you can only implement so many radical ideas at once," she replied.

Will walked over just then. "It's good to see both of you. You've been scarce lately."

"We're alright," replied Yevgeny. "We just had a conversation with Dimitri." It seemed wise to change the subject.

"Will, I have my doubts about the value of Columbus 8," continued Alexandra. "In the last two years we've retired half the heads of our support staff on earth, laid off half the staff, and trained part of the rest to come here. So now we're getting less work done than before, but we have to pay salaries five times as big."

"Alexandra, we've been over this before, haven't we? Our capacities here will increase fifty percent and the engineering and design staff we're gaining will now be doing construction work as well, which will inform their theoretical work. The support staff on Earth is smaller, but we now have more experience and need less support."

"Well, I hope that proves to be true."

"Lisa has the same worry with the environmental management and agricultural support facilities, but everyone says it'll work. We're getting some good people."

"The Export Department is gaining some good staff," agreed Yevgeny. "Will, Alexandra and I have been meaning to talk to you for the last few weeks. Can we meet you at your office tomorrow morning?"

Alexandra was startled and stared at her spouse. Will tried not to notice the reaction. "Sure; 11 a.m.? I've got an appointment before then."

"Okay; thanks," replied Yevgeny.

Will walked away, leaving Yevgeny to face Alexandra's ire. "Why did you do that?"

"Because it's time to tell him."

"But he'll argue with us!"

"Even so, Alexandra, Will's a friend. We need to tell him."

Just then the door to the kitchen opened and out rolled the first buffet table. Everyone gathered around to watch table after table of food roll out: stuffed turkeys, heaps of fried chicken, rounds of beef and pork, trays of tilapia and catfish, great platters of rice, bowls of different pastas, kettles of soups and tomato sauces, mixed dishes of portobello mushrooms with noodles and cheese, or lentils and rice, or goulash, many bowls of different vegetables, potatoes of every sort, five kinds of bread. . . every table was different. Lines immediately formed.

Helmut Langlais knew what to look for and soon got in the line that would get him most of what he wanted quickly. He headed for a table close to the Elliotts where

Neal and Rosa Stroger habitually sat; Neal was a good friend from their trip to the asteroid Gradivus. But before they arrived, an attractive young woman with auburn hair and bright green eyes walked up to the table. “May I join you?”

“Yes, of course!” Helmut was startled by her. “I’m sorry, but I don’t know your name.”

“Clara Forsythe.”

“Newly arrived on Columbus 8 from—”

“Vancouver, British Columbia.”

“I’ve never been to B.C. It’s supposed to be beautiful and green.”

“It is. So, you’ve been to five worlds, but not to B.C.”

“Six worlds; but who’s counting.”

“Six?” Clara was puzzled and started counting in her mind. Helmut watched, amused.

“You must be a fan.”

“Sort of. Phobos?”

“No, never been there. I’ve put in for the next mission and am on the waiting list.” Clara obviously wasn’t coming up with it, so he added, “Earth, moon, Deimos, Mars, Gradivus, and Gradivus’s moon.”

“Oh, of course! I forgot the moon. What was it like?”

Helmut shrugged. “Superficially, all these small worlds look alike; gray with a bit of metallic tint or dark carbonaceous material, rolling surfaces, close horizons, scattered craters, and a rubbly regolith more or less covering the bedrock. The interest is mostly geological; Gradivus’s moon tells us about the fragmentation history of Gradivus, which

itself is made up of three large chunks that have been either orbiting each other or stuck together at various times." He looked at her. "You seen to know all about me, but I don't know anything about you."

"Well, what's there to say? I'm a systems engineer; I was the chief day officer on the flight out. Before training for this mission I served at Shackleton Control for two years while finishing my Master's degree."

"Really? That must have been exhausting."

"It was, but I was motivated. I'm here to work in Mars Control, at Dawes or Cassini, and to drive P-200 Prospectors in my spare time."

"Settler?"

"I suppose. Life is unpredictable. Are you planning to stay?"

"I wasn't, but I suppose I am now. ESA doesn't seem to want me for the Mercury or Venus projects, assuming they ever fly a Mercury mission, and NASA hasn't responded to my application for Project Argo. Here I can explore an entire planet and put in for Mars-crossing asteroid missions every year or so. I suspect Mars will be sending missions to the asteroid belt in another decade or so."

"This place will be the center of a lot of exploration," she agreed. She glanced him over, sitting in his seat; he was tallish, with blonde hair and blue eyes and a strong, handsome jaw. She had been dying to meet him for months. Furthermore, they were the same age, though his birthday was six months before hers. She wondered whether he'd go look at her bio on the web. But his eyes suggested he would; he looked at her auburn hair, hazel eyes, and full figure with interest.

"What have you put in for?" he asked.

“Mars Control, and I got it. I’ve heard Dawes and Cassini are hardship posts, so I avoided them.”

“They’re smaller places and people work harder, but they’re worth spending some time at, especially since a lot of expeditions depart from them. Do you know geology?”

“The basic stuff; I have a field expedition certificate from the moon. But there’s not a lot of systems engineering on an expedition.”

“No, but don’t you need some variation? That’s the great thing about Mars; you can do something different every six months. But come to think of it, I bet the Meridiani Project needs a systems engineer. It’s a six-month project to clear the Meridiani Trail from here to Dawes Outpost; eight meters wide, very straight and smooth so that robotic vehicles can drive it at sixty kilometers per hour, and it’ll include an extensive geological component so that we can ascertain the history and resources along the route. There will be oases—fueling stops and shelters—every seven hundred kilometers with a sunwing landing strip and a wind turbine farm; the wind turbines will be the big resource investment.”

“Sounds like you’re going.”

“Yes. I didn’t want it, but last year I had really good luck choosing my assignments, so I guess this year my luck isn’t so good.”

“It sounds pretty interesting to me.”

Just then the Strogers arrived with their two children, seven year old Richard and four year old Sarah, followed by the Vickers and their daughter, five year old Caitlin. Clara seemed surprised to be plunged suddenly into a domestic environment, but she quickly adjusted and began to play the role of auntie to the kids, which was more or less

expected; anyone uninterested in helping children sat at childless tables. But looking around she could see there weren't many childless tables.

"This is a pretty family-oriented place," she observed.

"We don't have any extended family here," replied Rosa Stroger. "Children help to anchor us as a community and focus us on the future. They deepen our culture too."

"And we don't have singles bars," added Charles Vickers. "We work together, live among each other, and socialize together here on the patio."

"Do families eat any meals by themselves?"

"Sometimes," replied Neal Stroger. "On the weekends, especially, I'll bring breakfast home from the Patio. Lunches on the worksols, every family has their own table here on the Patio; the kids come here from school or daycare to eat with their parents."

"Families seem to be rather small, though."

"Eammon and Irina have five kids, but the rest of us have one or two," replied Rosa. "People keep saying we really should have two each, but it seems unlikely we'll ever reach that number."

"Would you like coffee or tea?" Charles asked Clara.

"Oh; coffee," she replied. He rose and went to the table with the desserts and drinks, returning a few minutes later with two cups of coffee and a slice of apple pie. Clara and Helmut got desserts and chatted about the flight out.

When Will Elliott walked to the stage, a hush fell over the crowd. The Governor of Mars always closed the dinner and opened the cultural evening with a few words of welcome.

"When I look out at the crowd before me, I feel excited," he began. "Columbus 8 has brought Mars sixty-one new migrants, five tourists, and four special visitors. The *Elysium* arrives in another month with eight more migrants after a visit to 2019KL16. The crowd here has been swelled by a lot of people in their late twenties and thirties, highly trained, devoted to settling this world, young enough to have energy and enthusiasm but old enough to have experience and skills. You are immensely welcome and badly needed."

He paused to let people applaud. "We now embark on the eighth columbiad of Martian settlement, twenty-six months of new opportunities and projects. This columbiad, more than many, will be shaped by the situation on Earth. The depression that started last year has spread and deepened and appears likely to last at least another year. Uncertainty has settled into the culture of Earth, which has been shaken by a massive computer virus and a nuclear bomb; those who have just arrived can tell us their personal stories of what they lived through. The decision of the American administration to protect their damaged economy from imports has triggered a trade war that has unraveled the fabric of world trade. Investors have pulled their money out of the American economy, threatening the dollar with collapse. Uncertainty over currencies has undermined confidence in the entire world economy. Until governments realize their efforts to retain the remnants of sovereignty will simply weaken their economies and subject them to terrorism, uncertainty will remain. And uncertainty means the price of gold will remain high.

"Mars shipped 150 tonnes of gold to Earth back in the spring; it arrived there last week. We just sent 138 tonnes more to Earth, where it will arrive in eighteen months.

Together, they will earn Mars eight billion redbacks; twenty billion euros; eighty billion dollars in its value of last year; one hundred sixty billion dollars in its current valuation. That fact will be the principal shaper of the eighth columbiad.

"It has two principal implications. First, the money must be spent. Five billion belongs to the Commission, three to the three mining companies. Their stock has gone through the roof, banks are extending them credit, and they want to spend more money to expand their facilities; they might even consider asteroid mining. We have to spend our five billion as well. Over the last year we have had to cut our terrestrial support expenses sharply because of declining governmental subsidies and uncertainty over the size of our gold income. We must invest some because the price of gold, inevitably, will fall and our income will shrink drastically. So how will we spend the rest? We need ideas and input from everyone. We are already funding or considering research for better biomes, bigger shuttles, cheaper habitats for interplanetary transportation, new ion engine technology, more reliable and efficient life support systems, more flexible pressure suits, genetically modified crops for low-pressure environments, and a dozen other things that will make settlement of this world safer, more reliable, and cheaper. We need about fifty billion redbacks of investment, but five billion will have to do for now.

"The other implication is that we must focus a larger portion of our human resources on gold mining and related investments than ever before. Right now, few nations will subsidize the transport of a citizen to this world; they're broke. But if we can move closer to economic self sufficiency, we will garner more investment in land and mineral rights, which will drive expansion of the population, which in turn will generate

efficiencies of scale and close the gap between expenses and income. Mars is at a turning point.

"The objectives implied by all of this are as follows: augment our gold mining staff by at least fifty percent; deploy a mobile gold mining capacity so that we can go after scattered high quality deposits; increase gold exports to take advantage of the high demand for our product; expand our infrastructure, in particular by building the Meridiani Trail to speed up and automate surface transport to the Central Highlands; solve the energy crisis brought on by growth by greatly increasing our use of wind power and by initiating manufacture of solar cells; create a permanent exploration capacity in the polar regions; drill the north polar deposits in order to recover a record of the global climatic history and drill the Hellespontus thermal region to search for underground microorganisms; expand Embarcadero; construct a permanent facility on at least one moon; launch at least one, preferably two, missions to Mars-crossing asteroids; choose a plan to expand interplanetary passenger and cargo capacity and our capacity between the Martian surface and Mars orbit; identify other exports to the Earth and moon, such as platinum-group metals, solar cells, light manufactures, agricultural products, and volatiles; collaborate with the Venus-Mercury Commission to support their efforts; expand our total pressurized space and our capacity to build biomes more quickly and less expensively; move the Bioarchive project to the next phase; implement the next stage in the growth of Mariner Institute of Technology and Mariner Hospital; continue the development of the arts and culture on Mars; and hold another conference on quality of life issues.

"Can we do all of these tasks in two years? Probably. Mars, fifteen years after the first landing, has 226 human beings, including thirty-seven children. Its capacities are unimaginably greater than they were in 2036 when six of us erected hab 1 a hundred meters from the base of Face Rock. In another fifteen years it will be 2066 and humanity will be ending the second third of the twenty-first century. What will our population be then? A thousand or so? We may see the first births of the third generation of Marsians by then. The tasks we are initiating this sol will be accomplishments in the history books of 2066, and Mars's goals will then be far greater. Mars's future rests in our imaginations, our creativity, and our hard work. So let us enjoy our cultural program tonight, go through our training programs in the next week, and get to work."

4.

Transitions

January 11, 2051

Will reached his office at 10:58 a.m., barely before the Lescovs were scheduled to arrive. He was about to open his attaché when he heard a knock at the door. It was Alexandra and Yevgeny.

He rose to greet them. “Come in. Good morning.”

“Thanks, Will,” said Yevgeny. Then he saw the patch. “What happened to your eye?”

“I just had cataract surgery. I was Dr. Lee’s first patient this morning. Arieh was there to assist; he’s learning the technique. They implanted a new kind of lens that is flexible, so I will no longer have trouble focusing my eyes close up.”

“No more bifocals? I’m scheduled for next week,” said Yevgeny. “I’m tired of wearing glasses.”

“About forty people are scheduled for eye work,” said Will.

“Didn’t Dr. Lee have a lot of trouble on the flight out?” asked Alexandra.

Will nodded. “He was unable to adjust to artificial gee; the coriolis made him sick for almost three months.” Will tapped the patch. “I wear this for twenty-four hours, then I’ll see what I can see. How did dinner go last night, do you think?”

“Pretty well,” replied Yevgeny. “Your speech has given everyone a lot to think about. Some was carried on television.”

“I haven’t seen the report from Louisa Turner, yet, but I saw a bit of it on CNN. It’s good to see Mars getting coverage.”

“How much longer before a new Commissioner’s chosen?” asked Alexandra.

“The process is so political, it’s hard to say. The United States has been making it very complicated and everyone else has been retaliating with their own unreasonable demands. Meanwhile, I am free as Acting Commissioner to do what I think is best, since I am not in the running for Commissioner.”

“I wish you’d change your mind about that,” said Alexandra.

“I won’t.”

“What if they offered it to you anyway?” asked Yevgeny.

“I’d have to think about it. I do not get involved in partisanship, period. Anyway, that’s neither here nor there. How can I help you?”

Yevgeny closed the office door and the three of them sat around a table. “We thought we should tell you what’s going on,” said Alexandra. “I’m pregnant, and we’ve been agonizing about what to do. We don’t want to keep the baby; we’ve never wanted to be parents or have a family. I’ve been talking to Martha and Arieh. He’s willing to give me an abortion. We’ve considered putting the child up for adoption, but I don’t think I want to see a child around the Outpost who looks like me.”

Will nodded. Alexandra’s body language was unambiguous; she didn’t want to be in his office and didn’t want to be told what to do. “The decision belongs to you and Yevgeny,” replied Will. “We have no law banning abortion. Have you talked to Madhu?”

“No, I’ve been working with Martha.” Will couldn’t argue with that; Martha was their psychiatrist, and Madhu, as a conservative Protestant, was opposed to abortion.

“Has it been a while? I’m curious why you haven’t had an abortion yet.”

“I’ve needed to take time to decide.”

“Have you looked at studies on women who had abortions? Most have had serious regrets afterward.”

“So I’ve heard. But some of that’s cultural, Will. The abortion rate among Russians has been high for decades; we’ve adjusted culturally to it.”

“Even so, whether you regard it as murder or not, there’s no doubt that a human potential is being eliminated. And Mars needs humans; that potential is pretty precious here.”

“I know. And I know I’m something of a role model here, since I’m the head of a department. But Will, I can’t let that sway me.”

“Do we know whether there are couples who will adopt? And maybe they’ll live at a different Outpost. You may not see much of the kid.”

“We’ve never needed an adoption list before, so there isn’t one. Even if they live elsewhere, they’ll have to come here for shopping and other things. So far, the only baby living elsewhere is Emily and Muhammad’s boy.”

“What do you think you’ll feel if you see the face of a biological child you’ve given up?”

“Oh, Will, I wouldn’t want to be reminded of the whole situation.”

“I can understand that. But couldn’t you see in the face of such a child a precious chance to give life to another human being and a family to another couple? One can see the child as a loss and a source of personal pain, or as a gift and an opportunity.”

“I. . . know what you’re saying, but it would be very, very difficult.”

“I didn’t say it would be easy. There are no easy choices in this situation. I feel terrible about your dilemma, I really do. What can I do to help you?”

That surprised her. “I. . . don’t know. I think I need someone to just give comfort. That’s the main thing I need.”

Will turned to Yevgeny. “And you? What help can I give you?”

“I think you’ve been a great help already.”

“I’m glad. Alexandra, are you worried that the pregnancy and maternity leave will put you at a disadvantage where Dimitri and his ideas are concerned? Yes, he wants to meet with me about all sorts of ideas. I was in videomail touch with him often when he was in Moscow and when he was flying out. Please let me assure you that your position here is in no way compromised, regardless of your decision. Your dedication to the work is unequaled and your experience makes your advice essential for all aspects of administration and planning. I mean this quite sincerely.”

She smiled. “Thank you. I wasn’t fishing for a complement. But it is good to know that whatever I decide won’t undermine my seniority.”

“Of course not. Alexandra, you have sacrificed for Mars. Not everyone can say that. I wish more people had the devotion you and Yevgeny have demonstrated again and again. You are my personal friends, too. I can’t judge you for whatever decision you make. You know my feelings; I don’t have to repeat them. But whatever decision you make, I will support you.”

Alexandra’s face brightened. “I’m really touched, Will. I’m. . . very moved.” And a tear came out of one eye. Will reached over and put his arm on her shoulder. Yevgeny had a tear in his eye as well.

“I can’t tell you how difficult this has been,” he said. “We feel terrible anguish about the situation. We have always been very careful about birth control also.”

“So were Ethel and I, and things took a different course,” replied Will. “Marshall will be eleven in three months. And he has been a blessing for us. He was a blessing for Mars; if we hadn’t gotten pregnant accidentally, I don’t think Mars would have 226 people right now, or 37 children. It was an emotional watershed for this place. It shows how providential accidental events can be.”

“And how they can bring good results, in spite of everything,” added Yevgeny. He looked at Alexandra. “Shall we go?”

She looked at him, then nodded. “Yes, I think so. Thanks, Will. I’m not sure you’ve helped us with the decision we have to make, but then, it is our decision anyway. I feel much better.”

“Good. Let me give both of you a hug before you leave.” They all stood and Will hugged both of his close friends. Then they headed out of the office.

He sat behind his desk and closed his eyes, wondering whether he had said and done the right thing. Abortions on Mars. They were inevitable; but in addition to the tragedy of snuffing out a life that already existed, Mars needed children, and Mars had a lot of adults whose fertility had declined. It was difficult to say why; their population was still too small for the data to yield statistically significant results. The average parent on Mars was in their mid to late thirties at the birth of their first child, at least a decade older than the average on Earth. Reproductive efficiency inevitably was lower. He suspected several couples would be happy to adopt a baby.

But Alexandra was proud and stubborn. He could not push her. Yevgeny’s smile at the end seemed to suggest he wanted Alexandra to carry the baby. Maybe Will’s gentle approach would work.

He looked out the window at Aurorae Valley's northern escarpment, a wall of rock fifteen hundred meters high. He stared at the stony cliffs for a minute. Then he glanced at his attaché and saw his friend David Alaoui, Assistant Commissioner of the Venus-Mercury Commission, had sent him a message. He pushed the "activate" icon.

David's face appeared. At 50, he was a year older than Will, but in the last decade he had lost much of his hair and thus much of the youthfulness Will still retained. Yet David's friendly expression and determined enthusiasm were unchanged. "Good sol, Will. The Venus-Mercury Commission, after months of deadlock, has decided to abandon its negotiations with the United States over the use of LOX-Augmented Nuclear Thermal Rockets. The U.S. has been making unreasonable demands and hydrogen-oxygen fuel from the moon is cheap enough anyway. We'll send Mercury missions via Venus with our Venus resupply flights and we'll use solar-powered ion propulsion, which is practical at Mercury's distance from the sun, for some of the terminal delta-v. We're also initiating an effort to develop large solar sails; a three square kilometer sail can push thirty tonnes of cargo to Mercury in about a year.

"We anticipate diplomatic retaliation by the United States, and possibly by the Chinese as well, who will have their own LANTR tug flying in another year and have pressured us to use it. This will raise the already high levels of partisanship on the Mars Commission's governing Board. I suspect it means the deadlock over replacing Morgan will continue and you will be acting Commissioner even longer. I don't know what it will mean in terms of your freedom to run things.

"Since we'll be flying more craft to or past Venus, we hope you'll consider launching cargo to Mars via a Venus gravity assist. It offers two advantages: the delta-v

is less than a direct flight to Mars and the cargo will arrive at a different time. We also want to build up a large fuel cache in both Venus and Mercury orbit in order to make the transportation system more robust. Mars should put in a bid for the job, because you can get fuel to either destination for less energy than the moon can.

"Since our transportation system will have a lot of commonalities with the Mars system, we'll be able to lease equipment back and forth and share development costs. Transfers between Mercury orbit and the surface will be accomplished by a Mercury shuttle. The fuel tanks will occupy the same volume as a Mars shuttle's, but will store hydrogen and oxygen fuel; Mercury's polar ice sheets are glacial in size. The cargo hold will be twice as large and will accommodate thirty tonnes of payload, and I know you could use that! This is an opportunity to design a larger vehicle that will benefit both worlds. With the advances in materials over the last twenty years, a shuttle with a cargo bay twice as large should mass the same as the Mars shuttle does now.

"We need to talk about this matter soon. The *Caloris* leaves for Mercury in four months. It's a slightly modified Mars shuttle—its engines can use hydrogen and oxygen fuel—and its thirty tonnes of cargo is located in exterior cargo pods. But we want a new cargo bay for the Hermes 2 mission because it'll fly crew. It departs in October 2053.

"I was pleased to see that Columbus 8 arrived safely and that the new annexes worked out, even if they proved bulky to pack and deorbit. It's amazing what capacities we are developing. Pretty soon the asteroid belt will be open, and then Jupiter. Mars, Venus, and Mercury all have important roles to play, and I hope we can work together, my friend. Bye."

Will smiled and hit reply. “Good sol, my dear David. What would we do without you. Yes, you’re right; we could use a larger cargo hold. There are some other modifications to the Mars shuttle we have been considering, such as improving the heat shield. And solar sails for cargo are a good idea for us as well. If you heard my speech last night, you’d know we are rethinking our transportation system, so this is the time. I’ll talk to my people and get back to you in a few days. I hope your family is well; we are all fine up here. With Columbus 8’s safe arrival, we’re all pretty happy, too. Bye.”

Helmut was late for lunch; he had taken a group of arrivals on a geological hike of Snow Crater, complete with a safety drill. As soon as he entered he looked around for Clara. After two years of being by far the youngest adult on Mars, she was water in the desert. The fact that she had similar interests, a pleasant personality, and was physically attractive made the situation even better.

Clara was seated with John Hunter and Vanessa Smith, who was so pregnant she looked like she could pop. Helmut grabbed a tray full of lunch and joined them.

“John and Vanessa were telling me about their plans to raise their son,” Clara said, after they exchanged greetings. “He’ll be American and New Zealander, Lakota and Maori, and Marsian all at once.”

“When’s he due?” asked Helmut.

“Tomorrow!” replied Vanessa. “But he’ll probably be a few sols late.”

“I was also telling Clara about the Meridiani Project,” said John. “I think she should put in. We won’t have a systems engineer, and a case could be made for one. The project involves eight road construction personnel in two bulldozer/grader trucks, eight

construction folks with two rangers, six geologists with two rangers, a cook, two mobilhabs, and three nukes. The cook's supposed to keep inventory as well, but that's too much work. There will be construction supplies arriving by robotic truck three times a month. There will be work schedules to update. And there will be a lot of data to monitor; eight vehicles with life support systems, for example."

"A variety of tasks," said Clara.

"I'll go with you to talk to Lal Shankaraman, if you'd like," volunteered John. "He's in charge of the project and would be the one to talk to Elliott."

"Okay," said Clara, with a smile. "Thank you, I'd appreciate the help!"

Helmut looked at John as if to say thanks, and John's expression seemed to convey understanding. "I think you'll enjoy the expedition," Helmut said. "We'll see a different area every sol, we'll probably find gold—we'll visit several potential gold fields—and the camaraderie on expeditions is always special."

"It won't be boring," agreed Vanessa. "It's more than twice the size of a typical geology expedition; lots of folks to associate with, especially since there will be personnel rotation." She sighed. "I'm afraid my days on trips like that are over for a few years."

"And I won't be going out for a while, either," added John. "So enjoy, and come back to tell us what you experienced."

"Alright, I will," agreed Clara. "And I'd like to babysit."

"Great!" replied Vanessa.

Their conversation turned to other matters. They paid little attention to the crowd that came, ate, and went. Will Elliott arrived and ate with his family. But just before Ethel

and the children left, Will moved over to Érico Lopes's table, then when Alexandra and Yevgeny arrived at the Patio he beckoned them over. The Lescovs looked like a weight had been lifted from their shoulders.

"We just finished talking to Martha," said Alexandra. "She'll be talking to several couples."

"Good!" replied Will. "Wow, that's . . . big."

"And difficult," added Yevgeny. He looked at Érico, a good friend, but offered no explanation.

"I need to talk to my Director of the Spaceport and Director of Imports and Exports this afternoon," Will said. "The Director of Construction will have something to say about this as well. I got a call from David Alaoui this morning. The Mercury project is developing some new equipment and wants our collaboration. One is a solar sailing cargo vessel; a three square kilometer sail for moving thirty tonnes of cargo from Earth to Mercury."

Yevgeny's eyebrows went up. "We could use that even if it took two years to move cargo from Earth orbit to Mars. The vessel wouldn't be very expensive, it would never wear out, and it would move things between planets practically for free."

"We could move Phobos water and methane just about anywhere," agreed Érico.

"They also want to create a modified Mars shuttle; a 'stretch' version," continued Will. "The volume of fuel will be the same, but the cargo capacity up or down will be thirty tonnes, so they need a cargo bay at least twice as large."

"Hum," said Érico, looking at Yevgeny and Alexandra. "We'd need a few other redesigns, too."

“The shuttles are limited by cargo volume more than anything else,” agreed Yevgeny. “One hundred fifty tonnes of liquid methane and oxygen can lift sixty tonnes of cargo to low Mars orbit, but there’s no room inside for that much stuff, except for gold and other incredibly dense items. The engines and structure aren’t designed for extra cargo mass either.”

“With the rapid growth in mass transported between the planets, we need more lift capacity,” added Érico. “The shuttles would need heavier aerobrakes to go into Mars orbit, but those are already developed and available. Heavier parachute systems would be needed and new software to handle the higher entry speeds. There’s also been a study about the value of variably deployed aerobrakes; they have strakes that extend outward from the base of the vehicle to increase its aerobraking surface and to steer the vehicle. We should work on that as well.”

“And ballutes,” exclaimed Yevgeny, referring to parachute-like devices for use in reentry.

“Would this mean each shuttle flight could deorbit two annexes instead of one?” asked Alexandra.

“I think so,” said Will. “Or one annex and a crew compartment. Or a larger load from an automated cargo vehicle.”

“The shuttles is that they have become more and more reliable over the last fifteen years,” added Érico. “The engines are better; maintenance is easier. If they had a bigger cargo compartment, I don’t see any reason why we couldn’t keep upgrading the basic vehicle and retiring the older models. Eventually we might need larger fuel tanks and a

larger cargo bay to accommodate, say, fifty tonnes up and down, but we would still be scaling up the basic vehicle. A Mars shuttle is much simpler than a terrestrial shuttle."

"A lot less delta-vee," agreed Alexandra. "Still, we need to look at some other options. A landing system for the annexes, for example."

"It'll cost more to develop than this option," reminded Will. "But I agree, we need to look at our options further. Let's all review the future options web pages and see how this offer changes things. Can we meet at 3 p.m.? I'll get some of the folks in Houston on board as well. We need to pursue this opportunity."

5.

Departures

March 1, 2051

Will Elliott, Ethel MacGregor, and Jimmy Leong stood before the metal carbonyl fractionator, a shiny ceramic cylinder two meters in diameter and extending from the floor of the Vandevelde industrial facility to its ceiling five meters above.

"Robotic design requires very different organizational principles," said Leong. He pointed at the fractionator. "Redesigned for robotic control, using the latest self-auditing software, this thing could process twenty tonnes per sol instead of five."

"How much more energy consumption?" asked Will.

Leong considered. "Two and a half to three times. You'd get thirty or forty percent better energy efficiency. Meteoritic nickel-iron varies in composition significantly, especially here where you have eolian admixture and partial oxidation. The self-auditing software will track that literally every tenth of a second as the powdered meteorite flows into the processor, and will constantly adjust the heat and CO inputs. The result will optimize the platinum group extraction."

"Can you design a retrofit for our existing system?" asked Ethel.

"Not very easily. If we want to go into a partnership on this, we'll have to discuss the terms. I'll need to control a team here dedicated to the project. And I'll need to recoup expenses plus a significant profit."

"Of course," replied Will. "We have a standard arrangement with the three gold mining companies."

“Perhaps it’s adequate. The big concern I have is what fraction of an annum the fractionators would be down because of lack of power. Dust storms are an economic problem. Nuclear power is the solution.”

“And much more expensive,” said Will. “Reactors are two hundred times as expensive as solar panels and two thousand times more expensive than wind turbines. It’s cheaper to store power for the dust storm season in the form of liquid methane and oxygen. If you want to invest, we’d store the power you need.”

“Platinum production is very energy intensive; three thousand kilowatts of continuous power to produce one tonne of platinum group metals per year.”

“We’re prepared to make that sort of investment.”

“Good. The really good nickel-iron deposits on the moon are not near the polar mountains with near-perpetual sunlight, the infrastructure to store energy for the 14-day nightspan is expensive, and nukes drastically raise costs.”

“Admittedly, our shipping costs are higher,” said Will. “A tonne of platinum costs one million redbacks to ship to Earth from here, but only half that from the moon, and the moon can send it in a week rather than in six months every two years. But we can probably cut shipping costs in half over the next decade.”

“The moon hopes to do that as well.” Leong pointed out.

“Our electricity is a bit cheaper than the moon’s,” persisted Will. “And our ore is easier to obtain. When a nickel-iron object impacts into either world, most of its mass ends up underground, but here wind and water can remove the overburden. We have nickel-iron meteorites that made craters in eolian dust deposits in the high latitudes, and then the dust blew away, leaving massive chunks of nickel-iron waiting for harvest. Here

in the Aurorae Valley we've exhumed paleochannels with nickel-iron lag deposits and boulder bars deposited by catastrophic floods that are over ten percent nickel-iron. Thousands of cubic kilometers of regolith was transported out of the Marineris system by flood waters, and those waters did a lot of sorting."

"I know," said Leong. "You've done an excellent job of prospecting for deposits, also. I was looking at your map the other sol."

Two million metric tonnes of nickel-iron in deposits of 5% ore or more within 100 kilometers of Aurorae, containing about sixty tonnes of platinum group metals worth three billion redbacks."

"And with demand for platinum for hydrogen fuel cells going through the roof, the price should remain strong," agreed Leong. "I agree, Dr. Elliott, Mars has a lot to offer. I probably will invest in a facility on the moon as well, but I'll have to import carbon from Mars! Have you considered platinum-group extraction on Phobos or Deimos?"

"Yes, it's under consideration," replied Will. "The bedrock on Phobos and Deimos has a bit more nickel and platinum group metals than most chondrites, but the techniques for fractionating carbonyls in microgravity have not yet been developed. So platinum-group metal extraction on the moons is still a decade and a billion Euros away."

"Fair enough. That's still ahead of extraction on near-earth asteroids; the robotic techniques are just not there yet."

"Especially when you include robotic repair of equipment," agreed Will.

There was a moment of silence. “This is a project I’d like to work on,” exclaimed Ethel. “For the last decade, since we had our kids, I’ve been playing support roles, but I’ve spent much of my time with the carbonyl process.”

“You’ve written the book on it,” replied Leong. “A highly automated system would need a boss and six staff; three shifts, two people each, one to run the processor and one to coordinate the robotic meteorite harvesting vehicles and do repairs.”

“We would be extracting meteoritic material from land owned by many people,” added Will. “They’ll get a royalty, but it adds only modestly to our costs and boosts demand for land.”

“Why haven’t you done more extraction of platinum group materials already?”

“It has been a goal, but gold extraction came along first and is simpler. We only need 150 tonnes of nickel-steel per year, and that quantity of meteorites contains only 4.5 kilograms of platinum group metals. We haven’t had spare human resources to devote to the task, especially building and testing robotic ore harvesters.”

“With the new computers and software, that can be highly automated,” said Leong. “The ideal vehicle would have a nuclear reactor and a carbonyl processor built right in; it would roll through lag deposits, sucking up the regolith, separating the ore magnetically, and processing it on the spot. A robotic truck would pick up the separated elements and a crew on board would handle routine maintenance.”

“But we don’t have very many reactors and they cost three hundred million redbacks each. That’s ten tonnes of platinum group metals,” replied Ethel. “We’d have to process three hundred thirty thousand tonnes of nickel-iron to get that much, and pay for development and production of the metal extraction equipment, the salaries, etc. It’s a

huge unnecessary expense. It's a hundred times cheaper to refuel the unit with methane and oxygen robotically, or beam power to it from fixed solar panels."

"Of course, you're right. I love nuclear power, but it really hasn't arrived yet," he conceded.

"A mobile processor could be developed for several hundred million Euros," continued Ethel. "We can refine and test ideas produced on Earth. Any effort would have to be a partnership; you can't test a large scale unit on Earth, you don't have the exterior conditions or the available meteorites."

"True. We could develop a lot of parallel technology, though, because this technique could be used to recycle scrap steel alloys more effectively."

"That would be excellent because the terrestrial steel industry can pay more than we can!" exclaimed Will.

"There's one other factor to consider," added Ethel. "Right now the market on Earth for platinum and related metals is small because they cost thirty million redbacks per tonne. If we start extracting dozens of tonnes per year the existing market could realign and the price could fall to half, maybe a quarter, of what it is now."

Leong smiled. "But demand will also go up. The switchover to the hydrogen economy will happen faster, and that means more fuel cells with platinum catalysts. Besides, I like shaking up markets. That's why I'm here."

They turned and walked out of the industrial facility. "I hope you've enjoyed the visit to Mars," said Will.

“Oh, yes; this has been the event of a lifetime. It’s been incredible. The spirit here is really indescribable. Your people are incredibly devoted to the idea of opening an entire new world to humanity. And the hospitality has been legendary.”

“You’ve seen more of Mars than I have,” added Will. “I still haven’t been the length of Marineris or to the top of Arsia Mons; or to the top of any of the big four, for that matter. I’m sorry we couldn’t get you to the south pole.”

“Dust storms can happen even out of season. I greatly enjoyed seeing Dawes and Cassini, though, and the fretted terrain at Deuteronilus. And who would have thought that I’d be on Mars when you were acting Commissioner, and thus would be in the position to conclude a business deal as well! Now I’m looking forward to the visit to Magellan Station and studying Venusian geochemistry; I have a Ph.D. in it and get to do real planetary science!”

“The dozen of you will quadruple the population of Magellan and triple its science output.”

“Who would have thought that it would be possible for a tourist to go to Mars and Venus!”

“I’ve really enjoyed meeting you, Jimmy,” said Will. “Would you like to come to my office this afternoon? We can settle details.”

“Yes,” agreed Leong. “Can we make it 4 p.m.? That’ll give me time to talk to staff back at corporate headquarters in Singapore, and to some of our leading engineers in our R&D unit in Bangalore. I’d like to sign a memorandum of understanding about developing platinum group metals before I leave.”

“Sure, 4 it is.” Will offered his hand, and they shook. Then Jimmy Leong headed to his apartment in Huron biome to do some work.

“He’s a friendly fellow,” said Ethel. “And seems reasonably easy to work with.”

“He’ll be a tough negotiator, I think. I had better ask Silvio and Yevgeny to join us. You should sit in as well.”

“Thank you. I was serious; I’d like to do this. I need a new challenge.”

“I know, I’ve felt your frustration for some time. I think it’s a great idea. Can you refresh your memory of the details of our systems between now and then?”

“Sure, I’ll get started right away. But what about the appearance of favoritism?”

“What can we do? It isn’t fair on you that you’re stuck with obscure, unimportant tasks because we don’t want me to be accused of favoritism. You have seniority over everyone else here, including me. Don’t worry about it.” He kissed Ethel; she smiled and kissed him back.

Will headed for his office in Mars Control while Ethel headed back inside Vandevelde. Will found Brian Stark waiting for him when he arrived.

“I want to say goodbye,” Brian said, offering his hand.

“Thanks.” Will smiled and they shook. “I’m sorry the reactor proposal didn’t work out.”

“So am I. Mars needs large-scale nuclear power. But the political climate is wrong right now; the White House will give Mars nukes only if Mars comes under U.S. authority, and only if some of the enriched uranium can be diverted to military ends. Neither of those goals is tolerable to the population here. It’s understandable they aren’t.

I've told the White House that several times, by the way. That may be why their goals for Mars have shifted."

"I think so," agreed Will. "I appreciate your efforts to explain us to the White House. With Doug Morgan permanently incapacitated and unable to return as High Commissioner, we've lost our best lobbyist with political conservatives."

"Once I'm back on Earth, Will, I'll advocate Mars to conservatives as best I can; assuming there are still some in power by then!"

"It's looking grim for the President right now."

"He went too far. He narrowed his political base way too much and the moderate Republicans are abandoning him. His bill to pull the U.S. out of the United Nations is going to be defeated in Congress, which is just as well: the Earth needs a coordinating body. That's one perspective I've gained from being up here."

"Yes, we have a pretty remarkable, international team up here, though it's driving me crazy keeping everyone on friendly terms. Six years ago it was integrating the French, then four years ago the Spanish, and two years ago it was a group of African-Americans who felt alienated. This year it's the Chinese. But it'll work out."

"This place exemplifies *e pluribus unum* better than any other human community. Mars represents many American ideals, such as freedom, democracy, justice, and fairness. It tempers some other ideals, such as individualism, but that's inevitable considering the collective effort to survive here. Mars has a lot that conservatives should be proud of, and I plan to say that."

"Thanks, I appreciate that. Skip seems to want to advocate Mars to liberals. Maybe the two of you can be a traveling road show."

"I'm sure we will be, since I'm the star in his Mars-made movie. You can count on me."

"Thanks. Have a safe liftoff tomorrow morning, and enjoy seeing Venus."

"I'm not looking forward to Venus. I've got six months of floating in space, then five months orbiting a hell hole whose science is utterly uninteresting to me, then three months floating in space again. I'll miss the liquor I can buy here! But I'll be in touch."

"Thanks, I'll keep in touch with you as well." They shook hands again, then Brian left. Will turned to his messages. Louisa Turner, head of the Mars Commission's Office of Public Information, had left him a message two hours earlier. Louisa was not one to ignore; she also kept track of politics and did some of the Commission's lobbying. Will activated her message.

"Good sol, Will. One of my sources indicates that the White House has decided to try to block involvement of the Chinese in the Venus-Mercury Commission and they'll threaten to withdraw their cooperation from all space ventures to get their way. That would have worked twenty years ago, but now the technology of ITVs, lifters, and shuttles is so well established and so reasonably priced, and mostly licensed in the public domain, that Europe Russia, China, even India and Brazil could continue to develop and use them without the U.S. So it appears the White House is being naively foolish and will simply hurt space exploration.

"My source says they have also decided to oppose any collaboration between the Mars Commission and the Venus-Mercury Commission regarding a new shuttle model and will call for a meeting of the national representatives to stop the plan. Krister, Pierre, and I are already on the phone to the national representatives, asking them to oppose the

White House move and possibly even refuse to hold the meeting. I'll be getting the working points to you in a half hour for your review. Look it over carefully so that we can meet in three hours to finalize our strategy. Bye."

Will hit reply. "Send me the talking points and I'll review them right away. I always feel at an immense disadvantage on matters like this because I can't talk to anyone face to face. Let me know who you want me to call. You know the style of our response I expect: principled but pragmatic. I'm amazed the White House thinks it can threaten to pull out of space flight and make everyone fall in line. Just about every part we need is made by two companies, one in the U.S. and one in Europe, and all the specs are public. It won't be hard for us to rally the other representatives against the American position. Meanwhile, I saw this morning that the dollar has fallen another five percent against the euro. A friend of mine said that he thinks they'll soon realize that what they think is in their self interest is precisely what is not in their self interest! But they haven't figured that out yet.

"I suppose you need a statement about the new shuttle. I'll draft something, saying that the Mars Commission welcomes opportunities to cooperate with everyone in the exploration of space, that we welcome the opportunity to lease American LANTR engines if they are available and not too expensive, and we welcome the chance to collaborate with the Venus-Mercury Commission to build an enhanced shuttle. Let me know if you need something else. Bye."

He sent the message with a sigh; he hated politics and hated dealing with it. He turned to a more pleasant task: the latest news about setting up Colorado Biome. But before he was able to begin reading the memos and notes, he received a videophone call.

He pushed the activate icon. Silvio DiPonte's face appeared. The planet's store keeper, banker, lawyer, and judge looked agitated. "Will, are you available for a trial right now? We have a case of intoxication."

"When; now? I have a lot of serious tasks to do this sol."

"I'm scheduling the trial for 12:30 p.m. so the public can attend; it's their right, and the defendant's, though I suppose he would prefer that this incident remain private. The case is straightforward; we have the breathalyzer evidence. Greg is clearing his schedule to serve as defense counsel and will be meeting with the defendant in another half hour or so. I want to hold the trial this sol because one option is sending him back to Earth, and blastoff is tomorrow morning."

"That would be pretty drastic."

"This is his second offense. I can't imagine we would do it, unless he is defiant, but Greg will explain the procedure to him and the possible consequences, so I suspect he'll be contrite."

"Yes; Greg does a good job. Okay, I'll be there. How are the stocks of the mining companies this sol?"

The Dow closed down half a percent a few hours ago, but our stocks were basically unchanged. They're as high as they can go, so I wouldn't expect further gains. I was talking to Susan Van de Velde earlier this sol about the Van de Velde Mars Immigration Foundation. We now have enough to endow a single immigrant if we wipe out the entire fund, or to partially subsidize someone, if we can raise more."

"I'll remind Mr. Leong about the fund when I meet with him this afternoon. I think Susan talked to the other tourists herself. Anyway, I've got to run. Bye."

“Bye.” The screen went blank. Will turned to his other work, then went to lunch a bit early so that he’d have some family time before the trial. They always sat at the same table at lunch and there were no extra chairs so that no one could sit with them. But he got up at 12:27 to walk back to Riviera Biome, where the trial would be held. A steady trickle of people was following him, mostly new arrivals; they knew the defendant and had never seen a Mars trial before.

The conference room one floor below Mars Control was able to hold fifty people. It had a raised platform in front bearing an imposing dais. The room served as a legislative chamber for the Mars Council, their nine-member planet-wide legislature, a place for public meetings of the Borough Council, and their court room. The defendant, Mikhail Golvashchenko, was already seated up front with Greg Harris.

Érico Lopes, the Clerk of Aurorae Borough, who also doubled as the clerk of court, opened a door in the front of the court room and entered. “All rise,” he called, and everyone stood. Silvio DiPonte entered wearing black judge’s robes and sat at the dais.

“You may be seated,” he said. He glanced at his attaché. “This case is the People versus Mikhail Golvashchenko. Mr. Golvashchenko, you are charged with unlawful intoxication. The people of Aurorae Borough passed an ordinance on February 5, 2045, that specified that alcohol could be consumed only between Frisols at 5 p.m. and Sunsols at 7 p.m. The ordinance also specified: first, that the majority of the population of Aurorae is engaged in work that involves complex equipment, health, or children, hence the community has an interest in restricting the time alcohol can be consumed; second, that workplaces can add additional restrictions on alcohol consumption by their employees; and third, that because emergencies can occur inside the outpost at any time,

extra environmental management and emergency staff must be on duty during the times when alcohol consumption is allowed. The ordinance specified that the first violation requires a written warning and counseling. You received the first warning on January 22nd. The second violation requires a fine of a minimum of one week's salary and a maximum of two months salary, plus either probation, home confinement, or expulsion from Mars, though a jury trial is an option when that penalty is under consideration. The third violation requires a jury trial and involves a fine of up to three months salary, confinement, and expulsion, although the Governor has the power to pardon someone from expulsion.

"I have two sworn affidavits before me, which your counsel, Greg Harris, also has. The first, from Kent Bytown, the Borough Constable, states that this morning, Wednesol, March 1, 2051, he was anonymously informed that you had drank excessively last night and planned to go to work this morning. He found you eating breakfast on the patio, brought you back here, and administered a breathalyzer test, which showed a blood alcohol level of 0.06, which is below the 0.08 definition of legal intoxication, but proved you consumed alcohol last night. He then brought you to Mariner Hospital. My second affidavit is signed by Dr. Arieh Rimmon and states that he examined you and administered a second breathalyzer test, which confirmed the consumption of alcohol within the last twenty-four hours.

"I am about to ask you how you plead. You may plead innocent if you wish to dispute the evidence or argue for extenuating circumstances. Mr. Golvashchenko, do you understand the ordinance and the penalties it specifies?"

"Yes, your honor, I do."

“Mr. Harris, do you feel your client needs any further explanation of the charges?”

“No, your honor, I do not.”

“Mr. Golvashchenko, how do you plead?”

“I plead guilty, your honor.” He said it in a very quiet voice.

“Did you say guilty?”

A louder voice. “Yes, your Honor.”

“Very well. Do you have anything to say before I sentence you?”

“Yes, your honor. . . . I am very sorry that I violated the law.”

“Why do you think you did it?”

“Your Honor, in Russia, where I come from, drinking is a very common custom and habit, and there are no restrictions of this sort on it. I am sorry to say that I did not. . . understand that the law was a serious one.”

“It is a very serious law, Mr. Golvashchenko, because this is not Earth, where air is free. Our air is expensive and hard to contain, and could leak away on us in a moment. In an emergency situation we have to count on everyone to know what to do and have the ability to help others, especially children. That’s why we hold depressurization drills twice a year. Have you anything else to add?”

“No, your Honor.”

“Mr. Harris, have you anything to add?”

Greg stood. “Your honor, Mikhail has an exemplary record as a geologist and a promising future here. He has many friends and is known as a very sociable and friendly man. In our discussions I was impressed by his contrition.”

DiPonte looked at Golvashchenko, seeking evidence of contrition, but the defendant's face was largely expressionless. "Mr. Bytown, as constable, have you anything to add?"

"No, your Honor. The facts have been stated."

DiPonte looked around the courtroom. "Are there friends of Mr. Golvashchenko present?"

No one moved or spoke for a moment. Then Tomas Racan raised his hand. "There are a few of us, your Honor, who are here."

"Who else?"

Three other hands went up.

"Do any of you have any comments to add about this incident?"

"In the evenings he's usually with us on the Patio, watching tv, playing cards, and drinking coffee," replied Tomas. "But last night he was depressed about something and stayed home, so we didn't see him."

"I see. Will the four of you support your friend in his effort to overcome a drinking problem? Because from a legal point of view, this is a drinking problem. Perhaps from a psychological point of view as well, but that will have to be determined by a professional. When someone has a tendency to drink, especially if they are unhappy about something, their friends should intervene and help. Can the four of you do that?"

"Yes, your Honor, I will," said Tomas, and the other three nodded.

"Speak up," said DiPonte. "Nods are not adequate for our court recorder."

"Yes your Honor," replied the other three.

"Very good. Mr. Golvashchenko, please rise and hear your sentence."

Mikhail Golvashchenko rose. Fear was obvious on his face and a hush fell over the court. DiPonte paused for effect.

"I thank you for pleading guilty and am pleased to see you have good friends here to help you, because on Mars we have to count on each other. I sentence you to a fine of one month's salary, to be collected by the Clerk of Court this sol; counseling at Mariner Hospital for alcohol dependency; confinement within Aurorae Outpost for three months, which means no use of a pressure suit or riding in a pressurized vehicle during that period; and you are forbidden to consume any alcohol for the next year. What have you to say?"

"Your Honor, I am scheduled to depart on the Southern Hemisphere expedition next week."

"Your work assignment will have to change. Governor Elliott, what say you?"

DiPonte usually called on Will in situations such as this. He rose. "Your Honor, we will reschedule Mr. Golvashchenko to do geology laboratory work for the next four months."

"Very well; the matter is settled then. Does anyone have anything else to add?"

No one spoke. DiPonte looked around. "This court is adjourned."

The Patio underwent a change of character between 7 and 8 p.m. At 7 p.m. the sun was sending slanted golden beams across the space; people were still arriving to eat supper. By 8 p.m. the sun was gone and the sky black, invisible because of the Patio's dimmed lights except for Phobos, which shone low in the east; people eating dinner had finished; all the families had left so that the kids could go to bed; and many of those without kids,

especially the singles, had stayed or were returning. The wall screen was split into fourths, each showing a different tv show, and those wishing to listen programmed their ear pieces to pick up the appropriate audio. The buffet was replaced by a simple snack bar. A few tables were removed to create a dance floor.

When Helmut arrived at 8:30 he immediately looked around for Clara and was disappointed to see she wasn't present yet. But Skip Carson was, so he went straight to his table, which was already crowded with others.

"Skip, have a safe flight home," he said.

"Thanks, Helmut." Skip stood up to give the young man a hug. "I'll miss you."

"We'll all miss you."

Skip sat again. "And I'll miss everyone! I arrived twenty-eight and a half months ago as a tourist who planned to stay one month. I decided to stay eighteen months until Columbus 7 returned to Earth before opposition, and that flight was canceled because everyone, including me, wanted a few more months here and visit Venus. And here I am, finally leaving after twenty-eight and a half months! I feel like I belong here now."

"Well, you can always stay," exclaimed Johnny Lind.

Skip shook his head. "I'd like to, but my life is back on Earth. I've made a movie here, starring our own Brian Stark, and the special-effects version needs my attention. I have two commitments to make movies that I must honor. Besides, I plan to do a lot in Hollywood for Mars. Maybe I'll be back in another decade, though." He turned his face away and sipped his coffee so that no one could see the tear forming in his right eye.

"We've really appreciated having you here," said Helmut. "If nothing else, you've made the place exciting!"

“There are plenty of young people who can continue the political debates, and I’ve promised to help Louisa Turner with a new media project. And I’ll be a videomail away! Keep in touch, all of you.”

“Thanks,” replied Helmut. He looked around the Patio and saw Clara coming out of DiPonte’s store with a small chocolate bar. She came over and sat next to him.

“Your nightly chocolate bar,” observed Skip.

“Yes, our five redback fix,” replied Clara. She handed a square to Helmut, who accepted it with a nod.

“Don’t complain; imported chocolate bars cost one hundred fifty redbacks each, whether they’re highest quality or the lowest,” replied Skip.

“This way, the money stays on Mars,” added Clara. “Though the quality is less. I’m sorry I didn’t get many chances to get to know you, Skip. Have a safe flight.”

“Thanks. We’ll be doing a super-fantastic video documentary of the Venus visit.”

“Always developing a new project,” said Helmut.

“I would propose a toast to your success, but all we can drink is coffee, tea, or water,” said Johnny, irritated.

“That was an interesting trial, but I didn’t know the drinking ordinance was taken so seriously,” said Clara.

“Elliott’s a tea totaler,” complained Johnny.

“This has nothing to do with Elliott; it was passed by the Borough in a town meeting,” replied Skip. “The Mars Commission had a similar regulation and people complained about it, so the Borough was given the chance to vote on it, and they did.”

“Yes, I suppose it is necessary,” conceded Johnny.

“I was surprised by how big the fine is!” said Clara.

“DiPonte’s tough. He usually favors the high end of the range,” replied Helmut. “Since I arrived two years ago we had two trials before this sol. One was a harassment charge and the other was a divorce settlement. Silvio was pretty stern each time.”

“I was surprised Mikhail didn’t have access to a lawyer,” said Clara.

“He could have chosen to have a trial in Houston in absentia, but it would have cost him a lot,” said Helmut. “Greg must have explained that to him.”

“They probably consulted a lawyer by videomail,” added Johnny.

“I see.” Clara broke off another square of chocolate and handed it to Helmut. She never offered any to the others. She looked at Helmut. “John and I talked to Lal a few hours ago and he agreed that I could be systems coordinator for Meridiani.”

“Really?” said Helmut, lighting up. “Congratulations!”

“Congratulations,” added Johnny. “You’ll enjoy the trip.”

“You’re running the southern hemisphere expedition, right?” asked Clara.

“Yes, and with Mikhail’s confinement, we have a vacancy. Helmut, you could apply for it. You’re on the waiting list.”

“That’s true.” He looked at Clara. “But I think I’ll stick to Meridiani. Like you said, it should be an enjoyable trip.”

6.

Colorado

March 2051

Will Elliott's stomach wouldn't stop growling. It was March 2 and the first sol of the Bahá'í fast, so he wasn't eating or drinking from sunrise to sunset. The first few days were the hardest and the lack of food was a distraction. When he saw Dimitri Lyubinin, their new interior designer, entering Colorado biome, he reminded himself to concentrate.

"Good sol, Dimitri!" he exclaimed. "How are you?"

"Fairly well," replied Dimitri. He looked around a bit nervously, to make sure Alexandra Lescov wasn't present. "Thank you for accepting my invitation, Governor. I've become frustrated in the last month and want to clarify my views directly with you."

"So I understood from your email. We're all professionals here and we treat each other with respect, but that doesn't mean everyone has to be present to discuss every detail, especially if there are clashes of opinion. I want to understand the problem you and Alexandra have been having."

"It's a difficult time for her, right now, being pregnant and planning to give up the child, and the Construction Department is under immense pressure. The transition to making kevlar and other high-performance plastics has been slow and there are major construction delays. I don't blame her for that."

"Nor I. We've had some serious technical problems with the equipment." Will pointed to Colorado Biome's interior; they had met at its eastern entrance. "What would you do with this space differently?"

"Alright, we can start with that issue, if you'd like." Dimitri led Will into Colorado, a circular space 60 meters across—their largest enclosure to date—with a transparent plastic dome soaring to a 35 meter apex. Unlike the other biomes, Colorado's floor sloped downhill to the northeast, with a pond to their right at the low spot. A brook, Colorado Creek, flowed into it; the creek started at another pond at the high end of the biome, flowed through a short, narrow canyon four meters deep, and dropped over a three meter waterfall just before it reached the lower pond. Its path was lined with aspen saplings; the rest of the central space was planted with wheat, except for clover, flowers, and some vegetables along the sidewalks and patios. There were six cylindrical buildings on the north side of the biome and six more on the south side. They were arranged in groups of three, with each group located on a different level and having a farm on top.

"This arrangement is superior over the earlier biomes in several ways. The interior space is more open and brighter. The slope and the staggered levels of construction make the space more dynamic, and the brook with its little canyon and waterfall gives it a naturalness. The two ponds are a luxury. I'd shape the outer duricrete walls to look like cliffs in the Rocky Mountains, but that's a minor point.

"Most of the interior is agricultural, which decreases its attractiveness; I'd design spaces where most of the agriculture is on the roof. Some of the little courtyards behind buildings are a waste of space, decrease the openness of the central area, and complicate construction."

Will was surprised because Dimitri knew how limited their space was. "So, have you discovered the secret of terraforming Mars?" he asked with a wry smile.

"Hardly. But I think we can make significant changes that will make enclosures cheaper. Alexandra's not opposed to them, but hasn't tried them yet because of the emergency conditions. I'd build some biomes exclusively for agriculture and the bioarchive project, with no housing. That means we can eliminate the heavy concrete foundations, the gravel beds for drainage, and the exterior walls. There's a new design for a biome that involves no foundation at all. The site is cleared of rocks, a meter of soft eolian dust is put down, and a heavy plastic membrane is laid on top that extends fifteen meters beyond the biome. The plastic bubble has a skirt that also extends fifteen meters beyond the enclosed area that one sews and glues to the membrane, then one piles tonnes of dirt on the skirt to seal them together permanently and hold in the air pressure. I'd pressurize to lower pressure to save time and money. One installs additional waterproofing, adds a half meter of soil, and starts farming."

Will nodded. "I've read the proposal and asked Alexandra about it. She said the plans for sealing the membrane and skirt were not developed enough."

Dimitri scowled. "I don't think that's true any more. When I was in Moscow, there was a team at the Institute for Mars Construction hard at work on the problem. They were also working on spray-on insulation and waterproofing for the floor and lower dome. The plan is quite robust. We can make an agricultural biome for about one third the work of our standard biome. Standard biomes can have a higher population density and more park land, which are better uses of them."

"Interesting." Will was careful to sound noncommittal, but Dimitri was not to be placated.

"I'm not sure what's the best way to put this, Will. We may be in crisis. Our current formula puts three-story accommodation units on about half the floor of a biome, yet we need equal amounts of outdoor and indoor space. Consequently, we have the housing space for Columbus 8, but not the agricultural space, so we're building farms to feed our current population and drawing down our food reserves. Some of the agricultural space for Columbus 8 will have to be refurbished to provide the accommodation space for Columbus 9. Refurbishment is a waste of time and building foundations under farmland is unnecessary work. Overall, the arrangement is inefficient. We're so far behind, we may have to cut rations or import food from Earth; a lot of food. We can build purely agricultural biomes faster and more cheaply."

"You have a good point." Will looked around at Colorado. He had been intensely proud of it, but now he had mixed feelings. "Where can I read more?"

"The report is at the Institute for Mars Construction's internal website. I assume you have a password to get in."

"Yes, I do. I'll take a look, then I'll either get back to you or talk to Alexandra directly."

Alexandra hated taking time off from her work; there was too much to do between the finishing touches on Colorado, the excavation of Shenandoah, and the revisions of the plans for Dakota. But the baby had to have some priority, even if she planned to give it up. Eve Gilmartin's examination was quick.

“Both you and the baby are healthy,” she said to Alexandra and Yevgeny. “Your blood pressure is a bit on the high side, but it doesn’t appear to be serious. I suppose you are feeling much better, also.”

“Sure; I’m in the middle of the second trimester. Other than massive hunger at odd times, I can work reasonably well,” replied Alexandra.

“How are you feeling about the situation?”

She shrugged. “As well as I can, I suppose. Everyone knows I’m planning to give up the baby, which is embarrassing. I’m not getting comments saying ‘I’m proud of you for being so selfless’ and too many implying that I’m too selfish to raise a child. I feel like the object of ambiguous moral judgments from people who should mind their own business.”

“It’s part of living in a small village,” replied Yevgeny. “But Alexandra, I think you read too much into people’s comments.”

“That’s easy to do,” agreed Eve. “We have three couples interested in adopting the baby; we’ve started running them through the screening process. Soon they’ll be ready to be interviewed. Do you want to participate?”

Alexandra recoiled. “No, not at all!”

Eve nodded patiently. “Think about it, alright? You and Yevgeny can decide who will adopt the baby; then you will feel comfortable with the situation. If I have to decide, there’s no guarantee you’ll be pleased.”

“I understand, but I’d rather not get involved in this entire messy process.”

“How involved could we be in the life of the child?” asked Yevgeny, causing Alexandra to scowl.

"That depends," replied Eve. "We're talking about an 'open adoption' where everyone knows everyone else. You would give up all legal rights to the child; it can have only one set of parents. But that doesn't mean you and the adoptive parents couldn't make an arrangement whereby you could give the child birthday presents or make visits."

"This is getting complicated," exclaimed Alexandra, shaking her head. "I don't want to be an on-again, off-again parent. Either I am, or I'm not! I really don't want to be a mother and if I'm giving up this child, I really don't want to know about him or her!"

"Alexandra, I don't want to press, but I'm concerned," said Eve. "Children are a lot of work and a big headache. I know; Juliette is three. But children are also a great joy and they become the love of your life. I think you could make a wonderful mother."

She shook her head. "No, I couldn't, I'd just make a mess of it, just like my mother made a mess of the lives of most of her children."

Yevgeny reached over and put his hand on Alexandra's shoulder to comfort her. Tears were welling up in her eyes. Eve looked at him, wishing to help. "Well, if there's anything I can do—anything at all—please let me know. This isn't easy, Alexandra, but I am very grateful for your effort."

"I hope I will be, too," she replied. She turned to Yevgeny. "Let's go."

He nodded and they headed out of the examining room. After they left the hospital, Alexandra turned to him and said in Russian, "If I'm cutting off contact with this child, you have to do the same. I can't have it any other way."

Yevgeny swallowed. "Alexandra, you aren't your mother and I'm not your father. He was never around; but I will be. For you."

She stopped and looked at him. "You'd like to keep the child, wouldn't you?"

“He or she will be our flesh and blood.”

“Yevgeny, you are being emotional about these things, not scientific.”

“Flesh and blood is not a merely emotional matter, my dear, it is fundamental to our humanity. You’re the one whose emotions are clouding your judgment.” He said it plainly, matter-of-factly. It stung her and for a moment she was speechless.

“I should have had the abortion,” she finally said.

They walked in silence to the Patio for lunch, where they sat at their table. Martha and Charles Vickers usually joined them, but Charles was on the south polar expedition at the time, doing geology and collecting meteorites; Mars was an incredible place to study meteorites and Charles had just published a conclusive analysis of what he argued was the first meteorite known from outside the solar system. Martha, their psychiatrist, had daughter Caitlin with her, who was about to turn six. Alexandra watched her friend negotiate with Caitlin over the birthday party scheduled for Satursol. They made small talk about terrestrial politics. When Alexandra walked back into the cafeteria to get a cup of coffee, Yevgeny turned to Martha.

“You’ve got to talk to her as a friend. Eve asked us about helping to select the adoptive parents and she said no. She’s very upset about the pregnancy again.”

“Yevgeny, what happened? I know she had a bad childhood with an alcoholic mother and no father.”

“That’s it.”

“I wish she’d come to group therapy. I have a parenting group that meets weekly and we spend more time talking about how we were parented than how we parent our kids! She’d realize she’s not alone.”

“I think she wants to think she’s alone.”

“That’s Alexandra.” Martha shook her head. “How do you feel?”

“Well, I wish she’d consider keeping the baby. It’s my child, too.”

“I’m sorry about the situation, Yevgeny; it must be tough. Maybe you should come to group therapy.”

“I’d have to talk about Alexandra, and she wouldn’t want that.”

Martha nodded. “Well, are both of you free tonight about 9:30? Come to our flat for a visit.”

“Okay. Maybe some casual conversation would help. I know it did last time.”

Alexandra walked back to the table with a large cup of hot tea. “I just ran into Will. He wants me to stop by his office in an hour. He has an appointment with Lisa right now to discuss agriculture.”

“Oh?” said Yevgeny.

“We’re very short on farm land right now, and Colorado has been producing only six months, so it didn’t generate much of a reserve. Another problem to solve.”

“Well, come to my flat tonight after Caitlin goes to sleep and we’ll have some hot cocoa or ice cream and relax. Maybe that will help your stress.”

Alexandra cast a quizzical glance at Yevgeny. “I think that’ll be nice,” she said.

A few minutes later they all finished their meals and headed back to work. Alexandra went to her office in the Vandevelde Building long enough to check the construction schedule and the status of various construction experiments. She read the abstract of the new paper advocating construction of bubbles by gluing a floor membrane to a bubble skirt. Then she headed to Will’s office.

He was just finishing up his conversations with Lisa Kok, head of environmental management. As Lisa walked out, Alexandra came in.

“We’re just reviewing the figures for the next three years,” said Will to Alexandra, pointing to a chair across the table from him. “I’m concerned that the construction schedule puts us in the position to feed 226 people at least a year from now, while we have that number now, and will have a few more pretty soon. If Columbus 9 flies 90 people here, which is possible, we’ll have to import about one hundred tonnes of food to make sure we can feed everyone comfortably. That’s a lot of money we shouldn’t have to spend.”

“I know, I was just looking at the figures before coming over. The construction schedule slipped last year because of the computer virus and the nuclear attack on Houston, and it still hasn’t recovered.”

“What would you recommend if we decided we’d have to feed 230 in half a year, and to raise our food output to a level to feed 320 a year later? Currently we’ve got the biome space to accommodate 300 people, so housing and work space is in good shape.”

“Hum. We could hurry along the construction of new biomes by installing the foundations but not raising the structure to support the rooftop gardens. Of course, that means we’d have to tear out farmland later to build the housing.”

“We have an all-agricultural biome at Cassini and another one planned for Dawes, with simplified foundations. Right now we’re actually importing food from both outposts. Could we take that approach here, with all-agricultural biomes?”

Alexandra considered. “Don’t forget the new design that eliminates foundations entirely; the biome is built out of a heavy plastic membrane and a bubble that are sewn and glued together.”

“I remember we discussed it. How fast could you build one?”

“We have the hole for Shenandoah just about ready for its foundation, so we could start making the bubble for Dakota right away. It’ll be sixty meters across. Maybe we could complete it and Oregon in fifteen months.”

“Hum. What if we delayed Shenandoah and built them first, or built Shenandoah for agriculture only? That would raise food production more quickly.”

Alexandra frowned. “Will, you’re ripping up the schedule we agreed on months ago.”

“Because we can’t feed everyone adequately, Alexandra. And we must plan for bioarchive. So far we’ve committed pitifully little space to the four sample ecologies we’ve received. If we expect the money to continue to flow, we need to devote half a biome or more to each one.”

“I know, and we’re very far behind. Alright, I know about these plans for biomes without foundations, but I haven’t tried them. Tell you what. We can try them out on Shenandoah and Dakota. That will give us one biome for agriculture in three months and a second in maybe seven months, which will free up more space for bioarchive.”

“Good.” Will smiled. “Please make it so. I’d move Oregon north to the ‘farming belt’ we’ve planned and leave spots for housing biomes to a later time. That’ll give us how much more food?”

“Hum. Fifty-meter Shenandoah will have 1950 square meters and sixty-meter Dakota will have 2800. At 80 square meters per person, they’ll feed about 60 people.”

“That’s about what we’ll need for Columbus 9 if we build two more biomes for housing and include rooftop gardens. Can you give me a preliminary report about this change in plan by tomorrow afternoon?”

Alexandra nodded. “Sure. This is a pretty big change, Will, but I have to admit that agriculture is not keeping up, especially if we get significant growth in two years. Anything else?”

“No. Let’s do a tour of Colorado some time, and maybe an outside tour of the other biome sites, once you’re ready. I want to stay abreast. How are you feeling?”

“Okay. It’s been a rough few days; stressful. But I guess pregnancy is always stressful.”

“Yes, it is, but worth it in the end. Just hang in there, my friend.”

Alexandra had to smile. “Thank you, my friend.”

Will nodded and they exchanged goodbyes. He watched her leave, relieved he hadn’t had to say anything about Dimitri Lyubinin; if she was feeling stress, that could only make it worse. He sat back in his chair and tried to relax; he had another five hours and sixteen minutes of rumbling stomach to go before sunset and suppertime.

Will did his best to keep himself busy with office work the rest of the afternoon, but it wasn’t easy. He was too hungry. He walked the Outpost and stopped to see how everyone was doing. Ethel had a plan for expanding carbonyl extraction of platinum group metals nearly complete. Toru Takahashi, their new computer hardware expert, showed him a room filled with 100 resurrected computers and attachés, all reprogrammed

to work together as a gigantic supercomputer. The computer virus that had struck last year had forced them to repair as many reject computers as possible, then they received a whole new batch in a few months back, resulting in a lot of surplus computer power. The surplus was now assembled into a supercomputer that could analyze seismic and meteorological data, generating better maps of the planetary interior and weather forecasts than ever before. That reduced strain on the communications facilities between Mars and Earth, which otherwise had to transmit vast amounts of data to supercomputers on the home world. It was an important development and a completely unexpected one.

At 5:30 Will went to get the kids and he watched them play while his stomach growled even more. Finally at 7 p.m., with the sun nearing the horizon, he went through the cafeteria line and loaded up on a big supper, grabbing a lot of extra desserts for the small crowd gathering at his house to break the fast together.

Soon others began to arrive: Ananda Thanarat, a Thai who was a third generation Bahá'í; his wife Kim Irion, an American, who had just become a Bahá'í after three years of marriage; Enrique Delrio, Mexican, who became a Bahá'í on Mars about four years earlier; Ethel, Will's wife, who have become a Bahá'í on Mars nine years earlier; and the Elliott children, Marshall and Lizzie. They were about to say prayers before breaking the fast when someone knocked on the door.

"Tomas, what a pleasant surprise," said Will, opening the door.

"Enrique told me of the devotional meeting; can I attend?"

"Of course, come in. We're about to start," replied Will. He ushered in the young man, a horticulturalist from Croatia who was Anna Racan's first cousin. Enrique made room on the couch. And then they began to pray.

Everyone said a Bahá'í prayer or read a prayer or scriptural passage from an interfaith book Ethel had. Then they turned to their food, for the sun had set.

"I'm sorry; I didn't realize it was the Bahá'í fast," said Tomas, embarrassed that he had already eaten supper.

"Oh, don't worry about it; we have apple cake and lemon pie, what would you like?" asked Ethel.

"The lemon cake," replied Tomas.

"You can have more later; we ordered the desserts from the cafeteria specially," added Ethel slicing the lemon cake. "So, how did everyone do this sol?"

"This fast has started off really hard for me," replied Will. "Usually the first sol or two, my stomach growls a lot, and then it adjusts. This sol I had no energy at all for the last two hours of the day."

"You're getting old," replied Ethel in jest. Will was months short of his 50th birthday. "This one wasn't so bad for me."

"How many times have you fasted?" asked Kim.

"This is my eighth fast," replied Ethel. "I skipped the fast in '41 and '43 because I was nursing babies and '42 because I was pregnant."

"This is my. . . 33rd fast," said Will. "No, I take that back, my 32nd. My first fast was when I was fifteen years old, but when I was sixteen I decided I really didn't want to be a Bahá'í and didn't fast, much to my mother's consternation. I skipped the fast in 2027 because of astronaut training and 2030 because I was on the moon."

"What sort of exemptions are those?" asked Enrique.

“Perhaps ‘performing heavy labor.’ I probably should have fasted both times, but it was too complicated.”

“When would you fast on the moon, anyway?” asked Tomas. “Sunrise to sunset doesn’t make any sense!”

“You fast by the clock, 6 a.m. to 6 p.m.,” replied Will.

“What’s the purpose of the fast, anyway?” persisted Tomas.

“It’s a reminder to be detached from this world,” replied Ethel. “We often take our material environment around us for granted. It helps us remember that the real purposes of life are spiritual: perfecting our characters, chipping away at our bad qualities, freeing ourselves from material concerns.”

“I think of it as a kind of spiritual spring cleaning, too,” added Ananda. “Every year I focus on prayer and purge my system of attachments. I’m from Buddhist background, and for Buddhists, desires and cravings are the cause of human suffering. The solution is detachment and freedom from the cares of this world. Fasting helps me achieve that goal.”

“I can appreciate the Bahá'í focus on social and ethical issues, such as equality of the sexes and eliminating prejudice,” exclaimed Tomas. “But no one told me about the spiritual dimension of your faith.”

“What’s a religion without prayer and devotion to God?” asked Ethel. “Social and ethical progress is hampered without spiritual values to keep it on course.”

“Look at the Earth right now,” added Kim. “It’s a mess of political shortsightedness, patriotic selfishness, national egotism, mutual suspicion, and haughty aloofness. But there are Bahá'ís in every nation and we’re united across national and

ethnic lines. It's because we believe in the oneness of humanity and take it seriously as an ethical as well as spiritual principle."

"Like your marriage," added Enrique, referring to Kim, an American, and Ananda, a Thai.

"But there aren't very many of you," noted Tomas.

"The current social crises on Earth is causing a growth spurt," replied Will. "In the twentieth century, membership grew from 100,000 to six million, and the 21st is seeing the pattern continue. Here on Mars there are just five adult Bahá'ís, but three are new members, so we aren't doing too badly."

"Especially since we can't be aggressive in talking to others about the Faith," added Enrique. "Everyone here knows everyone else."

"But that's fine," replied Tomas. "People here aren't very religious, but they have a curiosity, and they aren't opposed to religion like in parts of Europe. It has a place in our society, just like anything else."

"Exactly," said Will.

"But I think you should emphasize the Bahá'í Faith more," said Tomas. "Its teachings seem perfect for Mars."

"We agree; the oneness of humanity is a principle Mars needs," said Will.

"Let's turn to our study topic for the evening," said Ananda. "We have this marvelous new Wilmette Institute course on building unity, and not a lot of time together to study it. We even have a faculty mentor on Earth ready to answer our questions."

7.

Meridiani

early March 2051

Helmut Langlais opened his eyes to the golden light of dawn streaming in through the porthole of his sleeping cubicle. He looked around momentarily to orient himself. Near his head on his right side he had velcroed several photos of his father, brother and late mother. Down by his waist and feet were drawers for his clothes, which also provided a bit of sound insulation from the other sleeping cubicle. He stared up at the domed ceiling a meter above him, which slanted down and became the wall on his left side. His personal space was about the size of a telephone booth laying on its side; small, but if one wanted to avoid cabin fever, one went outside.

The sun had just cracked the horizon. He looked out at Meridiani Planum, undulating terrain covered with cinnamon dust to the horizon, with hills, crater rims, occasional rocks, and dunes—some large—scattered about. Typical Mars. The conestoga was rolling forward robotically at twenty kilometers per hour.

It was time to get up; this sol he would be in the lead vehicle doing road construction. Helmut rolled onto his stomach, pushed open the door at the foot of the bed with his feet, pushed his legs out until they touched a ladder rung, and climbed down into the main area of the conestoga. Two of the three other inhabitants of the conestoga were already there; the four of them included two men and two women, but not, to Helmut's disappointment, his friend Clara. The faint conversation from the room below him had been a factor in awaking him.

Since the bathroom was occupied by Johnny Lind, their commander, he joined them at the table, drinking coffee and orange juice, eating freshly toasted bread driven in by robotic truck from Aurorae the sol before, smothering it with butter from Aurorae cows and jam from Aurorae strawberries, or spreading Aurorae tofu cheese on it. The bathroom door opened and out stepped Lind, showered and dressed; Helmut had to wait his turn as another went in to clean up.

They ate breakfast and talked. Just as Helmut got his twenty minutes in the tiny bathroom, they reached the end of Meridiani Trail. He was getting into the shower as he heard the rear airlock clank in place against the other conestoga; they had to talk with the construction team. When he came out of the shower, fully dressed, he was pleased to see Clara sitting in the main room with six others.

“The assay was one hundred grams per tonne, but the deposit wasn’t very large,” Johnny Lind was saying, describing the gold deposit they had found the sol before twenty kilometers south of the trail. “It may be worth a month or two of extraction work. The potential deposit you’re checking this sol looks to be larger.”

“Scattered deposits are really not very useful,” exclaimed Lal Shankaraman, who was in charge of the other conestoga as well as the entire expedition. “I’m not confident it’ll provide the resources for another borough. Let’s hope Conestoga 4’s hunt goes better. There’s not much new to add about the trail. We cleared fifty klicks yesterday; straight, flat, gravely ground is always easy. But you guys have to thread the route between several large craters this sol, so good luck! I predict twenty five kilometers.”

“No, we’ll manage thirty,” replied Johnny. “Wait and see. It shouldn’t be that bad. We’ve got one arroyo to cross.”

“That one looks tricky, too,” added Lal.

“Nah,” scoffed Johnny, who was notorious for his excessive optimism.

“I want to make a crew change,” said Lal. “Clara will do better work at the road head than on an expedition, and her accounting setup is in the construction conestoga.”

“Okay.” Johnny looked around at the others. “Helmut is rotating onto construction, and this sol we reach the crash site. You can handle that, right?”

Helmut nodded, though he did wonder how it would feel to revisit the site of the sunwing crash two years ago that had killed Guillaume Van De Velde and injured him.

Johnny looked around. “Tanya?”

Tanya Leonov nodded eagerly. “Always glad to do geology instead of road clearing,” she said.

They laughed; geologists always wanted to avoid road clearing. They reviewed recent work, then it was time to switch vehicles. Helmut climbed back up into his cubicle and in two minutes had pulled everything out of drawers and off of shelves. In five minutes he had moved into the identical cubicle in conestoga 2.

“It’s good to see you again,” he said to Clara quickly, when they had a moment of privacy.

“Thanks; good to see you as well,” she replied with a smile. They had managed a few short walks outside, but the resulting privacy came with a pressure-tight barrier between them. On the other hand, one certainly got a good idea of the other person’s character, living in tight quarters with them and two other people. Helmut had been in a conestoga with Clara for a few sols on the drive out and it had been very nice, though it had been sexually frustrating.

“Let’s go,” said Johnny. Helmut nodded; he was the first driver. He sat in the driver’s seat, activated the fuel cells, and started the conestoga forward.

Johnny sat next to him and navigated. The route had been meticulously mapped by a team on Earth, who had reviewed dozens of routes proposed by amateurs and the crude first cuts made by computers. The entire route was photographed by sunwing to ten centimeters resolution and measured by radar to an altitude of a centimeter; all the data was available on a public website. Even so, the terrain did not match the data perfectly and sometimes the driver had to abandon the recommended route.

They started off arrow-straight across the slightly rolling, gravely plain, the conestoga’s bulldozer blades clearing a 4.5 meter wide path free of rocks. Conestoga 3 followed behind, widening the route to eight meters and cleaning up rough spots; finally, a ranger pulling a very heavy roller went over the cleared “trail,” packing it down. Both conestogas often had to stop, back up, and work over an area a second time. Meridiani Trail was a simple dirt track, but because it was straight, wide, and smooth, the speed limit was seventy kilometers per hour for humans and sixty kilometers per hour for computers. Once finished, the five thousand kilometer drive to Dawes would be twenty percent shorter than the old Circumferential Trail and twice as fast.

Soon they approached a cluster of three craters and aimed the trail carefully toward a gap between them. The road clearing became slower and the route had to bend around obstacles. Johnny was driving by then and Helmut navigated, guiding him left or right of boulders and other landmarks. Sometimes they stopped and made judgment calls because the computer projection showed two or three alternate routes, color coded to indicate their rating. Most of the time the grade-A route proved fine, but once they turned

around and followed the grade-B route for two hundred meters because of patch of rough bedrock that had been undetected.

Helmut found it much easier to navigate as morning was succeeded by afternoon. He felt more and more uneasy about the crash site. It made him gloomy about life. He reflected on the inevitability of death, the possibility of disability, the long years stretching ahead of him—he was only 28—the question of how he would top the asteroid mission he was on last year and what great things he would manage to do in the upcoming decades, whether he should stay on Mars, whether he would marry and have children, whether he wanted to have children at all, whether he'd ever see Jupiter or even Saturn later in the century. . . and all the time he wondered about cancer or thought about the coma Guillaume was in after the crash had decompressed the sunwing and robbed his brain of oxygen for four crucial minutes. Sometimes life was macabre.

About four p.m. they entered the lee of a large crater and the character of the terrain changed, from rolling gravel and stonescape to dunes and drifts. They had to steer around frequent dunes that would bog down the wheels. Finally they went around a large dune and Helmut was startled to see they had reached the crash site. "This is the place," he said.

"It sure is," replied Johnny. The plane's skid marks across the drifts was still easy to see a Martian year later.

"Stop there," said Helmut, pointing. Johnny nodded and drove the conestoga over to a long gouge in the ground where the fuselage had come to rest. Except for a few scraps of metal, there was nothing left to see. Their footsteps still covered the ground and only occasionally had been partially filled with wind-blown dust.

Conestoga 3 rolled up, followed by the ranger. They began to suit up. By the time they went out, conestogas 2 and 4 arrived, having completed their geology.

Sixteen men and women soon stood by the gouge in the ground. “There’s not much I remember, actually,” Helmut said to everyone. “We crashed in the middle of the night during a dust storm, so there was nothing to see, and we were evacuated within an hour of dawn by a shuttle. Strange as it is to say, I actually do not recognize this place. Maybe I’ve blocked it from my memory.

“There were five of us on board the sunwing, which lost part of one of its wings when it was hit by a very powerful updraft during a storm. Four of us survived. Guillaume van de Velde was a remarkable man; very funny, he had a good sense of humor, an excellent pilot, and he loved being on Mars.” Helmut felt his voice choke up, so he stopped speaking.

Lal moved closer. “Let’s have a moment of silence,” he suggested.

They all bowed their heads. For two minutes all they could hear over the earphones was breathing. Helmut closed his eyes and the whole experience rushed back. Tears streamed down his cheeks, which he could not wipe away.

“Thank you,” Lal finally said. It seemed like an eternity. “Okay conestoga 1 and 2, you build the berm along the southern edge of the crash site. The rest of us will clean it up and pile rocks along the top. Conestoga 1 can start by building a pile right here.” He pointed to a spot thirty meters from the gouge made by the crash.

“Acknowledged,” said several. But everyone turned to Helmut first. Lal, noting everyone’s concern, embraced him. Everyone else followed.

Then they turned to their work. Johnny and Helmut climbed into their conestoga, followed by Clara, who had to send out emails to everyone reminding them of their afternoon and evening tasks. Johnny let Helmut drive. He lowered the bulldozer blade and drove northward, across the trail, plowing the beginning of a big dirt plaza fifty meters wide. The dirt would form a wall about a meter high, except for a special pile that would serve as a sort of overlook. Helmut began to build that pile on the west end of the plaza while conestoga 2 started on the berm on the eastern end. Others in pressure suits straighten and smoothed the piles with shovels, freed up rocks loosened by the excavation, and constructed a line of stones on top. Meanwhile, in the back of the conestoga, Clara did her best to send emails in spite of the bouncing.

Soon there was a mound of regolith and eolian drift about two and a half meters high and three meters around. Helmut then began to pile up a berm westward from it, widening the plaza. The berm was about thirty meters from the crash site and gave a good view of it; no one would walk past that point, thereby respecting the site.

A half hour before sunset, the oasis construction team—eight men and women—rolled up in their two large, two-story “mobile habs” that provided plenty of work and sleeping space. The eight of them had just finished Margaritifer Oasis seven hundred kilometers to the west. It consisted of a buried metal and plastic Quonset hut of Martian manufacture ten meters long and wide, with its own simple life support system; a landing strip for sunwings; a small cache of frozen food; two wind turbines on a high local prominence able to make about forty kilowatt-hours of power per sol, two or three times that much in dust storms; a microwave power transmitter and matching receiver, so that the oasis could send excess power elsewhere via Phobos or receive power; a water well

and water tank; liquid oxygen and methane tanks; and a fuel making system that could make oxygen and methane from water and carbon dioxide. Meridiani Trail would have six such oases, one about every seven hundred kilometers. Once the system was completed and extended from Dawes to Cassini, vehicles would be able to drive among Mars's three outposts without hauling along a nuclear reactor or impossibly large fuel tanks. As traffic increased they'd beam more power to the oases and make more fuel at them. The system had disadvantages: it would require a full-time staffer to maintain the oases and direct the power. But if it worked, seven thousand kilometers of trail would be open to potential settlement—indeed, residency at the oases might even be encouraged some day—and the system could be extended all the way around Mars.

Right behind the mobilhabs came a robotic truck pulling the materials for constructing Meridiani Oasis. A minute later the expedition's second 100-kilowatt reactor rolled up under its own control. The entire Meridiani team and its equipment was now in one place, for the first time in three weeks. The two mobilhabs pulled up next to each other and docked, followed by the conestogas, making a chain of vehicles.

"Let's go join the party," said Johnny, once their vehicle was docked.

"I'll be along in a second," said Clara. "Where's the ranger? They're supposed to dock to our airlock."

"He's pulling around now," said Helmut, pointing. "I can stay to verify the connection."

"No, I'll do it," replied Clara.

“While you two fight about it, I’m heading to the party,” replied Johnny. He opened the right-hand pressure door, pushed the other vehicle’s pressure door open, and closed both behind him.

Helmut and Clara watched the television screen as the expedition’s sole ranger backed up to the airlock. A spacesuited figure was directing, then stopped it and began to latch the sleeve in place.

“How are you doing?” asked Clara.

Helmut shrugged. “I didn’t think this would bother me at all, then it hit me like a tonne of bricks. I was embarrassed.”

“Oh, don’t worry. It’s understandable.” She reached over and massaged his shoulder. He smiled, appreciative of the affectionate gesture. Then she leaned over and kissed him.

He was momentarily startled. He looked at her, then reached over to embrace her and they kissed passionately.

They separated and looked at each other. Helmut wasn’t sure he felt a rush from his pent-up longing for her or a release from the intensity of his grief; but looking at her, he felt a heat he’d never felt before. He kissed her again, even more passionately this time, and she reciprocated. Weeks of close contact in a never-private space were finding their result.

Clank! Clank! The latches began to fall in place, attaching the airlocks together. Startled, they both looked up. Their privacy was waning, bolt by bolt. Helmut had to monitor the work; he shrugged to her and turned back to the computer screen. It showed half the latches in place, all properly.

“Docking complete,” he said when the last one was done. “Ranger 1, you are go to pressurize the connection.”

“Acknowledged,” replied Sandy Richardson, a construction worker who was in the ranger. A moment later the short, half-meter long tunnel began to fill with air. In a minute it reached atmospheric pressure. They confirmed pressurization and she came across.

“Thanks, Helmut,” she said. Helmut and Clara nodded and watched her walk through the conestoga, then exit through the right door.

Helmut turned back to Clara and they kissed again. Then she pulled back slightly. “They’ll wonder where we are; we had better join the party.” She pointed to the airlock leading to the ranger. “There’s always tonight.”

“Isn’t someone sleeping there?”

Clara smiled. “No. I’m sure, because I’m in charge of the bunk assignments.”

“We’ll have to wait until everyone has gone to bed, and that may be late; I bet there will be a crowd in here watching television until midnight.”

“Or playing bridge. But the airlock and bathroom doors sound the same.”

“Lal won’t approve,” said Helmut. He looked at her, then shrugged. She giggled.

8

Changes of Heart

mid March 2050

Anna Racan had always been one to rise at dawn, and the new baby had not changed the habit, even if two-month old John didn't sleep well at night. Having just fed him, and noting that the sky was suddenly brightening—a sure sign the sun was nearing the horizon—she left the baby sleeping on top of Greg, pulled on a stylish nightgown, and walked to the Patio in Yalta to get breakfast for both of them.

The Patio was almost deserted, as it always was when dawn rays stretched across the biome and bounced off the silvery insulating blanket covering its western side. That morning the Bahá'ís were gathered around two tables pushed together, and having finished their breakfast just before sunrise, were praying, an activity that did not seem to offend the other early risers. Anna barely noticed them; they had been there every morning for the last ten sols. But then she spotted her cousin Tomas seated with them, and that startled her. She stopped to look more closely and could see that he, too, had eaten breakfast before dawn.

She slipped into the cafeteria and quickly filled a plate with breakfast items, scanned the tray to pay for it, and hurried back home to tell Greg, who shrugged.

She worried much more at lunchtime, however, when Tomas didn't show up to eat. She and Greg were finished with their supper and were about to leave, at sunset, when Tomas arrived.

"Where have you been? We were looking for you," she said when he reached their table with food, just as the sun was disappearing.

“I worked late.” Tomas sighed. “The new robots can’t pick beans right; the image recognition software is identifying only the very ripe ones. So I was picking all sol.”

“A major waste of time,” said Greg.

“Were you fasting this sol?” Anna asked point blank.

“What?” Tomas was surprised and looked a bit guilty as well. “Why do you ask that? Sometimes work forces a change in eating habits.”

“Sometimes it does, but when I arrived here to get breakfast this morning I saw you seated with the Bahá'ís.”

“So? They’re very nice people with a good religion. I decided to try fasting this sol after having breakfast before dawn with them.”

“Why? That’s not a natural thing to do, fasting’s not healthy, and it’s not a Christian custom anyway.”

“It’s perfectly healthy, Anna. I did fine with it, actually. And it isn’t that different from Lent.”

“Except we eat and drink something,” replied Greg.

“I’m just worried,” said Anna. “I don’t want you. . . swayed.”

“Swayed?” Tomas was irritated by that. “It’s my choice what I believe, right?”

“Well, yes, of course, but I’m concerned anyway. Are you interested in Bahá'í?”

“Maybe some.” He was non-committal. “I’ll put it this way, cousin. How would you compare the two religions. One teaches that Jesus is a member of the trinity, that he saved us from sins, that he created a way of salvation through the church, that his mother was a virgin. The other teaches equality of races and sexes, spiritual solutions to economic questions, a plan for world peace, a world governing system, the importance of

education, the need to struggle against racial and other biases. . . which set of teachings do you think is more relevant?"

"Tomas, that's not a fair comparison!"

"Besides, Bahá'ís can't offer salvation, and Christians can believe in all the things you list," said Greg.

"Then why don't they?"

"And you think the Bahá'ís are perfect?" retorted Greg.

"No, but at least they aren't a church struggling with some ideas that are five hundred years out of date, pretending everything is fine while the number of priests plummets and the whole institution rots from within."

"They weren't around five hundred years ago, and may not be five hundred years from now either."

"Oh, I don't know about that, Greg. They're growing fast on Earth right now."

"It's a temporary growth spurt."

"Tomas, are you thinking about leaving the church?" asked Anna, upset.

He shrugged. "I don't know."

Anna looked at Greg, worried. He looked back at her. "Well, this is a free place, and we'll love you either way," Greg finally said. "You're our only family up here."

Tomas smiled. "Thank you. Both of you are very important to me and I love you both. I'm sorry if my remarks hurt you."

"That's alright," replied Anna. She leaned over and kissed her cousin, though she still seemed distant and worried.

"How was your sol?" he said to both of them.

Greg shrugged. “Reasonably good. It’s the busy time; usually the hard-core problems adjusting to Mars emerge about four or five months after people arrive. So I have a stream of people seeking help because their marriage is under strain, or their girlfriend just left them, or they’ve realized they can’t make ends meet here with an income of 300,000 redbacks per year.”

“But at least John’s sleeping better at night,” added Anna, looking at her baby.

“Both of us,” added Greg. He looked at Tomas. “Did you hear the latest news?”

“What?”

“It looks like the House of Representatives will impeach President White.”

Tomas looked delighted. “Good; the U.S. would be better off without the idiot.”

“I agree, but it doesn’t look good when the legislature tries to impeach three of the last five Presidents. Besides, it weakens the government at a time when it has to be strong. That’ll slow economic recovery.”

“They say unemployment in the U.S. has now hit sixteen percent, and in Europe it’s eighteen,” added Anna. “Not to mention what the depression has does to Latin and African economies, which are so much weaker.”

Their conversation trailed off at that point. Tomas started to wolf down his food; a sol of fasting had made him hungry. Anna looked at Greg, then rose. “We’ve got to get home and prepare the baby for the night,” she said.

“Okay, see you at breakfast tomorrow,” replied Tomas.

“Bye,” added Greg, standing up. He took John from Anna, and the two of them headed across the patio toward home.

“I’m afraid the church will lose him,” Anna finally said to Greg, once they were out of earshot.

Greg sighed. “Maybe. But remember, it’s his choice.”

“Yes, but it would be embarrassing to have the cousin of the only Catholic priest on Mars convert to Bahá'í.”

Greg shrugged. “It’s a free world, dear. Let’s have no inquisitions on Mars. It’ll be harder to associate with him, though, since we talk about the church so much.”

Will was rubbing his right cheek and jaw delicately when he walked into Ruhullah’s office. The local anesthetic was beginning to wear off and the tooth was beginning to hurt. “Anything new?”

Ruhullah Islami looked up from his desk. “No. Lal called me because he was trying to reach you. How was the appointment?”

“This was the worst dental experience I’ve had in twenty years. The cavity was very small, but was in an awkward spot below the gum line and Elsa couldn’t numb it up. She had to give me five shots! And we had to wait between each one to see whether it was working.”

“You were gone a long time.”

“Two hours! Now the morning’s shot! And I’m in a foul mood. Dental visits usually do that. They remind me of my mortality.”

Ruhullah laughed. “Oh, come on, Will! It was just a little cavity.”

Will smiled. “I suppose that’s true. I guess I can catch up this afternoon.”

“Sure. Alexandra was here to give you a report about Dakota Biome, so she gave it to me. They plan to inflate the enclosure next week.”

“Wow! This new simplified approach is working, then.”

“Yes. She’s pleased. Dimitri clearly is happy. I checked the food production schedule; Lisa revised the numbers upward. So we will have better food production.”

“What did Lal want?”

“He didn’t say.” Ruhullah was now in charge of sol-to-sol operations at Aurorae; it freed Will to manage the entire Commission. But the Meridiani Expedition was Will’s responsibility.

“I’ll call him, then.” Will waved and headed up the stairs to his office on the top floor. He kept rubbing his cheek; it still hurt. But his mood was improving.

He entered his office and sat. His attaché, as he feared, had half a dozen messages. All of them had to do with the “stretched shuttle” or “Hermes model” as they were calling the new design. Engineers at the Venus-Mercury Commission and the Mars Commission were recommending updates to the engine; they’d cost three hundred million redbacks, but sounded like a good idea. He sent a few questions. Another message detailed the advantages of the new seven-meter height of the cargo hold. Two companies had completed proposals for an aeroshield that gave better performance and maneuverability. It was hard to believe the first model would be ready for Columbus 9.

Then a flashing icon appeared; it was a news flash from one of the media companies Louisa Turner used. He started to read the article, but before he finished a videomail from Louisa arrived.

"Will, did you see the news! President White has decided that survival is more important than principle. Six moderate Republicans in the Senate said they'd vote with the Democrats for impeachment unless he agreed to radical changes in policy and personnel, including replacement of the Secretaries of Defense, State, and Treasury, and the Attorney-General, and would vote with the Democrats for the rest of the President's term if he reneged. There's a similar group inside the House of Representatives as well, but they didn't have the guts to go public. The polls support them, too; the President's popularity has fallen to 19%. Everyone in big business is ready to revolt because of his economic policies and isolationism. We're calling our contacts to see whether these changes will result in a new space policy. I'll call Brian Stark, too. He has been talking to everyone. Bye."

Will immediately hit reply. "Louisa, yes, I just saw the news. Very interesting. I'll follow it up here. Let's remind everyone we want cooperation in space. The price of gold won't stay high forever; we need United States involvement and financial support in the Commission, but without compromising our essential concerns. I'd emphasize that. Bye."

Will pondered the political news a moment, wondering whether Americans would realize their democracy wasn't so infallible after all, and that they needed the rest of the world to prosper. He sighed and called Lal. The Indian answered right away. "Governor, thanks for returning my call! How are you this sol?"

"Not bad, for someone who just had his tooth drilled without proper anesthetic. You guys are where? Meridiani Oasis?"

"Correct. We stopped last night to set up Meridiani Oasis; we'll be here two sols to rest, then we'll clear the trail to the Opportunity landing site, then on to Dawes in two

more months. We just set up the microwave transceiver this morning so that we can beam surplus power to Dawes."

"So, all is well?"

"Yes. We have a budding romance and I'm afraid it became more public than expected, but they're dealing with the embarrassment pretty well. I called to give you the news. We now have seven gold finds scattered across Margaritifer and Meridiani, and the quantities aren't bad."

"Yes, I've been following the reports closely. Your work is going to pay the bills, Lal. I just got another estimate for the Hermes model shuttle; expenses are going up. We'll open up the entire area to bids in May or June. If there's enough gold in one spot to support a permanent settlement, we'll name one, but otherwise the plan is to go after the gold using mobilhabs or temporary surface housing."

"We're talking about 1 or 2 million square kilometers of area; that's worth a lot of money!"

"Billions! Meridiani Trail opens up a lot of choice territory. We could establish five boroughs. So keep up the good work. What happened with the couple?"

"They sneaked into a ranger last night for. . . perhaps we shouldn't speculate why? They needed. . . privacy. But unfortunately for them the pressure alarm for the connection between the ranger and the conestoga went off. One could speculate that a lot of movement in the ranger jiggled the pressure sleeve loose, but that might be unfair."

Will laughed. "So much for privacy! And I suppose the alarm woke up everyone?"

"Pretty much."

“Oh, my. I don’t need to know who they are, but please extend my condolences if they will be comforted by it.”

Lal laughed. “I’m not sure they want it! Have a good sol, Will.”

“You too, Lal. Bye.” Will chuckled as he closed the circuit. They had come a long way from Columbus 1, when a romance between the Commander and Vice Commander had become a personnel crisis.

He turned back to routine work, reviewing the argument that Cassini needed a third biome, considering the schedule of the next borough meeting and the Mars general election, and approving the text of a proclamation making Equinox—the northern spring equinox—a paid holiday. He was wading through the fourth draft of a new policy allowing Martian residents a round trip flight to Earth every ten columbiads—22 years—when his attaché beeped with a videomail from Earth. He was surprised to see it was a call from the Administrator of NASA, Charles Kerns.

“Good sol, Dr. Elliott,” he began, carefully avoiding such titles as “Governor” and “Acting Commissioner” that NASA had rejected in the past. “Recently, we have been reviewing NASA’s future. Argo 1 has been an immense success; it’ll land on a third near-earth asteroid in a few weeks, then head home. Argo 2 departs in six months with a LANTR engine, a bigger supply of fuel, and a new fuel manufacturing system. If it refuels itself as it goes it should be able to visit four near earth asteroids in thirty months.

“But at that point NASA may leave the exploration of Earth-crossers to others; both the Brazilians and Indians are interested, as are two commercial ventures. So we want to venture farther, to the asteroid belt and Jupiter. A staffed outpost on Callisto could accomplish a hundred times more science in Jovian space than robots controlled

from Earth. To get ready for an expedition like that by 2065—fourteen years from now—we will need improved propulsion systems, longer-lived life support systems, and experience with ultra-cold conditions. Nuclear-powered variable specific impulse electric propulsion will solve the first and the Martian poles and the asteroids are key to the third.

"Mars is a natural player in the effort. Expeditions to the asteroid belts should be launched from Mars; the delta-vee is lower and the fuel supply at Phobos and Deimos is abundant and relatively inexpensive. Therefore we are interested in opening negotiations with the Mars Commission about collaboration. Ceres or Vesta are the first mission targets. I'm sending you this informal videomail before beginning an exchange of details and actual negotiation about who will do what. We would be open to collaboration with India or Brazil, maybe even Europe and Russia if the breach can be repaired. We'd prefer to spread the cost.

"I look forward to hearing from you at your earliest possible convenience about this plan. Goodbye."

Will stared, stunned. Was this the same NASA that had tried to block the Hermes shuttle and collaboration with the Mercury-Venus Commission ? That had insisted on a hand-picked American head of the Mars Commission who was unacceptable to everyone else? That had tried to take over Mars operations and install a uranium separation facility that would provide bomb-grade U-235 to American military facilities in Earth orbit? Clearly, major changes were happening in Washington.

Will forwarded the message to Louisa Turner, Pierre Messier and Ruhullah for comments. Curious, he turned to Astrolabe, their interplanetary navigation system. From Embarcadero, a Hohmann minimum-energy trajectory to Ceres required 4 kilometers per

second and a one-way trip time of 1.3 years. Landing on Ceres required 2.7 kilometers per second; thus the one-way delta-v was 6.7 kilometers per second, less than from the Martian surface to Earth. A launch opportunity came along every three years; the next one was in 2053. Ceres had abundant water and carbon dioxide for life support and propellant, but the sunlight was too weak for agriculture.

Ruhullah knocked on his door. “Either they’re trying to trick us, or their position has collapsed.”

“Haven’t you heard the news? Six moderate Republican Senators went to White and said they’d vote for impeachment unless he changed his policies. I think Kerns is activating old plans he thinks will now be approved.”

“He isn’t one of the extremists. I wouldn’t give them anything unless they stop trying to block us.”

“Of course, they have to cooperate fully or they’re out. We could always work with the Chinese. How does ‘Mars-Asteroid Commission’ sound to you?”

Ruhullah laughed. “Or even Mars-Jupiter Commission!”

“Exactly. The technologies that are needed for asteroid belt operations would be helpful for us, such as larger habs and five to ten-megawatt deep space reactors with variable specific impulse electric propulsion, and Mars is the obvious port of call for all asteroid missions.”

Ruhullah nodded. Just then Will’s videophone beeped. “Ah, here’s Pierre’s reaction,” said Will. He pushed the play icon.

Pierre Messier sat behind his desk in his Paris office, and Louisa Turner sat next to him. “Louisa just dashed into my office, interrupting a very important meeting—well,

it was with my teenage daughter—to tell me to listen to your call from Kerns," he said. "We're flabbergasted."

"It's hard to say what to make of it," added Louisa. "They're probably serious, at least to the extent that they can get good press from the effort in order to prove to the world that they really aren't a bunch of closed-minded bigots who have never had a passport and never left the beloved U. S. of A."

"In other words, she counsels caution," replied Pierre. "I suggest that we be positive but noncommittal. Send Soderblom; he's the Vice Director for Government Relations."

"But no publicity; they have to earn it," said Louisa. "And I'd link this cooperation with a bunch of other matters, like the Hermes shuttle and immediate resolution of the question of who will be Commissioner. Otherwise this can wait."

"And we have to see the money!" exclaimed Pierre.

The two of them paused. "That's all we can think of," Pierre finally said. "Let us know your decision."

Will turned to Ruhullah. "Sounds like good advice. Soderblom can handle Kerns."

Ruhullah nodded. "A face-to-face negotiation would give us more details."

"Okay." Will sat at his desk and pulled up the message again. He listened one more time and jotted a few notes. Then he recorded a response to Kerns and blind-copied Messier, Turner, and Soderblom. "Good morning, Administrator Kerns," he began. "It's good to hear from you. I think we haven't spoken in person since 2032 or so, at the Mars

Science Conference we both attended. A lot of things have happened in nineteen years, haven't they? The world has changed dramatically.

"I'm delighted that cooperation may finally prove possible between our two agencies. We have always welcomed everyone to participate in the exploration and settlement of Mars within the framework of the international treaty that the United States has signed. We regret the U.S. has been unable to participate more fully in the last year or so. As a result, all of us have missed opportunities for exploration and new technology.

"We welcome collaboration in exploration of the asteroid belt. We'd also like to see the United States encourage cooperation in many other areas of space exploration, such as the exploration of Mercury and Venus, the Hermes Shuttle, and the effective functioning of the Mars Commission. We'd like to hear from you about these matters as well. Krister Soderblom, our Vice Director for Governmental Relations, will contact you. You are free to contact me directly as well. Goodbye."

9

Equinox

late March 2051

The afternoon sunshine was beginning to slant across the floor of Mars Control's conference room when Will and his senior staff began to gather there. "This should be a pretty fast meeting," Will said.

"It had better be fast; Equinox starts in four and a half hours, and I have a few things to do," said Yevgeny unhappily.

"I'm ready," added Ruhullah. He had several sheets of electronic paper spread out in front of him. He clicked on the corner of one with his stylus and wrote out the date and time; his attaché converted the handwriting to type and projected it onto the wall screen. Everyone chuckled; Ruhullah had become their master note-taker.

"I'll start," said Alexandra. "Construction is back on schedule. Shenandoah is inflated and we are preparing it for agriculture. Building foundations have been installed and we will get the frames up gradually between other tasks."

"How can you do construction in an agricultural area?" asked Ruhullah, curious.

"The sites of the future buildings are occupied by large planter boxes we can move. With our larger construction crew, the new equipment that arrived last fall, the simplified foundations, and the lower air pressure, we will be able to complete a sixty-meter agricultural biome every three months. Dakota will inflate in late June, Oregon in late September, Kauai in late December. Columbia, a housing biome with more complicated foundations, will pressurize in late May of next year. Then we'll start on our first seventy-five meter biome, Cochabamba, which will be a housing enclosure north of

Catalina and Shikoku. It should be ready when Columbus 9 arrives in December. At that point Aurorae Outpost will have over 30,000 square meters of pressurized space. Right now we have 12,000."

She stopped to let it sink in; everyone was impressed. "Will we be able to walk around in the agricultural biomes?" asked Érico.

"Their air pressure will be half standard; 0.16 atmospheres. When the effect of humidity is included, you'll get half the oxygen of terrestrial sea level and two thirds what you're getting in this room right now. You could stroll, but I wouldn't jog. That's the minimum needed for flying insects and workers."

"How much space for bio-archive?" asked Lisa.

"Five thousand square meters. In two years we'll start building biomes exclusively for bio-archive and they'll use standard atmosphere. "

"How many square meters for agriculture per capita?" asked Ruhullah.

"When this expansion is complete, we'll have 100 square meters of interior space per person, but some will be parkland and transportation space. Agriculture will get 88 square meters, which is ten percent over the minimum."

"That'll give us more flexibility," added Lisa. "The biome space will provide some products as well."

"And that doesn't include Cassini and Dawes," added Alexandra. "They'll both have two biomes and 120 square meters of pressurized space per person."

"Which is the reason the agriculture there is focusing on chicken and beef production; they can raise animal feed," said Lisa.

“Yes, the other sol I got an email saying Dawes planned to export a tonne of beef to the moon!” Yevgeny laughed. “I replied that they should sell it to Aurorae for a million redbacks a tonne!”

They all laughed, but Lisa reacted defensively. “We’re now consuming 500 kg of beef a month here. When Columbus 8 arrived we were temporarily down to 65 square meters of agriculture per person, so we had to focus on the high-productivity staples, like tomatoes and potatoes, and we were serving three lunches a week of dehydrated food imported from Earth. With 88 square meters per person we may have the opposite concern; meat and sugar consumption will go up and we may get fat!”

“I’d prefer that!” replied Yevgeny. People laughed again.

“The bottom line is that we can now stay ahead of any population growth we anticipate,” concluded Alexandra. “So we can anticipate more recreational space, improved quality food, and entire biomes dedicated to bioarchive.”

“Great,” said Will. “Yevgeny, update us on gold production.”

“So far, production is running eight tonnes per month, whereas during Columbus 7 we averaged eleven. There are three reasons: everyone has exploited the richest deposits, they worked extra long hours before the last flight back to Earth, and recently everyone’s been busy putting together the new equipment and learning how to use it. But production should start to pick up.”

“The remaining deposits are still much richer than anything on Earth,” commented Lisa.

“Oh, yes. An army of technicians on Earth has been putting together gold deposit maps for each company. They know exactly what lies within five meters of the surface

and what order they want to dig the deposits. Every time the top five meters is peeled off and exploited, the neutron activation sensors are run over the new surface and the map's updated. But the word on everyone's lips is 'Meridiani.' The trail is almost finished through the gold fields, which are scattered and small but rich. We'll be putting them up for bid next month and mobilhabs with gold processing equipment will be on their way a month later."

"Are we establishing a borough there?" asked Ruhullah, looking at Will.

"A single outpost may not be the best arrangement. If there is no single deposit large enough to split between the companies, they may not be able to agree on a central location for an outpost and we may have to set up two."

"Will, are we getting a larger shuttle?" asked Lisa.

"Yes. Columbus 9 will arrive with three Hermes-class shuttles. Two of them are existing vehicles with new cargo holds and Hermes engines. The landing system will be stronger, too. I was thinking we should name the new model for Martian valleys."

"Kasei, Nirgal. . . that would be good," agreed Ruhullah. "We've run out of significant volcanoes."

"Have the plans for Columbus 9 been finalized with the government representatives?" asked Érico.

Will nodded. "Tentatively. Columbus 9 will involve two separate complexes, arriving three sols apart. We're getting about 100 arrivals."

"One hundred!" said Alexandra. "Wow!"

"And three hundred fifty tonnes of arriving cargo," added Yevgeny. "We hope to export that much gold, a hundred tonnes of methane from the moons, and a hundred tonnes of nitrogen, argon, deuterium, platinum-group metals, beef, and furniture."

"Will, what's the situation with the U.S.?" asked Ruhullah. "Have they really changed?"

"The evidence is good. You've seen the news: the President fired half his cabinet, ended the trade war with Europe, appointed a new ambassador to the United Nations, and is pulling the troops out of Turanistan. The Lunar Commission met last week. Sebastian told me the U.S. pledged to restore funds for the lunar interferometric optical telescope system. We've been told privately the U.S. will restore its Mars funding if we agree to a south polar station where materials and systems can be tested in the extreme cold, and if we beef up our commitment to bioarchive. They're developing a compact twenty-tonne, five-megawatt space power reactor, and will consider selling us one. They're initiating a five-year project to develop VASIMR—variable specific impulse magnetoplasma rockets—which can generate reasonable thrusts and high performance if they have five megawatts of power."

"That may make faster trips between Mars and Earth possible," said Érico.

"They've reapplied for membership in the Venus-Mercury Commission," added Will. "It's possible American astronauts will be going back to Venus orbit in a few years. They'll contribute to the development of Hermes so that some contracts are awarded to American firms. The second or third Mercury mission may include an American and the next Argo will include a European. Argo is being expanded to the asteroid belt, so the

first mission to Ceres or Vesta will probably be multinational. Let's hope that mission will come via Mars."

"A contract for habs or biomes would be good, too," reminded Alexandra.

"Any idea when we'll have a new Commissioner?" asked Yevgeny.

"Probably a month to six weeks. The negotiations have started. The U.S. is still holding out for an American, but the candidates have not worked out."

"You're an American," observed Alexandra.

Will smiled. "Yes, but I'm still the enemy. Maybe a Canadian will be the compromise." He glanced at his watch. "One more thing. Tomorrow I'll announce changes in some of our work rules. I'm increasing family leave to one year to be split between the parents. I hope that will increase our birth rate; I'd like to see it reach two children per couple. I'm announcing a free return flight to Earth and back to Mars to anyone who has resided here nine columbiads or nineteen years. That will mean our college-age kids will be able to go to Earth for university and return if they want. Their spouse can fly here for free if someone donates a ticket."

Everyone was surprised. "I'd worry whether it will encourage people to leave permanently," mused Érico.

"It'll be expensive," observed Ruhullah.

"That's why I'm announcing it while I'm still acting Commissioner, and before a new one's appointed! I think it'll prove manageable if our flights keep getting larger. No one's eligible yet. It'd make a nice vacation opportunity or a Sabbatical." He looked at the others. "Anything else?"

“I have an announcement, too,” said Érico. “At the town meeting next week, I plan to resign as Clerk of the Borough. I’ve done it a decade and it’s been long enough.”

“Really?” said Alexandra. “I’ve been thinking of resigning as Borough Chair because of the baby.”

“I thought you were giving it up?” said Lisa, surprised.

Alexandra hesitated, so Yevgeny spoke up. “We think we’ll keep him. If so, I’ll be taking most of the parental leave Will has extended.”

“Congratulations,” said Will, trying not to look too pleased, as that could appear to be interference. “Children are a real blessing.”

“In between the pain,” added Érico.

“It sounds like the elections next month will be exciting,” said Will.

Long sunbeams stretched across Yalta Biome as Will, Ethel, Marshall, and Lizzie headed for the function room in the basement of the north building. It consisted of their old flat. “What great decorations!” said Will to Kim and Ananda, who had devoted the afternoon to beautify the space for their Bahá'í New Year’s party, or Naw-Rúz.

“Thanks,” replied Ananda. “Some of these are left over equinox decorations.” The northern spring equinox on Mars was a big holiday; Bahá'í new years was always on the Earth’s northern hemisphere vernal equinox, or March 21. Coincidentally, this year the two were only a week apart.

“It does feel right for Naw-Ruz,” agreed Will.

“Tomas made the banners with the Bahá’í quotations,” said Kim. “He was here much of the afternoon decorating; he’s in the cafeteria right now to get the food for us.”

“He was at our house last night until midnight asking questions,” added Ananda. “I think he’s ready to declare.”

“Really?” said Ethel. She looked at Will. “That should be interesting.”

“It’s a free world,” replied Will, shrugging. “We didn’t ram it down his throat. When Enrique declared, no one was upset.”

“He wasn’t the cousin of the priest,” replied Ethel.

“We’ll see. What are you doing for tomorrow?”

“Us?” replied Kim. “I think we’ll play a round of golf, then come in and relax.”

“If you want to come to our place in the afternoon, feel free,” said Will, looking at Enrique as well. “I’m devoting the morning to cooking a turkey dinner.”

“Really? I didn’t know you could cook!” replied Ananda.

“Will’s incredibly good,” replied Ethel. “It’s one reason I married him. His cooking saved Columbus 1 from social disaster.”

“Really?” asked Kim, intrigued.

“I guess it’s something I can go back to, if I ever retire as Governor!”

The door opened and in came Tomas and Enrique bearing large trays of refreshments: vegetables, cold cuts, bread, salad, cakes, cookies, and fruit. Tomas was beaming. “Come on, say something,” Enrique said to him, nudging Tomas a bit.

“Oh, alright,” replied Tomas. He looked at the others and shrugged. “I’m a Bahá'í! I’ve signed my declaration card!”

“Really! Congratulations!” said Will. They all came up and hugged him.

“There are now six of us on Mars,” said Ethel. “This is very good news. Welcome, Tomas.”

“Thanks. But let’s not make it public yet. I have to tell Greg and Anna, and I need to wait a month or so.”

“However you want it,” replied Will.

“Thanks. Is there anything else I have to do?”

“Give the card to Ethel,” replied Will. “She’s our correspondent. But I think we can enroll you easily enough; we know that your heart’s in the right place, and you have the basic knowledge.”

“There’s so much to learn!” exclaimed Tomas.

“A lifetime of learning,” agreed Enrique. “No one ever learns it all.”

“It’s a process,” agreed Will. “Ananda and I were raised in Bahá'í families and we’re still learning.”

“I was wondering whether I could invite people to the Satursol institute class,” said Tomas. “I was talking to Robert Wairimu and he’s interested. I think Toru Takahashi might come, too. The Bahá'í teachings are so obvious; I don’t know why everyone doesn’t accept them!”

“Maybe it’s us,” replied Ethel. “We’ve been very quiet. Maybe we should be more active.”

“Well, it’s a new year,” replied Will. “We can make a New Year’s resolution to be more active. I think we should start strengthening our devotional meeting by adding some food after it, and discussion.”

“I like that idea,” agreed Kim. She was beaming; they were all immensely excited that someone else had accepted their Faith. Their new year’s celebration would have an energy it had never had before.

10.

Elections

early April 2051

The cameras at Embarcadero captured the firing of the engines quite well; methane and oxygen burned a bright orange-tinted blue. The *Apollonaris* and *Tharsis* accelerated rapidly from Mars's interplanetary transit facility, then shut off their engines almost simultaneously three minutes later.

"The burn looks perfect," reported Daichi Furukawa, pilot of the *Apollonaris.*

"We copy, *Apollonaris,*" replied Rostam Khan, in Mars Control. "Doppler radar shows the burn was within a centimeter per second of the planned delta-v."

"Same here," added Hutan Hijazi, commander of the mission, who was located on the *Tharsis.* "Not bad; we'll refine it later. 2021BH, here we come."

"Congratulations, guys," said Will, from the control room. "Be careful and stay safe."

"Don't worry, we're missing Dusty Red already," replied Hutan, whose wife and son lived in Aurorae.

"You're in our prayers, Hutan."

"Thanks, Will."

Elliott turned to the screen. The vehicles were rapidly shrinking in size. In the next few hours they would dock together nose to nose and spin at four revolutions per minute to create artificial gravity for the three-month cruise. Twenty-five kilometers long, 2021BH—now being called Quirinus, a title for the god Mars—would be the largest body ever visited from Mars. It orbited just beyond Mars, so the mission was the

first visit to an asteroid belt object. Quirinus formed from the collision of a chondritic body with a nickel-iron body, so the worldlet had both precious metals and a potential source of rocket fuel.

Will stayed in the control room to listen to the shut down of the propulsion system and the reports from the various navigational satellites. The mission was indeed on its way safely. Then he headed across the hall to the conference room to work, where he would be within earshot of any important developments. He always worked there when something important was happening.

Congratulations began to arrive soon thereafter. “A beautiful launch, Will,” said Louisa Turner. “We got a half decent audience in Japan, where it’s evening, and a good audience in Arab countries, thanks to Hutan’s role as commander. We can expect some editorials about Mars as the equal opportunity world, where Americans and Europeans don’t always dominate. Our new production director did a great job; Skip’s advice was useful. He mixed the shots during the burn, sometimes showing Embarcadero shrinking, sometimes showing the engines blazing away; it was dramatic! Maybe you’ve convinced me that these deep space missions are worth the risk. Bye.”

That was quite a concession; Louisa had been the consistent lone voice against exploration beyond Mars’s moons. Will thanked her, then turned to a video message Hans Muller, whose mining company was one of the three on Mars. “Good sol, Will. I was just watching the Quirinus mission on television; congratulations for a great launch. I do hope you plan to claim the asteroid for the Commission because it has great mining potential. Muller mining and its resources—its profits and credit limit—are committed to

Mars. We'd like to partner with you, and asteroid mining is the next frontier. Let us know what we can do. Bye."

Muller had expressed the same thought several times before. Will hit reply. "Good morning, Hans. Thank you again for your warm words and especially for your support and collaboration. The mission will bury a ten-meter annex bubble to shield it from micrometeoroids. They'll establish a volatiles well. A mineral rights claim will probably stand up in court if we leave a useable facility. But can the Commission make a claim to 'sovereign rights' as an intergovernmental agency? Can the crew, as residents of Mars, claim Quirinus for the Mars Council? These issues have to be settled in court. Furthermore, the technology doesn't yet exist to extract Quirinus's platinum more cheaply than from nickel-iron bodies lying all over the moon and Mars. Self-repairing robotic digger-processors may be decades away. So any claim may be premature. Bye."

He sent the reply and saw that a third message had popped into his box, from Charles Kerns. The NASA Administrator was white-haired, with a trim, gray goatee. "Good sol, Dr. Elliott, and congratulations on the Quirinus launch. It's a milestone, considering Quirinus's mineral potential and its elliptical orbit, which carries it as far as the orbit of Ceres and Vesta.

"This makes it even more important for us to collaborate. Next week the President will give a major space policy speech. He'll announce Odyssey, a project to build, in the next fifteen years, a vehicle capable of sustaining a crew of at least twenty-four independently for a minimum of five years with a propulsion system capable of taking it as far as Jupiter. We should be issuing vehicle specifications in a few months. Odyssey vehicles could transport larger numbers of people to Mars, and the propulsion system

could shorten transport time. A Martian south polar station to test equipment for the Galilean satellites is part of Odyssey. Looking forward to our continued collaboration."

It was an upbeat, friendly message. But removed from the negotiations by the speed of light, he could not get deeply involved. Will hit reply. "Thanks, Charles, we appreciate your kind congratulations. We're anxious to collaborate with you also. Krister's meeting with you tomorrow; he's our representative and can see you live, so I'll decline to get involved in the negotiations directly. We look forward to offer our input into the design of any vehicle that we could use as well. Bye."

Madhu grabbed her chair and walked over to the "Happy Equinox" banner that was still stretched across the entrance to the little courtyard. She stood on the chair and carefully untied both ends of the banner, rolled it up, and brought it back to the table.

"Sorry; it was bothering me. It was supposed to come three weeks ago."

"I wonder what happened," said Alexandra.

"We divided up the work, but I didn't do Colorado biome."

"This is the only one I've seen. I'm glad you're putting it away for next year." Alexandra smiled. "That was a really nice equinox celebration. The show you put together was incredible."

Madhu smiled. "Thank you. A quarter million people watched it over the web. Low-gee ballet is intriguing."

"Christina's a good ballerina, but the gravity makes it possible for her to exceed the imaginations of the greats on Earth."

"The 'Mariner Symphony' is good too. And of course Jack Alberghini is a first-rate comedian."

Alexandra laughed. "He is funny, it's true."

Just then Ethel entered the courtyard. "Oh, here you are. I thought we were having coffee in your apartment."

Alexandra waved her hand at the space around them, which had three cylindrical apartment units on three sides. "As you can see, this is almost a private courtyard. The only door is to our cylinder, which Yevgeny and I share with George Domeyko and Lin and Sophie Chen. Sophie comes home after a long sol's work and what does she do? Tends the flowers out here."

Ethel looked around. The courtyard had a central skylight with a circle of flowers below it; the rest of the courtyard was brick, with two tables on one side of the flowers and, incongruously, a kitchen facility in one nook. "Very comfortable, and much sunnier than I would have expected. I like Colorado, it's attractive."

"Everyone likes the sloping interior, and the trees are nicely laid out," added Alexandra. "Coffee or tea?"

"Sure; coffee." Ethel looked at the cylinder. "So, you have a three-story flat?"

Alexandra walked to the stove and poured her a cup, then came back to the table and handed it to her. She gave Ethel a small cupcake without asking; everyone knew she liked cupcakes. "We have half a cylinder; ten meters across and up to five meters wide. Our living room occupies the first floor, the master bedroom's on the second with a nice bathroom, and we have two offices on the third. There's a full kitchen out here; we split

the cost with Sophie, Lin, and George. The five of us use this space for breakfasts and relaxing."

"It's very nice," said Ethel.

"Where will you put the nursery; that is, if you keep the baby," asked Madhu.

"I don't know. Yevgeny said he'd sacrifice his office, which he doesn't use much. We might try to buy out George; his apartment is the other half of the first floor. We could also subdivide the living room, since we almost never use it."

"The third floor is pretty high up for a child's bedroom," said Madhu.

Alexandra shrugged. "Spiral ramps are pretty safe. I guess we'll keep the baby. Yevgeny really wants to and he said he'd stay home with him. But I'll still have to breast feed him day and night."

"Yes," said Ethel and Madhu almost simultaneously.

"It's really not that bad, though," added Madhu. "Alexandra, just *enjoy* this chance. Children are a burden and a joy at the same time, but if you emphasize the joy, the burden really seems to go away."

"When I see families struggling to control their kids at supper, I'm not so sure."

"Supper's the worst time because they're tired. The Patio's a zoo at suppertime," replied Ethel. "Madhu's right. Trust us; it'll work out."

Alexandra smiled. "I guess. But remember that both of you said you looked forward to getting away with me to chat *so you'd have time away from the kids*."

"You need that," replied Ethel. "But that doesn't mean the kids are a bad thing."

"I've already started rearranging my work schedule for the baby." Alexandra looked at Madhu. "So, what's your latest project?"

“I’m still recovering from decorating the entire outpost for Equinox and planning the concert! But, I’m going to add another labyrinth pattern to Memorial Park. It’s a pretty clever design; it’ll have separate red, green, and white paths, and it’ll lead to some pretty interesting mosaic art, which if you view in the right order will tell a story. Older kids who can wear pressure suits will love it.”

“I see you added another wind sculpture to the sculpture garden,” said Ethel. “It’s amazing that rock can erode that way. It almost looks like the figure of a woman.”

Madhu’s eyes brightened. “Isn’t that incredible? John Hunter brought it back from Deuteronilus Mensae. He spotted it two years ago, but they had no way to transport it; this time the expedition had space on a trailer for it, so when they were going by it John had them stop, and supervised its excavation and packing.”

“Thank God the expeditions support art,” said Alexandra.

“They love the wind sculpture garden! They’re bringing back weird shaped rocks all the time. It’s the Mars equivalent of picking up driftwood on the beach and making it into art.” Madhu poured herself another cup of tea. “But I’d really like to tackle something big.”

“Like what?” asked Ethel.

“I don’t know. The other sol when the Quirinus expedition set out, I saw several shots of Embarcadero and was impressed by how big it is; it now has several annexes and its axis stretches thirty meters. It occurred to me that it has become our Ellis Island. And I immediately thought of the Statue of Liberty and how impressive it was for the arrivals to see.”

“Great idea!” exclaimed Ethel. “Propose it to Will! Unlike the Statue of Liberty, it needn’t have much mass; the object could be inflatable.”

“That’s what I was thinking, and if it had metal reinforcements it would hold its shape even after the internal air pressure dissipated.” said Madhu. “But it’s so impractical!”

“It’s art!” replied Alexandra. “Art isn’t *practical* in that sense anyway. The problem I see is that it would have to be anchored to Embarcadero, or it would drift away and possibly collide with the station later. That means a truss would have to be attached to Embarcadero and to the statue. What did you have in mind?”

“My thoughts really didn’t get that far,” replied Madhu. Then she added, “A design did occur to me of a stylized figure—that new wind sculpture inspired me a bit, actually—female, arms flung up and open in welcome, with a flame emerging downward from her feet like a rocket engine.”

“Dramatic,” exclaimed Alexandra. “It’d take only a tonne or two of materials.”

“Heavy aluminized fabric, sewn and glued into the right shape, then inflated,” added Ethel.

“Oh, come on,” said Madhu. “No one would spend money to build such a thing.”

“Why not?” replied Alexandra. “I think it’s a great idea! Just because no one has built something like this in Earth orbit is no argument against us doing it! We’re a space-faring civilization now. Let Earth be inspired by our art.”

Madhu laughed. “You guys are pulling my leg!”

Ethel shook her head vigorously. “No, I agree with Alexandra. It’s a good idea. You should propose it!”

Madhu stared at them, wide eyed. Then she laughed again. “Okay, why not. I could sew and glue the aluminized cloth myself; I know how to do that, more or less. I’ll talk to Will about it.”

“I’ll back you,” said Ethel. “I’ve been here over fifteen years and haven’t taken much vacation. I could take some time off.”

“I don’t think I can say the same,” added Alexandra, patting her belly. “I have other priorities right now. But I can advise.”

That evening, supper ended a half hour early and the tables were removed from the patio. The chairs were set up in rows facing the stage. But the program was not the usual Satursol concert or music and drinks for singles and childless couples. It was the night before the Mars-wide elections and the usual time for the outpost’s meeting about Mars’s future.

Soon everyone began to arrive. At 7:15 p.m. Will Elliott rose. “Good evening everyone. Welcome to our Future Forum. We hold this forum every columbiad the night before the elections. At midnight everyone will receive an email that will give a web link to a ballot. To vote, click on the link, enter your name and password, and follow the instructions. There are no names on the ballot; it has been our custom since the first election during the third columbiad to have no candidates, so you are free to vote for anyone you wish. To give you some idea who has ideas and who takes what positions, we hold a Future Forum, where everyone is free to speak. No one who speaks is necessarily a candidate, though; by custom, we do not have people announcing candidacy here or anywhere else. That way, we are completely free to vote our conscience.

“Yet another custom we have is that the evening is chaired by someone who is not eligible for election. Until tonight that has meant me; as Governor it would be a conflict of interest for me to be an officer in the civil government and an officer in the Mars Commission. That remains true, but our outgoing Borough Clerk, Érico Lopes, and our outgoing Borough Chair, Alexandra Lescov, have both asked not to be reelected, and the Borough Council accepted their request at its last meeting. Consequently, I will turn the floor over to Alexandra in a minute.

“As a reminder—a Martian civic lesson, you might say—Aurorae Borough has a Council consisting of three officers elected by the people—Chair, Clerk, and Treasurer—and two at-large members. Your ballot will have three separate blanks where you vote for the officers and two blanks where you vote for the at-large members. The Council meets monthly and is in charge of the preschool, public school, the arts and culture office, and the constabulary. It sets the borough property tax, a subject it will discuss this year since the Commission’s full subsidy ends in December.

“Mars also has a Residents Council consisting of five representatives from Aurorae and two each from Cassini and Dawes. You are free to elect the same people to the Mars Council as to the Aurorae Council, or different people; there are no restrictions or customs. The Mars Council, along with the Mars Assembly chosen by land owners and the Governor chosen by the Mars Commission, grants charters to Boroughs, oversees land use and environmental regulation, and runs the health system and the university. Exports, environmental management, mineral rights, science and exploration, resource recovery, and coordination of Mars space remain the responsibility of the Commission and therefore are outside the scope of our discussions tonight.

"With that summary I will turn the floor over to Alexandra."

Will stepped down and Alexandra Lescov walked slowly to the podium. She pulled up a chair and adjusted the microphone downward. "Tonight, the chair will sit," she began. "I hope the Future Forum will focus on possibilities and visions for where Aurorae, and Mars, should be going. Our creativity and innovation is an important engine for moving this world forward. To give you an informal example, this afternoon three of us were talking and we came up with the idea that Embarcadero needs a sort of interplanetary Statue of Liberty to greet arrivals. We plan to propose it to the Commission in a few weeks. I hope all of you will have proposals as well.

"Now, to open the floor; please raise your hands in order to be recognized."

Hands shot up. Alexandra couldn't help but notice Johnny Lind's up high. He had put up a website where he had formally announced his "availability" to serve on the Aurorae Council and had flown back from the Meridiani expedition to be present at the Forum. She avoided him. "Toru Takahashi."

Toru rose. "Your reference to a Martian Statue of Liberty and the Governor's to the Office of Arts and Culture raises the issue of whether we can afford to spend a lot on the arts when we are so few in numbers, especially since we may soon have to pay taxes! While I like the arts, I think it is hard to justify them here."

"Comments on this subject only?" asked Alexandra. Johnny's hand went up again, but she signaled to someone on the other side of the crowd. "Tatiana Petrovna."

Tatiana arose. "This is a subject we could debate for a long time, I'm sure, but all of us know that the arts have a role in any culture, and since we have our own emerging culture, we have to find a place for it. I, for one, am immensely grateful we have it; not

only the labyrinths and the sculpture garden, but the Satursol concerts and variety shows."

Alexandra nodded. "Adam Haddad."

"Rather than debate a topic like this, I have a suggestion: we need a small art galley, maybe in Catalina near the university. Ernesto Alves and I are not the only painters here, and we have a few sculptors. We need a place to exhibit."

"Thank you. This is a good example of what I was hoping we could achieve: useful, positive contributions. Let's go back to general discussion. Kimberly Irion."

Kim rose. "Our baby's just nine months old and I am very concerned about how crowded the child care facility has become. I think it accommodates twenty-five kids, and there are a dozen more in kindergarten and elementary school. The twenty-five kids are being watched, usually, by three adults only, and some of the kids are really little babies. Sometimes there are only two adults, too. The parent volunteering isn't working."

Alexandra looked around. "I suggest Ruhullah respond, since he manages the day care facility."

"Sure," agreed Ruhullah. He was surprised to be called on, but rose quickly. "This is a very difficult problem and there have been times I went down to help out; and I don't have any kids! We can't hire someone. No one is available at any reasonable price. We've been pleading with parents on family leave to help. We have about five parents available at any time and if each one volunteered a sol a week, it would solve the problem completely. Even half a sol would help. So let me issue a plea to everyone right now, whether you're a parent or not: the kids need your help. We have a need in the elementary school, too; we want more experts to give the kids special classes. The

teachers will help you tell your material in a way appropriate for the age. Please don't ignore this; act." And he sat. Kim nodded, satisfied.

Hands shot up. Next to Johnny was his friend. Alexandra pointed to her. "Sara Travis."

Sara rose. "I want to make sure we discuss some of the issues Johnny has singled out on his website. I like it when this forum becomes a think tank and solves problems, or gives us all a vision, but I think it needs to call into account the people who are providing us leadership. I know a lot of us are very concerned about the plan to introduce property taxes in December, and we want a further accounting of what it will mean."

There was a brief silence after that. Alexandra looked around. "Commissioner Elliott, I think, should speak to that. Will?"

Will nodded and rose. "This gets to the three social models advocated for Mars: the kibbutz or pure socialism model, the mixed socialist/capitalist model such as Scandinavia, and the mostly capitalist model of the United States. From Columbus 1 through 3 we had the kibbutz model; all work was coordinated and all housing, meals, and health care were provided. Consumer goods, such as there were, were imported for everyone and available from the supply coordinator. Madhu cut our hair when necessary in the Great Room on Sunsol afternoons.

But as this place grew larger, its character changed. We got a store, we instituted land ownership and house ownership, and we privatized gold recovery by signing contracts with three mining companies. There's been talk of privatizing construction and horticulture. We have a private Satursol night ice cream stand, a beauty parlor, and a monthly flea market where people sell their crafts. The cafeteria is beginning to sell food

for people to cook at home. Where will this lead? To a more and more mixed economy, with more opportunities for residents to start private businesses. But that means we have to move toward fees for services. Starting next year we will have bills for electricity, heat, and water. There will be property taxes on all property in the borough, including land. In turn, the Commission, estimating the total fees and taxes that will be paid, will raise everyone's salary an equal amount. Theoretically, everyone will have the same buying power as they have now, though some will have a bit more and some a bit less depending on the services they need."

Will sat and Johnny's hand immediately shot up insistently. Alexandra nodded to him. "Basically, the argument is that we're moving from a more socialist model to a more capitalist model. I don't question that, but I question the pace. If you want to start businesses, don't suddenly hit them with electric and water bills and taxes! Let the services remain free so they can get started. It'll be very hard starting businesses here anyway. I favor limited privatization; it should increase our productivity, our creativity, and our overall satisfaction. Businesses that make consumer goods probably have the best chance to get started, since we need them badly. Let's encourage them." He sat to some supporting comments from the crowd around him.

Will rose and looked to Ruhullah. "I suggest Ruhullah Islami comment on Johnny's suggestion, because he has worked on the plan." He sat and Ruhullah rose.

"We've taken that into account. New businesses will be able to apply for a certain amount of free electricity and water per month. We want them to pay something above the basic amount to give them an incentive to save; we don't have unlimited supplies.

Businesses can also apply for tax abatements for up to five years. We're trying to arrange some small business grants to encourage them."

Johnny shook his head and raised his hand. Alexandra reluctantly nodded. "This is complicated and there's no guarantee businesses will get what they need."

Ruhullah had remained on his feet. "Well, sometimes life is complicated, and it rarely comes with guarantees. This way people will know their real expenses and can anticipate them."

Johnny raised his hand again, but Alexandra shook her head. "Let's move on." Hands shot up. "George Domeyko."

George rose. "I'd like a clearer accounting of the cost of housing. The rumor going around is that we are paying the entire cost of the imported materials, rather than a reasonable percentage."

This was another matter Lind had raised on his website. Alexandra looked at Will again, then Ruhullah, who rose to answer the question.

"I'm glad this matter has come up, so it can be straightened out. The total cost to make an annex and get it here is thirty million redbacks. Half that cost is covered by passenger tickets and the other half becomes a housing cost. But the cost of converting the annexes into housing—putting the cylinders inside a biome, building walls, etc—are also about fifteen million. That's where the claim that we are charging people the full price for the annex comes from. It isn't true."

Ruhullah sat again, rather decisively, since he had been rather hurt by the accusation. Alexandra nodded a thanks. "Tina Hvitmer."

Tina rose. “My concern about the future has to do with balancing exploration and domesticity. We have barely begun to explore this planet, and here we are reaching for the asteroid belt. We have very reliable vehicles, but reliable or not, accidents happen, and we can’t afford them. And now we may partner with the United States of America, possibly the most dangerous country on Earth and one that has proved unreliable and untrustworthy. I simply can’t fathom this situation.”

Will rose automatically but waited for Alexandra to nod, because no one else could answer the question. “Project Columbus has always included asteroid exploration; in eight Columbuses there have been five asteroid landings and seventeen asteroid flybys. Two years ago we initiated robotic exploration of asteroids with used equipment and sent a crew in two vehicles to Gradivus. The estimated chance of mission failure was one in several hundred; odds everyone who applied for the mission knew. One quarter of our residents applied and many more would have if they didn’t have family obligations. So the crewed missions are popular and will continue if the plans are reasonable and can be accommodated in our schedule.

“As for partnering with the United States, the Commission cannot blacklist any potential partner, nor can it hold grudges against anyone who has tried to hurt us. Columbus 8 almost didn’t fly here because the equipment was tied up in court, and when it did fly here, it came under chemical propulsion rather than nuclear; that was not our doing. But now it appears the United States is taking a different approach to us. We can be practical and generous, but we won’t allow ourselves to be exploited and we won’t compromise essentials. If an international effort to explore the asteroid belt and Jupiter

begins that brings us new technology, faster propulsion systems, and safer interplanetary transportation, and if it brings us business and traffic, that is to our advantage."

Alexandra nodded; it was a decisive, if vague, answer. Considering that the meeting was broadcast live over the Mars Commission's web television channel, that was the best to expect.

Will and Ethel usually sat on the couch together for an hour or two every night after the kids had gone to bed. Sunsol evening was one of their favorite times because they watched *The Edinburghers*, a television series about a wealth nineteenth-century family in Edinburgh, Scotland. But throughout the last half of the program, Will was distracted by a flashing light on his attaché indicating the arrival of an important message. When the show ended—the clock had just rolled over from 23:59 to 24:00—he looked at Ethel.

"Yes, go listen before we watch the next show," she replied.

"We don't have time to watch all of the next one anyway."

"Why?"

"Midnight's in 39 minutes, and that's when the election results will be released."

"Well, we can watch most of it—we'll want to skip the commercials anyway."

Will nodded. He rose from the couch and walked to the breakfast table where he had left his attaché. He activated it.

"It's from Charles Kern, Administrator of NASA."

"He's at the office late."

"Yes, it's . . . 8 p.m. Tuesday night in Washington." Will activated the recording.

"Good sol, Dr. Elliott," Kerns began. "Dr. Soderblom and I have hit a few snags in our effort to bring Mars into Project Odyssey. I was hoping your personal involvement could help resolve the difficulties. We very much want to invest in a Mars south polar station; it offers vast scientific potential as well as providing a Galilean-like environment for testing materials and equipment. But our investment is only possible if it is an American station and not part of the Mars Commission. Similarly, a Phobos nuclear reactor would have to remain under U.S. control and on U.S. territory. Both facilities can offer a vast amount to Mars. I hope to hear from you about this. Bye."

Will stared at the screen. Ethel was not so quiet. "The nerve of them."

"Krister told me earlier this sol. Besides being emotionally unacceptable to the population here, it would violate the Mars Commission treaty, which places all facilities in Mars space under the Commission's control."

"Old habits die hard."

"They can't push around the rest of Earth any more, so they think they can push Mars around instead. But they can't; if they don't have our cooperation, the extra delta-v to their destinations will cost them far more than a south polar station. Besides, we may provide them the uranium they need for their project, since launching it from Earth is difficult to sell to their population. I'm not going to answer this now. I'll copy it to Louisa and Pierre and let them propose a response over night." He pushed a few buttons to forward the message and typed a quick cover note. Then he came back to the couch.

"Now I'm distracted," said Ethel. "Johnny's campaign bothers me enough, but now this! I feel like we're threatened from inside and out."

“Oh, don’t get too upset with Johnny. He may have disrupted the Future Forum and made it the most contentious meeting we’ve had so far, but I don’t think he garnered support for himself. Most people seem to have felt that our explanations were clear.”

“You and Ruhullah did a good job. I was glad to see him stand up and speak in public; he’s been almost shy until now.”

“He’s developed a lot of confidence over the last year. He’s had to serve as acting Governor, and he’s done a good job.” Will paused. “Project Odyssey will work out. We’ll find the right creative compromise.”

“I hope so. Were you surprised by Alexandra mentioning the idea of a large art monument at Embarcadero?”

“I was. I think it’s a great idea; the best one to come from the Forum. The question is how to pay for it. Pierre sent me an email earlier this sol suggesting that he approach the French government for a special grant.”

“Really?”

Will nodded. “They gave the Statue of Liberty to the U.S. If they can’t, we can approach some corporate sponsors. I doubt it’ll be expensive; it’ll inflate into shape. It shouldn’t mass more than a tonne or so.”

“Good; that makes me feel better!”

The two of them snuggled up in front of the television together and started the next show. When the clock rolled over from 24:39:35 to 0:00:00, Ethel stopped the program. “It’s time.”

He nodded. They both rose and walked to the breakfast table, where Will told the attaché to find the web page with the election results.

“Ah-hah!” he said, surprised. “Ruhullah is Borough Clerk! Marvelous! With Yevgeny as Borough Chair.”

“And Lal as Treasurer. That should be interesting, I don’t know whether he can count! Madhu Gupta and Martha Vickers on the Council. How interesting; a psychiatrist.”

“She’s a good choice. Si is Lal. Radha will be relieved to have him around the Outpost more.” Will clicked on the “more votes” button. “Look, Johnny came in eighth for the two Council seats, after Érico, Alexandra, Father Greg, John Hunter, and me!”

“Pretty far down. I guess campaigning didn’t get him very far.”

“And his campaigning probably got Ruhullah elected, because otherwise he wouldn’t have stood up and spoken!”

Ethel chuckled. “You’re right. Well, let’s finish the program and go to bed. We’ll be able to read all the crazy analysis tomorrow.”

11

Commissioner

mid June 2051

Will stared out the window at the northern escarpment. He really didn't want to deal with Charles Kerns's latest. It was the only message that morning he hadn't opened. Kerns persisted in trying to shortcut negotiations with Soderblom and talk to Will directly.

Then the perfect diversion occurred to him; he'd videomail Brian Stark and Skip Carson. He pulled up the men's videomail numbers. "Good sol, Brian and Skip. I hope you're bearing up well in your little ITVs, floating across space to Venus. About now you must be crossing Earth orbit. It's a shame Earth's a quarter of an orbit away!

"Not much new up here. The bids on tracts of gold-bearing lands are due tomorrow and we already have some very promising submissions. You guys won't recognize Aurorae; two biomes have opened since your departure. The excitement over the elections has finally died down; it only took five weeks! Ruhullah is doing a good job and the Americans have said nothing about the election of an Iranian. We'll see how everything goes at the Commission Board's meeting in five days. I'm invited to attend a few of the sessions by videophone; quite a concession.

"Give me a holler when you can. Ethel and the kids are well. Marshall insists that I take him outside every weekend now and is begging me to change the regulation so that twelve year olds can go out alone. That's planning ahead; he won't be twelve for eight months! He is already thinking too much like a teenager, Daoud. I may need your advice about that soon.

"Well, I had better stop procrastinating and turn to my real work. Bye."

Will sent the videomail, then sent a similar message to David Alaoui. Out of excuses, he turned to the videomail from Kerns and pressed “play.”

“Good day, Dr. Elliott. I thought I should send a clarification of the request I discussed with Krister earlier today. The proposed Phobos nuclear reservation around the crater Roche need not occupy half of that moon’s surface. We could cut it back to perhaps a hundred square kilometers. A man with a jet pack can travel a long way on Phobos pretty quickly, and your facility isn’t that far away. Security is not an easy thing to maintain under those circumstances. We need a buffer around any nuclear facility. The south polar station will be thousands of kilometers from any habitation, so security is simpler. I hope that clarification helps. Bye.”

Phobos had 1,600 square kilometers, so a reduction of the nuclear reservation to 100 square kilometers was quite a “concession”; but it was a concession no one wanted, because no one wanted to give the Americans any of the moonlet at all.

Irritated, Will hit reply. “Good day, Dr. Kerns. Krister summarized the meeting. Perhaps he did not reiterate clearly enough that our population will not tolerate a military base in Mars orbit, especially one whose purpose is unclear. I’m surprised you can’t let us know what you plan to do with the reservation.

“As we have said repeatedly, a far more feasible plan would be an American nuclear research facility near Aurorae, with a suitable security perimeter around it. You’ll have better security, your people will be able to live more comfortably at or near Aurorae, and the residents will feel better about the facility because they’ll be able to mix with its personnel. As for the South Pole, there is no need at all for security there, so we

can’t bend the Mars Commission treaty on those grounds, and we cannot think of reasonable grounds under which we can lease territory to the United States.

“I hope that clarifies our position, though I would have thought it was clear already, Mr. Kerns. Goodbye.”

The last five hundred kilometers of the Meridiani Trail were completed in five very long and tiring sols. The area had already been thoroughly explored and the last oasis had been finished seven hundred kilometers west of the outpost, so the exploration and construction vehicles were available for widening an existing dirt track. An hour after sunset the last conestoga—driven by Helmut—hurried down the new trail and pulled up to the complex of vehicles. They docked to a side airlock of one of the conestogas and walked through the vehicles to the one attached to an airlock that led inside Dawes.

When Helmut stepped inside Dawes’s main biome, it was like stepping into Eden. They went from four and a half months of life in a series of cans into a humid, palm-lined, tropical garden. The biome had buildings on the north and south sides with a yard in between; the standard design. The buildings were covered by vines; the yard was filled with orange, grapefruit, lemon, mango, and coconut trees. At the far end was the outpost’s “Patio,” which, like Aurorae’s, was covered by tables. They headed for them. Everyone saw the last four arrive and started to applaud.

“They’re applauding for all of us, not just for you,” explained Lal.

“And because it means we can start eating,” quipped someone. The buffet table was piled high and had not yet been touched.

“Let’s start eating, then,” said Feodor Velikovsky, the boss of the Sibireco operation at Dawes and Commander of the Outpost, as well as Clerk of the Borough. “Guests first, please!”

The Meridiani expedition’s twenty-four members—who outnumbered Dawes’s permanent residents—headed for the buffet table. Helmut spotted Clara and walked over to her.

“Hi.”

“Hi. How was O’Keefe Crater?”

“Interesting. No gold, but some evaporite deposits and a network of young runoff channels, though they have no snow at their heads.”

“That’s pretty rare at the equator.”

“How have you managed, over the last fifteen sols?”

“Pretty well. So, you’ve been counting.” She smiled.

“I’ve missed you.”

“I’ve missed you, too.” She looked around to see what everyone was doing. Helmut leaned over and kissed her on the cheek.

“Well, I’ve taken care of our accommodation,” she continued.

“What do you mean?”

“We’ve got a small apartment together; bedroom, tiny living room, and private bath.”

“How’d you arrange that?”

She smiled. “I’m quartermaster, remember? Dawes has room for fifty people so that it can serve as a base of operations for expeditions, but it has eighteen residents. There are a lot of empty flats.”

“How nice. And we’re here seven sols at least.”

“Ten, if we all don’t get bored.”

“Well, you and I won’t.”

“No.”

He pecked her on the cheek again and they walked to the buffet table together. Then they sat at the end of a long table that had half the forty-two people present. Lal Shankaraman and Feodor Veikovsky sat together near the middle, where they could talk. Most of the way through the main course and the small talk, Feodor asked the billion-dollar question. “So, Lal, how much gold are we talking about?”

Lal smiled. “The reports don’t exaggerate. I wish we had more neutron activation results, but the richer data won’t change the picture much. The eight main gold bearing zones will at least equal Dawes.”

“A billion troy ounces,” said Feodor, letting the “l”s of “billion” roll off his tongue. “But the zones are fairly far from each other.”

“Mostly. Are you looking for a site for an outpost?”

“I’d love to hear your ideas.”

“There’s one obvious place for an outpost. Ashanti is a long, thin auriferous zone, and Deadwood is north of its middle. North of Deadwood is Tanana. The three zones hold 300 million, 140 million, and 40 million respectively; almost half the total reserves.

An outpost near the middle of Ashanti and close to Deadwood would give easy access to gold bearing deposits in three directions."

"Perfect for three companies."

"Exactly."

"There's the question of whether the three of us should be competitors or partners. If the Commission goes for the highest bidder, someone will get all of one deposit and someone else all of another and a joint outpost will be impossible. But cooperating could look like price setting."

"It's a problem," agreed Lal. "I was thinking of talking to Will. The geography of the area would require mobilhabs and mobile harvesting teams, or several separate outposts. Maybe that's okay, but it won't be as safe as a centrally located outpost with a clinic and rescue facilities."

"I'd favor a joint effort to set up one outpost. I'd prefer Dawes providing the support facilities, but it's too far." He sighed. "All of our companies are flush with cash right now; our profits are large and our stock price has gone through the roof. But all of them are diversifying and buying up assets, and they're all investing heavily in supercritical carbon dioxide extraction. I don't think any of the three want to pour a billion redbacks into Martian mineral rights. The gold price can't stay up much longer."

"That's my feeling as well, as a millionaire investor in all three."

Feodor smiled. "You, and everyone else on Mars. All three companies will need to hire Commission personnel to open Meridiani, if Will agrees to let them go." He looked around. "I think it's time to start the festivities."

Lal nodded. Feodor rose and banged on his glass. “Everyone prepare for the toasts,” he announced. “It’s Satursol, and no one will be working tomorrow anyway, so let’s enjoy this occasion.”

Several people jumped up from the tables to fetch the wine bottles; there were two dozen of them chilling near the buffet table. Lal smiled. “Russian hospitality.”

“I regret we don’t have vodka. This is half my supply of alcohol; that’s how important this event is.”

Lal poured himself a glass, wondering what he would offer as a toast next. Feodor watched the glasses fill, then raised his glass.

“To our friends on the Meridiani Expedition. For four and a half months they’ve dug, pushed, and blasted a dirt trail down erosion channels, across Aram Chaos, over crater rims, up broken cliffs, through dune fields, and across desolate stonefields. In the process they’ve made accessible eight gold fields. They’ve installed seven oases. We now have 5,000 kilometers of the finest road on the planet. Robotic vehicles can now get here from Aurorae in three sols, rather than a week. When they improve the road to Cassini over the next two months, we’ll be able to get there in a sol and a half. Furthermore, vehicles will no longer need nuclear reactors to supply their fuel, freeing the nukes for other uses. It’s a great, historic sol in Dawes because of them.”

“Here, here,” exclaimed someone. They all raised their glasses and drank.

Then Lal rose. “Thank you, Feodor, for your kind words. We are immensely grateful for your hospitality. We’re staying here in your beautiful tropical home for a week to rest and do some routine maintenance, then we’re off to widen the Cassini-Dawes Train and install two oases. This experience has been historic for all of Mars;

we've learned how to upgrade the planet's trail system quickly. Some of us will be back here in a few months to do further work on Dawes's physical plant. So we're honored to offer you this toast." He reached down to pick up his glass. "To the hard-working, generous people of Dawes. May they build a beautiful outpost with a great future and bring this world the resources it needs to prosper."

"Here, here!" And they drank.

Johnny Lind rose. "To gold, and the new trail of gold!" They drank to that as well. Helmut was irritated by that proposal, though, and stood with his glass in hand. "To exploration!" He said, and everyone drank to it as well.

Will looked at the clock nervously. He had sent his videotaped report about the condition of the Mars Commission eight hours earlier. The first meeting of the national representatives to occur in a year and a quarter was nearing an end. The agenda included many important topics: the size and composition of Columbus 9, the use of the Venus route for cargo and even people, involvement in Project Odyssey, the American requests for "reservations" at the south pole and on Phobos, reconstruction of the Commission's headquarters in Houston, moving the headquarters to Paris—which contradicted the other topic—involvement in the Hermes-model shuttle, continued development of the annex for interplanetary transportation, and the small matter of who would serve as Commissioner.

For the last year, Will had been the main force in all of them. Now he was forced to sit on the sidelines, and would soon have to pass the torch to someone else. His eight hours of inaction made him realize how much he had loved the job of Commissioner. Of

course, there was still a lot to do on Mars itself, and as Vice Commissioner he would still have a lot of weight. He thought of all the tasks that still needed to be done on Mars, especially around Aurorae. The outpost was now large enough to have an auditorium and theatre. The Dacha needed expansion. The system of oases needed to be expanded so that more of Mars was accessible without nuclear power. They had found two geothermal fields on Mars; both needed to be exploited, with the energy fed into a global system via a microwave transceiver on Phobos.

His attaché beeped with a video message from Earth. It was Pierre Messier. He eagerly pressed play.

"Good afternoon, Will. The national representatives ended their meeting about half an hour ago and I just got a call from Victoria Colville, the French representative. She said she regretted that you had not been invited and wished me to convey her greetings as well as the following summary. Louisa, by the way, is speaking to the Canadian representative at this very instant and will join me when she finishes.

"Victoria said they began their meeting by thanking Douglas Morgan, who was present. He's legally blind, gets around with an assistant, and uses a cane; his health will never recover. There was a short video tribute to him and everyone rose to speak of his important contributions. He thanked everyone for a marvelous eight years of service and for the kind offer that he continue serving as Commissioner—that came as a surprise to most of the reps present—and he declined.

"After he left, the agenda turned to simple items that had been approved without a meeting over the last year. Everything was approved unanimously: the extra money for Houston employees so that they could recover from the nuclear explosion, the last-minute

changes to Columbus 8 because American nuclear engines weren't available, the Hermes shuttle, the new year-long family leave policy, the free return to Mars after nine columbiads, the plans for Columbus 9, the further development of the annex.

"They had a very long and friendly lunch, partly to build the good will to tackle harder subjects. They agreed to postpone discussion of Project Odyssey when it became clear the U.S. had no allies in its push for land on Mars or Phobos. The question of who to appoint as Commissioner proceeded as if there had been no negotiations at all for the last year. The Europeans insisted on Karl Fischer; his experience running LeMonnier Station for the last decade makes him a strong candidate. But comments he made about the Americans last summer were extremely negative, so the Americans refuse to consider him. They countered with Jerry McCord, but he's been in retirement since Columbus 3 and has made some anti-European statements, so they refused to consider him. The Europeans reminded the Americans they had agreed the next Commissioner would be a European, to which the Americans replied that if they were going to invest a lot of money in repairing the Houston headquarters, they should get another term running the show.

"At that point the Canadians nominated Pete Theodoulos as a compromise candidate; he's been to Mars, he's a North American, though from the wrong side of the border, and with his acquisition of Greek citizenship last year, he's now European as well. But no one bought that argument, claiming he was too young. The French then proposed David Alaoui; I doubt they asked David first, by the way, because he loves running the Venus-Mercury Commission. The Americans said no, probably because he's French, Arab, and a Muslim, though they would never say that. I think the suggestion was made both for French pride and to embarrass the Americans. So Victoria replied by

nominating you; she said you were an American in whom the Europeans had confidence and you had an excellent record as well as the trust of everyone ‘up there.’ The Americans replied that you were not under consideration. The Chinese, Indians, and Brazilians all gave speeches about being inclusive and international and how they had increased their support for Mars; indeed, their share of Columbus 8 was higher than any other mission, while the number of Americans on board was the smallest percentage ever.

“By then it was 5 p.m. Most likely there will be a vote tomorrow, after which the differences will be papered over. It sounds like the Europeans plan to lobby all night.”

Louisa had arrived near the end. She nodded about the last point. “The Canadians want to push Theodoulos hard, but will probably support an American in the end. I told them to support you, Will! They are concerned about Project Odyssey; if the Americans get the Commissionership, they probably won’t get the reservations on Mars and Phobos that they want, and vice-versa.”

“That’s our report from this end,” said Pierre. “Let us know what you think. Bye.”

Will immediately hit reply. “Thanks to both of you. I know both Fischer and McCord and we can work with both of them. So I see no reason why we should inject ourselves into the question of who becomes Commissioner. I hope the matter is settled soon. As for the American request for reservations around a South Polar station and a Phobos station, we must uphold the Mars Treaty, which says that all facilities on Mars or in Mars space are under the Commission’s jurisdiction. The residents up here feel strongly about that point. I could see a partial exception made if we were talking about the issue of security around a facility with special technology, such as a uranium

separation facility or a nuclear reactor. Otherwise, I can't see a way to make the American request work. Bye."

Will sent the message and wondered about the situation. The thought of allowing a national station on Mars, separate from the existing outposts, was anathema; it might destroy the dream, so strong among Mars's tiny population, that they were the founders of a new nation that would embrace an entire planet. They were Marsians, not Aureans or Dawseans or Cassinians.

It was now 5:30 p.m. at the Outpost and he could stop his work. He went to find the kids, who were at home. He spent some time with them, then went to supper. After supper they all hurried to Kim and Ananda's flat for a Bahá'í meeting. Tomas had been bringing a series of acquaintances to hear about the Faith; that night Robert Wairimu, a Kenyan repair specialist, asked questions about the relationship of the Faith to Christianity. The steady stream of inquirers over the last few months had been quite exciting, and the meeting continued until almost midnight.

Will slept poorly that night, worrying about what would happen in Paris. As soon as he rose he activated his attaché. It had a message waiting for him from Kerns.

"Good sol, Dr. Elliott. As you may have heard, the debate about the new Commissioner continues, and you are under consideration. We may be in the position to support your candidacy, but we need some clarification of your positions. Is there any possibility you might support our request for a reservation on Phobos and at the Martian south pole? The treaty is not necessarily as absolute as some have argued. Please let us know what your thoughts on this matter are. Thank you, and good luck. Good bye."

Ethel bolted upright in bed as the last words came from his mouth. “The political snake!”

“They all are,” agreed Will. “They’d sell their mother for short-term gain. It’s quite sad.”

“Are you going to tell him off?”

Will thought. “No. I wish there were an easy way to compromise on non-essentials and remain absolutely faithful to ethical and moral—and legal!—principles. It’s hard to know what to do.”

“So are you going to compromise?” She sounded horrified.

“No. I’m going to think about it a bit.”

He went into the bathroom, brushed his teeth, shaved and stepped into the shower. He felt the warm water flow over his naked body, relaxing him, helping him think simply and clearly. Ideas began to come together and they gradually took shape into a logical pattern. He dried himself, dressed, put on a tie, and splashed cologne on his face.

“They won’t smell that over the video!” said Ethel, surprised.

“I know. This is my last sol as Commissioner and I plan to look the part. And enjoy it, also.”

“Sounds like you plan to tell him off. My Scottish Presbyterian grandmother would not approve.”

“Nor would `Abdu'l-Bahá; nor would it be professional of the Commissioner, either.” He sat in front of the attaché and pulled up Kerns’s message, which he listened to one more time. Then he hit reply. “Good sol, Mr. Kerns, Acting Commissioner Elliott here. Thank you for your message, which suggests that perhaps we have not

communicated as clearly as we could. Over the last year I have striven to accomplish my work based on several principles: fairness to all; forgiveness of others when they have tried to hurt me; inclusiveness, leaving no one out of the great enterprise of exploring and settling Mars who has been willing to participate according to the rules; and fidelity to the unity of this planet, which is both a principle of the Mars Commission Treaty and an element of faith to our population here. Regardless of the role I play in the Commission tomorrow, those are the principles I will follow.

"The principle of unity of the planet completely precludes the possibility of an American station at the south pole. Such a station, as I understand it, would be established for objectives that are scientific and engineering in nature. No national security would be involved. Therefore, there is no justification for a separate facility.

"The proposal for a facility on Phobos is considerably more ambiguous because its purpose has never been stated. One could justify a security jurisdiction around a station engaged in certain activities, such as running a reactor to make plutonium and other isotopes for sale to the moon or for use in space vehicles. I have stated that to you on previous occasions and reiterate it again. The purpose of such a station must be clearly stated if a security zone around it is to be justified.

"But I have already stated another solution, one that offers you a lot of advantages and maximizes the cooperation and understanding of the Marsian population: a small secure facility near Aurorae Outpost. Phobos has no gravity and there is still no easy way to build a gravitied rotating facility on the moon. Embarcadero is too far away. A rotating station orbiting the moon will expose inhabitants to a lot of radiation over time and they will be isolated. The solution is to put your facility a dozen kilometers from Aurorae

Outpost. Your people will have the benefit of living in Mars's largest settlement. They will know the local people and vice versa. We will be in the position to give you the maximum amount of assistance in terms of construction and emergency backup. If you have your own shuttle, it can use our spaceport; if you have your own pilots, they can lease our shuttles. Your people will vote in our elections and eat our steak. If your facility makes surplus power, it will have the largest power market on Mars readily available to it. But security should not be hard to maintain; anyone approaching your facility will be in a pressure suit or a vehicle.

"So what is the problem? Isolation is not to your advantage and does not increase your security significantly. It breeds mistrust. Let's maximize trust, keep the Mars Treaty intact, and foster exploration of the solar system. That's what I offer you. Good bye."

Will sent the message. Ethel was beaming. "I'm proud of you." She leaned over and kissed him. He kissed her back.

"Thank you, because in the real world, principle rarely wins."

"No, it doesn't, I'm afraid." She pointed to the door. "Meanwhile, your children have gone to the Patio by themselves for breakfast."

"I'm on my way."

Will went to the Patio for breakfast. Everyone complimented him on his dashing appearance; ties were worn on Mars for weddings, funerals, and sometimes for church services. He took the kids to school, then went to his office, where there were reports to read and instructions to give. He stopped in Ruhullah's office to get a briefing from him about the situation on Mars; after that sol, he would be back to running Mars itself, and Ruhullah's duties would diminish considerably.

He was about to go to lunch when he suddenly got a call from Louisa. “The European representatives just came out of the meeting and they’re aghast that you offered the Americans a security reservation! Apparently the vote was going against the Americans 15 to 1 on everything and they proposed a compromise based on your offer to them. Everyone’s taking a break for lunch to think about it! Let me know what you said and what to do, if anything. Bye.”

Will searched his videomail outbox and found the message he had sent to Kerns. He forwarded it to Louisa Turner and added a post script. “Louisa, here’s exactly what I said to Kerns this morning. The Mars Treaty specifies that sovereignty over Mars and Mars space—that is, a sphere defined by the Mars-solar Lagrange 1 and 2 points—does not belong to any terrestrial nation, but is possessed in common and administered through the Mars Commission and any arrangements it makes. The chapter is vague because there was already an effort by us to establish an outpost government, and it acknowledged the possibility that some day there would be a civil government over much if not all of Mars. But this means a loophole exists for other arrangements. If someone wanted to give Mars a special, high-tech, low-mass nuclear reactor we would be grateful, but naturally we would be sensitive to concerns that the design was a national secret.

“Consequently, I would favor granting the Americans or anyone else a security zone around any special facility engaged in activities that benefit Mars *and* require special security. I would not favor such a zone if it did not benefit Mars or if the work is not of the sort requiring security. Hence I reject the call for an American south polar station. And I advised that any secure facility should not be on Phobos, but right outside

Aurorae, within the Borough boundaries, where the workers can participate in Martian civil activities.

"My guess is that the Americans want to build a uranium processing facility to extract U-235 and U-234. Possibly they want to build a reactor to convert the uranium into plutonium and other isotopes. Perhaps they want to revive the Star Wars Project and obtain the uranium for it from Mars. If that is the case, I would advise everyone to fight the Star Wars Project; it is a waste of money in a world moving toward integration. But don't fight nuclear power on Mars. I don't want us to become an all-nuclear world, but remember we don't have coal and petroleum up here, solar energy is less than half as strong as at Earth, wind power is diffuse, and we have not yet exploited any geothermal power. We need reactors for mobile exploration and for polar facilities in particular, but they provide an essential minimum level of power for dust storms as well. Put the nuclear power where it is needed—at the outposts.

"Let me know if you need further information. Bye."

The message flew to Earth at the speed of light while Will went to the Patio for lunch with his family. He wasn't going to worry about terrestrial greens and their fear of nuclear power on behalf of Mars's population, or paranoia over laser beams in earth orbit. Mars had a bit over 200 human beings and was planning for its growth to over 300. It was building toward a great future.

After lunch he went back to his office and worked. Lal called and explained the various possibilities for dividing up the gold-bearing zones. Will never turned down a chance to define the future. He called the heads of all three of the mining company operations and asked them to serve on a committee to resolve the matter, along with

himself, Lal Shankaraman, and Érico Lopes. Feodor Velikovsky volunteered that they meet at Dawes and possibly travel together to some of the sites to make decisions. It took all afternoon, but in the end they had a timetable to make a decision about the Meridiani gold fields, which meant they had a date for starting the gold recovery effort as well.

The sun was dropping low over the outpost and it was almost time to go have supper when the message light on Will's attaché began to blink urgently. It was an important transmission. With a sigh, he pushed the activate icon to hear the news from Pierre and Louisa.

"Will, they picked you!" Pierre exclaimed. "The meeting just broke up! It was a pretty fierce, bruising fight. The Americans were going to lose it all, but they were willing to compromise and showed some humility in their looming defeat, so they nominated you themselves. The French came around first, and that was the beginning of the momentum. There is one catch: from now on the position of Commissioner will be for a five-year term, renewable once.

"They've agreed to no national facility on Phobos or the Martian south pole, but they will permit a facility with a 'national security zone' near Aurorae, Cassini, or Dawes. The Americans disclosed that the purpose of the facility will indeed be to separate uranium isotopes by centrifuge and to make isotopes in a special breeder reactor. The use of the fuel will be non-military. That's been approved by the national representatives, too."

"The press conference starts in five minutes," added Louisa. "You need to prepare a statement right away."

"Congratulations, Mr. Commissioner!" added Pierre.

Will stared at the screen, stunned with surprise and tingling with excitement. He reached to touch the reply icon, then paused to compose himself. Finally, ready, he hit reply. “I don’t know what to say right now; I’m in shock. I better go find Ethel and make sure this is reality! I’ll listen for the press conference, then have a statement ready. Bye.”

He sent the message, then grabbed his attaché, clipped it to his belt, and headed for Yalta. Ethel would soon be there to meet him and the children. As usual, he got there a bit before she—she tended to stay at work as long as possible—but she appeared a minute after he arrived. He hurried over. “Ethel, the national representatives have appointed me to a five-year term as Commissioner!”

“Five years? That’s new. But congratulations, I’m thrilled!”

“So am I, of course!”

“Of course!” she hugged and kissed him.

“What is it, daddy?” asked Marshall, who heard some of what Will had said.

“I just heard that I’m going to be head of the Mars Commission. But it’s a secret until they make an announcement.”

“And that’s it right there!” added Ethel, pointing to the big screen behind the stage, where they usually had a news channel playing during meals. The scene had shifted to a press conference where 15 national representatives were filing onto a stage.

Victoria Colville, representing the host nation, stepped forward and made the announcement. The Patio fell completely silent as she spoke, and when she announced Will Elliott’s name everyone erupted in applause.

They looked around and saw him with his family as well. “Come on, Will!” shouted Roger Anderson. “Let’s hear from you! Speech! Speech!”

“I think you’ll be making your acceptance sooner than expected,” commented Ethel.

“I guess so, but this is the best place to do it.” Will walked forward to the stage. Behind him, the news conference was still going on, but no one was listening. “I hope the people in Mars Control see this and transmit it to Earth,” Will said. “My first reaction when I heard the news was shock that I had been selected to be Commissioner for the next five years. My second reaction, when I saw all of you smiling and applauding, was deep humility and a sense of calling to give this position my best. It will not be easy to run a two-planet operation from the smaller, more isolated side. But it is also the more important side; the Mars Commission exists for the sake of Mars. With patience and by keeping our eyes on the ultimate goal—exploring and settling this world—we can make a two-planet operation function as one.

“Every five-year period has been important, but we are on the threshold of some particularly important opportunities. The outcome will determine a very important variable: the speed at which Mars is settled. Columbus 9 will have one hundred passengers. If we want to see Columbus 10 grow by a further quarter or even a third, we will need to institute new technology to make transportation both more efficient and cheaper. We need to create an economic revolution whereby Mars can profitably employ an ever-growing workforce. These are not trivial challenges. They will require costly investments and the dedicated effort of governments, friends, consultants, and employees. The result will be the emergence of a two-planet civilization, a major step forward for humanity. It is that goal to which I dedicate myself.”

12

Caravel

Sept. 2051

Will entered the conference room in Mars Control and was surprised to see Yevgeny Lescov, two-month old Boris Lescov in his dad's arms, Alexandra Lescov, Érico Lopes, and Louise Tremblay, their spacecraft repair expert.

"Oh?" he said. "I thought this was a quick briefing."

"It is," replied Alexandra. "We know you're busy planning the trip to Dawes."

"And don't worry about Boris; he's asleep," added Yevgeny.

"So I see." Will came over to look closely. "He's so cute."

"Isn't he?" replied Yevgeny, smiling.

"I haven't seen much of him. I haven't seen much of either of you, actually."

"You'll see more of me from now on," replied Alexandra. "Two months of maternity leave is enough; I'm now back to work."

"Who's taking care of Boris during Yevgeny's trip to Dawes?" asked Will.

"I am, and it won't be easy!" added Alexandra.

"Let's get started, so this meeting can finish," interrupted Louise. "Will, have you seen the new NASA specifications for the Odyssey-class exploration vehicle?"

"Yes: Twenty-four crew, artificial gravity, ninety-nine percent closed cycle life support for a three to five year voyage, on-board ecology..."

"That's the list," agreed Louise. "There are substantial potential overlaps with the needs of Project Columbus."

"I see where you're going. We should encourage a common design."

"No," replied Alexandra. "We should submit a bid to build the Odyssey class vehicle on Mars."

"What?" said Will. "Isn't that premature?"

"We don't think so," replied Alexandra. "We've thought about this extensively for two months. The vehicle they're talking about can't be built on Earth and launched into space; it's too large. It has to be assembled in space. Mars already makes fuel tanks, meteoroid protection systems, and thermal protection systems from our own kevlar, nomex, and nickel steel. In two years we'll be able to produce aluminum and weldalite. We can make high efficiency solar panels. We can't yet manufacture life support equipment, reaction control systems, avionics, fuel pumps, or engines, but we can import and install them. And we have something Earth lacks: a design and construction team that flies in space and thus has an intuitive sense of what works. With additional equipment and personnel, imported in the next two columbiads, we can make sophisticated vehicles."

"Can we show you the basic design?" asked Érico.

"You already have a design? Sure, show me," said Will surprised.

Pleased, Louisa opened her attaché and typed a code to project onto the wall screen while Will sat. "We call this model the *caravel*," she said, referring to the image of a round, flattish object. "It was a small, fast sailing ship; two of Columbus's ships were caravels."

"You can see why we've nicknamed it 'the flying saucer,'" added Alexandra. "It's a plate thirty meters in diameter with a flattish top and a curved bottom covered by a heat shield like a capsule. If it averages seven meters thick, its floor area would be 2,100

square meters, the equivalent of thirty ITVs. Rotated at 4 revolutions per minute, the outer edge would have Martian gravity. NASA specifications call for 80 square meters per crewmember for three- to five-year voyages, including the ecology, so it can accommodate 25. For passenger flights to Mars, though, 20 square meters is sufficient, so the Caravel could accommodate 100."

Will whistled. "How would we ever load them?"

"We'd need more capacity," said Érico.

"The outer hull with the heat shield and micrometeoroid armor would never rotate; there would be dead space between the outer hull and the rotating vehicle inside," added Alexandra. "This means the craft could be landed on Phobos or an asteroid and resume rotation after landing, giving the explorers a habitation with gravity."

"Clever. Propulsion?"

"It can be docked to anything," said Louise. "NASA's plans call for three VASIMR engines connected to three 5-megawatt nuclear reactors."

"What's the development timeframe?"

"Only three or four years," said Alexandra. "Most of the technology exists. It just hasn't been combined together this way."

"Costs?"

"On Earth, development would be twenty billion redbacks because they'd reinvent the wheel," replied Érico. "We can manage on half of that by recycling technology. The per-unit cost should be two hundred million. Project Odyssey needs three or four vehicles. We might need as many as ten, including one each stationed on Phobos and Deimos. That's enough to reduce the per-unit costs substantially."

“We could send out asteroid missions with them, if we wanted to,” said Will. “This is intriguing. What mass are you talking about?”

“The hull is forty tonnes,” replied Érico. “Life support is forty to eighty depending on the number of passengers and duration of the mission, the heat shield is twenty to forty depending on the cargo mass.”

“How would we ever launch it?”

“The outer and inner hulls can be made at Aurorae of advanced plastics and folded for launch inside a Hermes-class shuttle,” replied Alexandra. “It could be inflated on Phobos, covered with sand bags to reduce radiation levels, and construction of the rotating interior structure would proceed inside. The first one would serve as housing for subsequent construction. Adding the heat shield would require some new techniques.”

“Phobos and Deimos give us ship building sites with advantages unparalleled by any site near the Earth,” added Louise.

“Intriguing,” replied Will. “A little gravity is useful; you don’t have to worry about inhaling floating nails. The moons can supply all the water and air the crews need.”

“Not just what the crews need. Construction uses a lot of glue and the fumes are very hard to scrub from the air,” noted Alexandra. “The filtering system uses a lot of water, and we need extra air so we can purge the atmosphere periodically.”

“But the costs worry me,” Will said. “This is a big project. A big risk.”

“We’d be looking toward the future,” added Érico. “We’d be launching a shipbuilding industry.”

“We have to get Project Odyssey to buy into this,” added Louise. “If their vehicle is assembled on the moon, it would have to be launched against a relatively strong

gravitational field. If their vehicle is assembled in low Earth orbit, a large hangar would be needed with its own solar power arrays, orbital maintenance system, radiation shielding, and life support. That's a lot of bucks. Phobos provides all those things, doesn't have the gravity of Luna, and has unlimited supplies of volatiles."

"The sooner we do this, the sooner we short cut competition," added Érico.

"You're right, we could be competitive, but we're remote. The big unknowns are, how much work would we do, versus terrestrial manufacturers? And how much will it cost for us to do our share of the work? Surely we can't make caravels yet."

"No, Will, we could," replied Alexandra. "But we'd have inadequate construction capacity for biomes and additional housing. This project requires seventy workers to make the structure and thirty to integrate equipment imported from Earth. Columbus 9 is flying 100 people here; it's large enough to get this project started."

"Assuming we start building one caravel every two years," added Yevgeny. "One can fly one hundred more people to Mars every columbiad, which is enough to cover expansion of our ship-building capacity."

"That makes sense as a strategy," said Will, nodding. "We're our own biggest customer. The incremental extra cost for Project Odyssey would be reasonable. But we're talking about an enormous expansion of immigration."

"Getting the stuff to Earth orbit isn't a problem; the Swift shuttles are flying more and more every year, and both Boeing and the Chinese plan to manufacture a competitor. Getting from Mars orbit to Mars can be handled by the new Hermes-class shuttles. The increase in cargo can be handled by solar sailing vessels."

“Of course, the Mercury Project has hit some snags with deployment of their first kilometer-square sail,” noted Will.

“Serious problems,” agreed Yevgeny. “But nothing they can’t solve. Solar sails could eventually lower the cost of transport between Earth orbit and Mars orbit to about 100 redbacks per kilogram.”

Will nodded. “We need a larger vehicle; we can’t expand the system with ITVs much more. A single rotating plate that is the minimum size for Martian gravity is the next logical step up. I want a proposal I can take to the Commission senior staff, one that can be published. We need steps, costs, and a rough timetable. When can you have that?”

The four of them looked at each other. “Two months?” suggested Alexandra.

“If we have support staff,” agreed Louise.

“We can delegate folks in Houston, Moscow, and Paris to help, and maybe three or four up here,” said Will.

The four nodded.

“Good. I look forward to the result.”

That evening, Will, Yevgeny, and Ruhullah boarded a Sunwing-E for a fifteen-hour flight to Dawes. The latest model aircraft to be flown on Mars, its fifteen-meter fuselage could accommodate 1,500 kilograms of cargo or up to ten passengers. The front of the fuselage spouted biwings, one mounted on the top of the fuselage and two meters higher, with a wingspan of sixty meters and a maximum width of five meters. The upper wing had ten high-speed propellers, five on each side, with fuel pods built into the wings able to hold 1,000 kilograms of silane, a silicon-hydrogen compound that burns in carbon dioxide.

Half-way back, the fuselage sprouted a wing mounted near the bottom with deployable landing wheels. The rear of the fuselage sprouted a fourth wing mounted at medium height. Altogether, the four wings provided the aircraft nearly a thousand square meters of lifting surface, and since the entire upper surface was covered with high-efficiency solar cells, the wings could make as much as 150 kilowatts of electricity during the day.

They took off away from the lowering sun and rose quickly to cruising altitude. By then the sun was gone, but the plane had plenty of silane for high-powered flight all night. The three men ate a comfortable dinner, chatted, then set up hammocks and slept in and around the tonne of cargo occupying much of the cabin. They ate breakfast the next morning and enjoyed the view out the window while the plane flew on solar power. A bit before noontime Érico took over the controls and brought them in for a landing at Dawes, where a ranger met them and brought them to the outpost.

"Did you have a good flight?" Feodor asked them as they entered Orinoco Biome.

"Yes; the Sunwing-E is quite comfortable and spacious," replied Will. "I feel like air travel has arrived. I should have brought my son along."

"He would have loved it. Did you see the trail?"

"Yes, it was right below us the entire way," said Will. "It's very distinctive from 5,000 meters. We spotted two of the oases, too."

"They say the trail should be visible to the naked eye from Phobos. Come this way to the meeting. Gerhard and Bruce arrived this morning by ranger."

Feodor led the three of them down the middle of the yard and into the biome's south building. They took the spiral ramp up to the top floor, where a conference room had large windows overlooking the yard and giving a view of the Martian terrain outside.

Gerhard Bach and Bruce Curry, respective heads of the operations of Muller Mining and Consolidated Mining, rose.

"Good afternoon, Mr. Commissioner," said Bruce. "I hope you had a good flight?"

They shook hands. "Yes, quite comfortable; probably more comfortable than two days in a ranger."

"No, just a sol and a half," corrected Bruce. "The new trail allows eighty kilometers per hour in most places, especially with a ranger."

"But the sunwing would be much more comfortable; Bruce drives like a fiend," replied Gerhard, extending his hand. "It's good to see you, Mr. Commissioner."

"Please continue to call me Will. We're a small and informal operation up here."

"Thanks, Will. How's it been, serving as Commissioner?"

"I was acting Commissioner for a year, so in some ways nothing has changed. Ruhullah is Commander of Aurorae Operations and is Borough Clerk, and last month he was elected First Minister by the Mars Council at its meeting, so he handles a lot of the tasks that I used to handle. I'd say the big difference is the spirit of my team up here."

"How so?" asked Feodor.

Will looked at Ruhullah and Érico. "I'd say my people up here feel liberated to be creative in ways they weren't when everything was run in Houston."

Érico nodded in agreement. "It's easier; the boss is down the hall."

"The trick is to make sure the folks on Earth still feel creative, too, so I have to be in daily contact with the heads of staff down there," noted Will. "I just got a very exciting proposal yesterday that could revolutionize our life up here; but you'll hear more about

that by and by, when it's ready to be released. Let's sit down. What's the news from Cassini?"

They sat at the conference table. "The news is dominated by work," replied Bruce. "We're dealing with poorer gold deposits than two years ago, but with an additional four people on my team, four more support staff provided by the Commission, and another twenty tonnes of equipment, we're beginning to pull the gold output back up to earlier levels."

"Same for the Muller Mining Team," added Gerhard. "We have twelve folks at Cassini and four here at Dawes. With the new deposits we're chasing here and the new equipment we imported, our gold output has hit 4.5 tonnes per month."

"I have a question," said Bruce. "This new arrangement with the U.S. government that's taking shape; will it result in a permanent nuclear reactor at Cassini? Because we need more power, and when the supercritical carbon dioxide extraction unit goes on line in two years demand will be stratospheric."

"But it'll extract a lot of gold, silver, copper, and other saleable elements," added Gerhard. "Muller Mining will import a supercritical CO_2 extraction unit as well."

"I know," said Will. "It's a wonderful technology, and relatively cheap to use here because CO_2 is free. We're counting on it to concentrate aluminum oxide so that we can start aluminum production. The answer is that the first reactor will be sited at Aurorae; it's still the biggest power consumer. But we'll be in the position to ship a lot more solar power units, solar arrays, and wind turbines to Cassini and Dawes, so your power output should increase sharply. It has to; Mars needs the supercritical CO_2 facilities."

"I see," said Bruce, scowling. He was always pushing for something new at Cassini.

"Okay, let's get to business," said Will. He unfolded a piece of electronic paper that was a meter square. He pushed a button and a map of the Meridiani region appeared. "Here we are. Note the eight auriferous zones: Ashanti, Deadwood, Tanana, El Dorado, Kalgoorlie, Frasier, Dahlonega, and Kootenay. The first three are close together and could be served by a common outpost. El Dorado is a thousand kilometers west and could support a small outpost; the other four require mobile extraction.

"Your companies put in their bids a month ago and all three of you have mobilhabs exploiting gold at Kalgoorlie so your teams can become familiar with the area. I was hoping that the bids would be such that all three companies would get all or part of a zone near Ashanti, but of course it wasn't that simple. Since the bids are complete and the results are to be made public, let's take a look." Will pushed another button and the bids popped up in three columns. "All three companies bid for Ashanti, Deadwood, Tanana, and El Dorado. Muller Mining has the highest bid for Ashanti and Deadwood; Sibireco the highest for Tanana; and Consolidated for El Dorado. I'm wondering whether we can make an arrangement to split Ashanti, so that all three companies can work out of a single outpost. Comments."

The three company men looked at each other. "We want El Dorado," said Bruce. "Our analysis of the geological data, especially the orbital data, suggests that it's richer than indicated, and it appears to have some excellent concentrations that will help an operation start up. It's on the Meridiani Trail, so there's excellent access. We can reach Kalgoorlie from there; it's 350 klicks. That's why we bid high on it."

"So, you don't want to operate from the Ashanti-Deadwood region?" asked Will.

Bruce shook his head. "Not really."

"You realize it'll be a strain to support both locations safely?" asked Érico. "They'll both need two biomes, redundant life support systems, communications systems, and power systems. Both will need runways and additional roads. We'll have to plan for medical emergencies differently."

Bruce was unimpressed. "Meridiani will be a thousand kilometers away; a fourteen-hour drive. We've never had a biome failure and the buildings have their own an airtight bubbles. I don't know how both could lose air, unless someone deliberately sabotaged them. If that happened, we'd drive to Meridiani. If someone is injured and you have to send a sunwing or a shuttle, does it matter whether it flies to Meridiani or to Ashanti? Your guys built the Thymiamata Oasis in a month; they could move it 125 kilometers to El Dorado in a month. If I were you, I'd relocate two other oases to Kalgoorlie and Meridiani. Two outposts on the trail makes it safer."

Érico looked at Will, dumbfounded. The Commissioner turned to the others. "Gerhard, what are your thoughts?"

"Muller Mining wants all of Ashanti; that's why we bid what we bid. We would not have offered to split it with Consolidated. We'd be happy to work with Sibireco to locate an outpost that can serve their gold extraction from Deadwood, if they want to cooperate with us."

"Which we do," said Feodor. "We're satisfied by the location proposed by Lal Shankaraman."

Will looked around the room. He was surprised by both the result and the swiftness at which it was reached. They had come to Dawes for three or four sols of negotiations, including visits to the proposed outpost site. “Shall we visit Meridiani?” he asked.

“I don’t know that there’s anything we can accomplish together there,” replied Feodor.

“So, we’ll have two outposts,” exclaimed Bruce. “Do we have two boroughs also? A borough is usually less than a thousand klicks across.”

“Two, I guess,” replied Will. “One’s east of the meridian and south of the equator, while the other’s west and north. But I doubt they’ll have many residents.”

“For a while, yes,” agreed Bruce. “Note that Kalgoorlie is east and north; is it a borough as well?”

Will scowled at him. “It ain’t anything until it’s actually settled.”

The meeting continued another hour, then the men adjourned. Will did office work for the rest of the afternoon, then went to supper. Érico arrived at about the same time. “I don’t know about you, but I’m furious,” Érico whispered.

“We wasted our time coming here,” agreed Will. “Maybe we should be relieved we’re heading home sooner.”

“I am. It’ll take months to build their infrastructure, though.”

“I bet Curry will ask for a biome at Kalgoorlie as well. Wait and see.”

“I think he wants to increase the boroughs from three to six! And they’ll all be tiny.”

“We can’t give them three biomes; in fact, we can’t give them two! The two boroughs are getting one biome per year. Meridiani Outpost will be first because it’ll be bigger and involves two mining companies. El Dorado—I guess it’s Thymiamata Outpost—gets its biome in early to mid 2052. Curry’s crew will have to operate without one until then.”

“I think that’s pretty generous of you.”

“Not really. We can make biomes a lot faster than we used to. We’ll move Thymiamata Oasis to El Dorado and add a second shelter, so Curry’s people will have them for support. I suspect life support will have to run open loop because there will be too many people, but there’s plenty of ground water, and we can ship them an extra solar power unit.”

“So, do you think Curry’s trying to pack the Mars Council?”

Will shrugged. “Who knows. If so, it won’t work; based on the fundamental law, each borough will get one representative, and the Council will have to decide whether Kalgoorlie is a borough.” Will saw that someone was approaching the food line; he and Érico fell silent, as their privacy was ending.

As they left the food line, Will spotted a friendly face in the crowd eating. “Hey, Helmut!” he said. “I didn’t know you were here.”

“Yes, for the last month.” He pointed to his companion. “Do you remember Clara Forsyth?”

“Yes, I do! You arrived on Columbus 8. How are you enjoying Mars?”

"Quite well. Helmut and I were both on the Meridiani Trail project, and now we're part of the team clearing some new roads for the new super-heavy equipment. We'll be back at Aurorae next month."

"It'll be good to see both of you again." Will noted how closely they were sitting together. "In the meanwhile, best wishes with everything." He continued on to the next table, since Helmut and Clara were seated at a table for two.

"'Best wishes with everything?'" Clara said to Helmut, afterward.

Helmut laughed. "They say Elliott is an incurable romantic. He encourages marriage whenever he can."

"Oh? So he was referring to that?" She chuckled.

"I think so. How often do you see two people sitting *on the same side* of a table for two?"

She chuckled again. "I suppose that is a give-away. But I still haven't heard any sort of question from you, and we've been living together for three months."

"Oh, Clara, you know I love you! Besides, I want to put in for all sorts of asteroid missions in the future. I could be away three or four years. Do you want to be married to someone who's flying through the asteroid belt?"

"Maybe! I could even apply for the same mission!"

"That's an interesting thought, you and me flying to Ceres together."

"Why not? I'm a good systems engineer, and now I know geology and road clearing as well. Don't assume you're the only ambitious astronaut on Mars."

“Oh, I don’t. I really do feel torn, though. I’ve seen a lot of marriages break up because of space flight. My mom and dad barely managed to stay together; sometimes I think it was just out of force of habit. He was on the moon six months of the year.”

“I’ve seen that, too. At least here there’s a high probability we can get assignments in the same place if we’re married. We could fly to Phobos or Deimos together, for example.”

“That’d be fun. I’d still like to apply for a trip to Venus or Mercury. Venus has expanded to six people, and the Mercury plans call for the outpost there to grow to eight, then twelve over six years.”

“I’ll apply with you. I bet Marsian astronauts have a chance; we have a lot of experience. Maybe a group of us could apply together and a separate flight from Mars to Mercury could be arranged.”

“I wonder whether that would be possible?” Helmut pointed to the roof of the nearby building. “Come on, let’s walk for a few minutes.”

“Okay, but remember Elliott’s speaking in another fifteen minutes.”

Helmut nodded. They bussed their trays and walked to the south building, where they took the spiral ramp to the roof. Other than a Spider-15 agricultural robot patiently picking tomatoes and cucumbers, they were alone. They were high enough to see outside; the three craters south of the outpost were pretty in the golden light of the approaching sunset. They leaned against the railing and against each other and looked out.

“This is a beautiful place,” Clara said.

“Yes, though I miss the escarpment at Aurorae.”

“And the dacha. We’ll have to go there after we get back. Oh, by the way. There’s a potential adventure for us in October.”

“Oh? What?”

“Well, it’s exciting and tedious at the same time. When Adam Haddad arrived here yesterday on his way to Cassini we got to talking, and he told me that in October he has to drive from Aurorae to the Elysium Sea with a drill and other heavy equipment. He has to go via Dawes because the equipment is too heavy to pull up the steep grades from the floor of Marineris to the Tharsis Plateau. The fastest, safest way back is via Marineris.”

“So he’d be driving all the way around Mars on the Circumnavigational?”

Clara nodded. “He needs someone to go with him. I was thinking that we could take some vacation time and both go with him.”

“Great idea!”

“The driving alone will take three or four weeks. He’s taking a nuke and an emergency shelter.”

“How do we sign up?”

“I’ll arrange it,” said Clara.

Helmut looked at her. “So, would you like to go to Mercury and the asteroids?”

“Yes, I would. I applied for Mars because I wanted to be part of the wave of human expansion. At the time, I didn’t take consider that Mars personnel would be involved in exploration elsewhere, but that has happened. Do you think they’ll let you go on another expedition soon, though?”

“I don’t know. I was chosen randomly for the Gradivus mission; literally, it was a random draw for the position, and even then I was a last-minute replacement when Andries Underwood broke his leg! So many qualified people want to go that they chose a few positions randomly. Maybe it’ll be ten years, who knows.”

“There is plenty of exploration to do on Mars, meanwhile.”

Helmut nodded. “As we’ve seen.”

“Do you want to have children?”

“Yes, I think so. This place is a funny contradiction. There’s a lot of emphasis on family life, but anyone exploring has to be away from their family for months.”

“I think the time has come to modify those policies,” said Clara. “Mobilhabs are so big and reliable, one could take care of a child in one.”

“But what about radiation?”

“Add a tonne of shielding to one section of the mobilhab; it won’t add that much to its total mass. It would reduce everyone’s exposure. I’ve been thinking of talking to Vanessa about this; she’s really restricted in what she can do.”

“So I gathered. That’s why I feel torn about children. I was raised in a family where dad was away a lot. He was on Mars thirty months.”

“But you managed okay, and here you are following in his footsteps.”

“True, but my younger brother hated it.” Helmut was silent a moment. “I guess part of the problem is loneliness. In a family, you’re never alone. But I was terribly lonely my first two years here. I wasn’t completely aware of it, or maybe I should say being with you for the last three months has made me realize how lonely it was.”

“Why didn’t you have a girlfriend?”

“Because the women intimidated me; I was three years younger than any of them. Because most were looking for husbands and I wasn’t a great prospect. I was the youngest adult up here, and one of the few without a Ph.D. It was hard. That was one reason Skip Carson, Brian Stark, and I stuck together, even though our politics were radically different; we all felt like outsiders.”

“But you aren’t an outsider now.”

“No, things feel better now because I’m two years older, I’ve got more experience, and because there are ninety people here who arrived after I did. And you have been incredible, Clara. I feel so much more. . . whole. . .”

“You’ve been incredible for me, too.” They pulled closer together. “I want to be with you forever.”

“I want to be with you forever, too.” They kissed, long and passionately. “So, shall we get married?”

She nodded. “Yes, I’ll marry you, but you have to give me a ring, don’t you?”

“Yes. I guess that has to wait until we can get to Silvio’s.”

“Elliott, Lopes, and Islami are flying back to Aurorae tomorrow, and Adam drives back here in two weeks. We could ask for some time off.”

Helmut laughed. “You always surprise me! Let’s do it!”

13

Quirinus

late Sept. 2051

Clara pointed across the patio. “There’s Vanessa! I was hoping we’d run into her. Let’s go sit with her!”

“Okay,” agreed Helmut. He was a bit irritated by Clara; she preferred to hang out at Aurorae and show off her new engagement ring than go to the Dacha with him.

They went into the cafeteria and got lunch. Feeling gallant, Helmut swiped his credit card for both meals; 77.30 redbacks. He felt slight relief, since two lunches at Dawes would have run closer to 100 redbacks. He followed Clara, who hurried over to the table where Vanessa was slowly feeding her son, Maaka.

“Hey, how are both of you!” exclaimed Vanessa as she saw Clara, then Helmut. She stood and embraced Clara, who held out her hand with the engagement ring. “Wow, a diamond! Congratulations to both of you!”

“Thank you,” said Clara.

“When’s the wedding?”

“We don’t know, yet,” replied Helmut, figuring he had better get into the conversation from the start or remain silent. “It’s almost conjunction and communications with Earth take a long time. If we wait another year, we can get married close to opposition and can have parties on two worlds.”

“That makes sense,” said Clara. “Everyone’s postponing things until opposition; it’ll be a busy time! Sit down. It’s good to see you both. Where have you been?”

"Central highlands," replied Clara. "After the Meridiani Trail was finished, the expedition widened the Cassini-Dawes Trail, then we stayed at Cassini a month doing construction, then spent part of a month doing exploration south of Dawes and clearing some new trails there."

"And now we're heading back to Meridiani," added Helmut. "Did you hear? There'll be two outposts there."

"Yes, I just heard this morning on *Mars This Sol*. There's already a tune about it; they printed it:

"We were prospecting Dawes to Cassini

"Dug golden riches in Meridiani

"Found nuggets plenty in Thymiamata

"This land was made for you and me."

They all laughed. "I think Lal composed it," said Helmut.

"Are they starting construction on them already?"

Clara nodded. "Next week. It changed our plans, too; we flew here on the regular monthly sunwing flight and planned to return on the semimonthly cargo run, but that run has been moved up by three days to carry cargo to the site of Meridiani Outpost. We have to go back sooner than planned."

"That's too bad. I hope we get some time to visit; where are you staying?"

"Up at the Dacha," replied Helmut. "This is a little vacation; a sort of pre-honeymoon celebration."

"Very nice," replied Vanessa, uneasy. "When did you decide to get married?"

“Two sols ago,” replied Clara. “But we’ve been getting to know each other for nine months; pretty much since I arrived.”

“And I’ve decided to pursue my doctorate,” added Helmut. “I doubt I’ll be getting another asteroid mission for a few years, so we plan to settle down and finish our educations. I’ve already emailed an application to Mariner Institute of Technology.”

“Good! And the timing should work out. The fall semester starts in a month.”

“How are things here?”

“Fine. Have you gone into Dakota yet? They’ve got it inflated and it’s fully operational as an agricultural biome. The air’s thin, though, you’ll have to walk around slowly. You probably haven’t been in Shenandoah either, come to think of it. It’s inflated to standard pressure and is all agricultural as well, except for an area for bioarchive.”

“Two new biomes?” said Helmut, surprised.

Vanessa nodded. “And Oregon just inflated, though it’s still a construction zone. The new system is much faster. Of course, it helps to have fifty people working full time on construction and fabrication. There are plans to expand that department, too.”

“We heard about the Caravel Project,” agreed Helmut.

“How old is Maaka?” asked Clara, pointing to Vanessa’s son.

“Nine months! He’s got five teeth and is beginning to crawl, and he’s trying to say ‘mama.’ And he’s sleeping through the night, thank God.”

“Where’s John?”

“Hellas. There’s an expedition ten kilometers south of the Ice Chimneys, where they’re drilling a small, isolated fumerole. The goal is to determine whether there’s terrestrial biota there, and if so how deeply it has penetrated, and whether there’s any

evidence of Martian life, current or recent past, in the rocks there. Also, they want to assess the geothermal resources there."

"Power?" asked Helmut.

Vanessa nodded. "So far, there's no evidence of Martian life at the fumerole, though the terrestrial species we've found at the Ice Chimneys are in the ground there as well. There's a huge body of hot rock underground, but it's pretty dry. However, there's abundant water about fifty kilometers to the west, so water could be injected down one well and steam recovered up another."

"How much electricity?" asked Clara.

"Potentially, tens of thousands of kilowatts. If that proves true we'll have to make some difficult decisions: do we leave the hot rock alone as a biological reserve for the feral terrestrial biota or do we set up a small outpost there specializing in energy intensive processes, like aluminum refining, and energy exports."

"Difficult issues," said Helmut.

"The expedition finishes in October and the report will be final then. So we have a month before the arguing begins." Vanessa fed another spoon of puréed peas to Maaka.

"I suppose we could leave the matter to the Commission," suggested Helmut.

Vanessa shook her head. "This is too hot and involves too many interests. The Mars Council and Mars Assembly will have to be involved. If we want to create a biological reserve—a 'national park'—the Commission, Assembly, and Council would all have to agree."

"Do you wish you were at Hellas now?" asked Clara.

Vanessa looked up. “I haven’t dwelled on that question much, since someone has to take care of Maaka, and John’s expertise as a geochemist is more relevant than mine as an eobiologist.”

“I don’t know,” replied Clara. “It seems to me that a mobilhab is big enough for a baby, don’t you think?”

“Big enough? I suppose. The problem isn’t space; it’s radiation and safety.”

“I know. But what is the safety issue, really? Depressurization? And why can’t the radiation problem be reduced?”

“Depressurization is a serious issue. We’ve already had one death from ranger depressurization, and several close calls.”

“Those were with rangers, though, not mobilhabs.”

“True. Mobilhabs are safer with their redundant door latches and their multiple airtight sections. But there’s still the radiation problem.”

“Why can’t we increase the shielding, even for a part of the mobilhab? A baby doesn’t need much space.”

Vanessa shrugged. “I don’t know. That’s an interesting idea. If children could go along on expeditions, it would be easier for the parents, though maybe not for anyone else. Their crying would be a major noise problem.”

Clara looked around and saw Alexandra seated at a table nearby. She pointed; Vanessa nodded. “Hey Alexandra,” she said, beckoning the construction and design expert to come over. Alexandra had finished eating and was enjoying a coffee with Yevgeny—who was holding Boris—and the Vickers, with whom they had always been close. Alexandra rose and walked over.

“Here are some people I haven’t seen a while,” she said to Clara and Helmut. “Welcome back. Where have you been?”

“Meridiani, Dawes, Cassini, and now back to Meridiani,” replied Clara. “And I see you had your baby, and you kept him.”

“Yes; Boris. He’s now ten weeks old, and a joy. Thank God he’s a pretty easy baby and that Yevgeny is doing the lion’s share of the nurturing! So it’s worked out.”

“I’m so happy for you.”

“Thank you. I’m happy, too. I really am.”

“Say, I have a question for you. Why can’t mobilhabs be made child-safe? Safe enough for expeditions, that is.”

“Child safe. . .” Alexandra thought a moment, then shrugged. “There are two obstacles, I suppose; financial and emotional.”

“Emotional?” asked Helmut, surprised.

“Sure. People think they’re unsafe, and they’d continue to think so even if we could make them safe. There are cultural obstacles, too; not only do people assume kids can’t go out on expeditions, but the exploration culture has been developed based on that assumption.”

“What are the financial obstacles?” asked Clara.

“Well, it’d need a design review. Pressurization issues would have to be considered, a safe refuge in an emergency should be designed, radiation shielding would have to be added—”

“We have a refuge; the bathrooms,” noted Clara.

“Yes, and maybe they’d be enough; the design review task force would have to examine that. We have new software for designing radiation shielding which we’re using on the caravel. About a tonne of hydrogen-impregnated polyethylene in the right places would be needed. We also have several water and methane tanks that could be moved to produce an area of the mobilhab that is heavily shielded.”

“So, it’s possible?” asked Clara.

“I think so. The caravel will have several extremely low radiation zones for solar flares and they could also serve as sleeping areas for children; we’ve been designing on the assumption that someone could get pregnant on a long flight and that a very low radiation zone would be needed for the pregnant woman. The future Columbus flights will last four and a half months, so we won’t have to worry about births during them, but if caravels are used for asteroid or Jupiter missions, it’s a possible concern.”

“Alexandra, what should we do about this idea,” asked Vanessa. “I think it’s a good one. Fourteen years ago, Will and Ethel broke taboos and got married here, then they had children a few years later. But the family zone here is still pretty small. We’re not exploring Mars in cramped little rangers any more; mobilhabs are pretty large and safe. Why can’t they be made safe enough for an occasional child?”

“I doubt expeditions could handle more than an occasional child! They’d be noisy in cramped spaces, and a distraction.”

“Maybe we could use distractions of that sort on our expeditions,” said Vanessa.

“Let’s bring the matter to Roger, since he’s in charge of exploration, then Will.”

“How do we prepare something?” asked Clara.

"I'll look at the mobilhab design; I could use a distraction right now," replied Alexandra. "I can assign a team to consider the matter and generate a report. It'll take a month or so."

The cameras on the *Tharsis* were focused on the *Apollonaris* as it made its final approach to Quirinus. The *Tharsis* had just touched down on the asteroid; the second shuttle was just seconds behind.

"Five meters," reported Daichi. "Four. Three. Two. One. Touchdown."

On the screen in Mars Control they watched the shuttle's five legs settle into the asteroid's regolith. The shock absorbers absorbed the shuttle's downward motion, then converted it into an upward bounce. The reaction control system fired to keep the shuttle from rising back into the sky.

"We're on Quirinus."

The four personnel in Mars Control cheered and applauded. "We copy, *Apollonaris.* Congratulations," said Rostam Khan. "The image is great. It's good to have two vehicles down, safe and sound."

"We're all glad to be here," added Commander Hutan Hijazi, from the *Tharsis.*

The two pilots oversaw the automated checkout and shutdown of the propulsion system while the geologists—Kurt Hollingworth in the *Tharsis* and Andrea Shelton in the *Apollonaris*—began to suit up. Rostam, Roger, and Érico audited the procedure, but they could do little to intervene since they were twenty seconds away. In Houston another team was watching as well, but there round trip communications time was forty minutes.

Will watched and waited, making himself available if any serious decisions had to be made. A few minutes into the wait, before the teams went outside, his videophone line rang. It was Bruce Curry. He opened the connection.

"Good sol, Bruce."

"Good sol, Will. Say, what's this that I read about you not moving any of the oases on the Meridiani Trail? We need the oasis at El Dorado; otherwise we can't start gold recovery. I've got a team in a mobilhab and a conestoga almost ready to go. The sooner we start, the sooner all of us start making money."

Will was shocked by the call. "Bruce, half of Earth is watching the Quirinus expedition and you're calling me about *this*?"

"Will, half of Earth has gone to the bathroom or the fridge while the team suits up. I was reading e-mails while waiting and came across a memo from you on MarsThisSol.com."

"Read the memo again. It says we aren't moving oases because we're adding new ones; it's faster. Meridiani Trail will now be a lifeline connecting four outposts; the safer we can make it, the better. We'll shift the maintenance responsibility to the two new outposts, which adds to their personnel. Once the new outposts are set up, Adam Haddad won't have to drive the supply caravans any more; they can be completely robotic."

"Really? I apologize. When will you have the outposts set up?"

"Your team should be ready in two weeks. We'll start on the oasis then, which will provide enough infrastructure temporarily. We won't have biomes available for months. We'll give you a B-60 or even a B-75. Nice and big. But I've got to get back to the landing, Bruce. Talk later. Bye." And he hung up without waiting for a reply.

The pilots had finished the landing sequence and were suiting up as well. It made Will a bit guilty for hanging up on Curry; there was nothing to do but wait. The cameras on the two shuttles panned around the landing area. It was a typical asteroidal surface, with scattered craters, lone boulders, and a mantling of fine-grained, loose material. The one thing about the scene that was distinctive was the color: the carbonaceous chondrite was black, but the nickel-iron mixed in with it was metallic. Some boulders were clearly derived from one part of Quirinus and others from the other.

An hour after landing, the airlock of the *Tharsis* opened. Dr. Hutan Hijazi stepped out slowly, in full view of the cameras on the *Apollonaris.* He was carrying a Mars flag. Hutan took three very slow, gingerly steps on the surface of Quirinus; one could not speak of walking in a thousandth of a terrestrial gee. “Bismullah al-rahman al-rahim,” Hutan said quietly, then he added “Humanity steps onto another world.” Several explorers had said that with their first steps.

Kurt Hollingworth was just seconds behind him. Then the cameras were switched to the airlock of the *Apollonaris,* where Daichi stood. He stepped out as well, speaking in Japanese, followed by Andrea. “I dedicate this expedition to my baby, Marie,” she said.

They jetted toward a flat spot a hundred meters from each shuttle. All of them had experience exploring Phobos and Deimos; they didn’t fall or tumble. They gathered together in full view of the cameras on both vehicles.

Hutan pushed the flagpole into Quirinus’s sandy ground. “We hereby claim Quirinus and all its mineral and property rights for the Mars Commission and the people of Mars,” he solemnly announced. “Our month of exploration will seek to explore

Quirinus for both scientific and economic reasons. Our mission is purely peaceful and for the benefit of all humanity."

"Well done, Hutan," said Will quietly.

"Sounds like he got in all the fine print," replied Érico. "But we are generating controversy."

"I'll be receiving calls from reporters in about forty minutes," agreed Will. "I've set aside the afternoon for them. But our lawyers concluded this is legal. A nation can claim nearby islands whether they're 'offshore' or not. No one can claim every island in the Pacific by landing on one, and no one can expect every island in the Pacific to be part of a single future nation when the first few are being settled. That's true of the asteroid belt, too. It's a series of vast archipelagos. Some will be ours; most won't."

"And we'll mine Quirinus?" asked Rostam.

"When it's economical, yes. It's one of the best, it's one of the closest to Mars, and it now belongs to Mars."

Clara and Helmut spent the rest of the afternoon and early evening hanging out at the Patio, showing off the engagement ring with its big diamond and catching up with friends. Just before sunset they headed up to the Dacha, where they enjoyed the Jacuzzi in their room. The next morning they sat by the pool and called everyone on Earth to let them know about the engagement. Brian Stark was the first to call back.

"Congratulations, kids! What good news. I was there when the two of you began to get to know each other! I'll be sure to make a trip to Houston to visit with both of your parents and assure them it's a good match! I'll also volunteer to carry wedding presents

back to Mars; it's beginning to look like I'll be on Columbus 9, believe it or not! I'll have to tell you the details some other time. This is confidential information, so don't mention it to anyone else. You may want to shift your wedding a month or two, so that the terrestrial gifts are there. But if I'm not actually present, I'll be there in spirit. Best wishes to both of you. Take care of yourselves; of each other. Bye."

"How sweet of him!" said Clara. "I wonder whether we should reconsider the date. The time delay won't be that much more when Columbus 9 arrives."

"Brian's a good guy. It'll be nice to have him back."

"God, he's spending a lot of time flying through space. What a pain."

"Yeah. He was a United States Navy nuclear engineer and was always a bit mysterious. I suspect the U.S. government will ask him to come back as part of their nuclear team."

"If there is a nuclear team; half of Mars is angry with Elliott about it." She pointed to the screen. "Your dad's replied now!"

Helmut nodded and pushed a button. His father's face appeared.

"Well, congratulations to you both! Clara, welcome to the family. I'm thrilled for the two of you. I'll be sure to be in Houston at the time of the wedding so that we can plan a big celebration there. I'm sorry we can't attend in person, but at least you've chosen a date close to opposition when the time delay is minimized. Of course, I had always hoped Helmut would settle on Earth, not on Mars, but these things are unpredictable. Mars is a very exciting place to be; more exciting than the moon, even though we're now recovering from the tourism slump. I wish we had sent out some expeditions to Earth-crossing asteroids when we had slack demand, but money was tight,

the Board vetoed the idea, and I didn't push hard enough. I'll have to push the matter harder now; we're losing some of our best people to Mars! And maybe if there are some expeditions launching from the moon both of you will come back, raise a family here, and have your adventures near grandpa!

"Anyway, don't forget us; we miss you. Let's plan an entire day/sol together next time the weekends coincide. Bye."

"Your dad's thrilled," said Clara. "That's nice. He's sweet."

"And he really wants us to come back. Your parents feel that way too, I'm sure."

"Oh, yes. Wait till they reply to our announcement."

"I feel guilty about staying here, now."

"Well, don't! I don't want an affluent life in a rich Houston suburb with two kids and a husband somewhere else in the solar system. I want to explore with you and preferably with the kids as much as possible."

"That may not be possible, Clara."

"Will and Ethel changed things in spite of opposition from the Mars Commanders, one of whom was your dad. We can make some changes, too."

14

Power

late Oct. 2052

The lava ran red-hot and as fast as water at the bottom of the canyon, a hundred meters below the Prospector V-250's cameras. Sulfur fumes bubbles from the lava river, producing tendrils of smoke that rose rapidly in Venus's dense atmosphere. Helmut glanced at the canyon walls; his instinct was to zoom in to do some geology. But he had no control over the television image and the layers of lava and ash were melted into a smooth wall anyway.

The camera panned the length of the canyon, from the lava waterfall at the right to the misty distance at the left. It zoomed in on a small island being eroded by the flaming torrent. Some ash drifted across the view from the eruption a dozen kilometers away.

Then the image shifted abruptly to a rolling dune field. Another Prospector V-250 was slowly advancing between two dunes, which consisted of broken basalt fragments rather than sand. It stopped and zoomed in on a rock until Helmut could see crystals.

But before he could study them, a third scene appeared, from a little Phoenix robotic airplane zooming in on a Prospector negotiating Navka Planitia. The vast wasteland was littered by basalt blocks, loose dirt, and large cracks in the lava plain; the Prospector looked lost in the desolation. As the Phoenix zoomed in on the Prospector, it deployed a whip with a metal catch on top. The Prospector sped up and passed just centimeters above the catch, but its capture hook caught it. Up came the catch, whip, and the sample canister, full of samples. The Phoenix gunned its engines and headed for the

Samandar sunwing flying sixty kilometers overhead, where automated equipment would analyze some of the samples and store other fragments for transport to orbit.

Skip Carson's face replaced the desolate scene. "So, what do you think? One week in Venus orbit and I've already run two Prospectors! I didn't fly the Phoenix; the Magellan crew supplied the footage. Most of us spent months in training; it broke the monotony of the flight here. Now we're thrilled to be on Venus via virtual reality. They have six functioning Prospectors, so there's one available most of the time. Before I leave here I should have a pretty good documentary. I've already started interviewing the crew. They're thrilled to have us here; Magellan's population went from six to sixteen overnight! Brian's going to do some of the narration. Unlike the rest of us, he's bored to death. Venus does not interest him at all.

"If you have any ideas, pass them on. There's real drama here; the exploration of Venus is not dryly robotic. Hope you and Clara are doing well. Bye."

Skip's face faded. Helmut stared at the screen a moment, then hit reply. "Hey, Skip! I think the scenes are incredible, but I suppose the narration is what will bring it alive. Otherwise, a lot of your audience will have Brian's reaction. The fact that you ran the Prospector yourself is what excited you. But I'm sure you know that and plan to show shots of you moving your arm and the Prospector arm moving in response. I'm looking forward to the narrative; I was amazed by your Mars documentary!

"Not much news here. Clara and I just reached Aurorae and we plan to relax a while before we go back out. Bye."

He sent the message and looked at Clara, laying on the bed. "We'd better get to the Patio; dinner has started."

“I was waiting for you.” She rose and they headed to Yalta.

When Helmut and Clara entered the biome, they were surprised to see paper snow flakes dangling from strings and plastic snow men on the lawn. “What’s this?” asked Helmut.

“I don’t know,” replied Clara. She searched the faces at the tables and spotted Vanessa and John Hunter. “Let’s ask them.”

Helmut nodded and they walked over. Vanessa was surprised to see them. “My goodness, everyone returns to Aurorae at once!”

“Yes, the Meridiani expedition is finally over,” said Helmut. “Two more months of construction; but two outposts are now started and in pretty good shape.”

“Were you doing construction, too?” John asked Clara.

She nodded. “In between keeping the records and assignments, I ran a crane that lifted the wind turbines in place and learned welding.”

“You never know when it might be useful,” added Helmut. “I now have certificates in welding, laying electrical wire, and running a bulldozer.” He looked at John. “You got back this sol, too, didn’t you?”

He nodded. “Yes, four months in southern Hellas. It’s winter there; noticeably colder, short work days, and we even had a bit of snow!”

“What are the decorations for?” Clara asked.

“Winter festival,” replied Vanesa. “For the last six weeks Huron and Colorado have had half a meter of snow on the ground. It started at conjunction, which we celebrated Mardi Gras style. Silvio’s carried masks and costumes.”

"It was Rio Janiero Mardi Gras, not New Orleans," added Érico Lopes from his seat at the next table.

"Érico was Chair of the Planning Committee," explained Vanessa. "There was a costume parade, children's activities, a concert, a lot of food, and winter activities in the biomes. Enjoy them while you can; spring thaw is scheduled for next week."

"We'll go for a walk there," said Helmut. "How was the Hellas expedition?"

"Go get your dinner and come back. I'll be telling the story in a few minutes."

"Okay," agreed Helmut and Clara. They walked over to the cafeteria and got in line. When they returned to the table, two seats had been saved for them. Lal Shankaraman and family had arrived; his daughter Aditi, now 4 ½, had Downs Syndrome and was mildly retarded. Shinji Nagatani, one of their physicians, was there with his wife, Michiko, and their six year old, Yuki.

"The story is so short," said John, noting that the last members of his audience had now sat. "We spent our first three weeks setting up an oasis. It was nice to have a permanent shelter, though; it gave us a lot more room. We set up a solar power array angled to maximize the winter sun and three wind turbines. This is a pretty windy time of the year, with the polar cap rapidly expanding to the south.

"Then we turned to drilling and exploration. Some of us returned to the Ice Chimneys to study the steam flow, temperature fluctuations, the growth and sublimation of the ice structures, the biota, etc. We flew samples back here weekly. The photosynthesizing organisms go dormant in the winter; too little light penetrates the ice chimneys. We'll soon know whether there are any new species."

"Two so far, unofficially," added Vanessa.

"And of course there's still no sign of native Martian organisms, though the feral terrestrial ones apparently have been here sixty-five million years! There's a lifetime of research to do on them, and their importance is gradually being recognized.

"We made a lot of five-sol trips around southwestern Hellas, visiting craters, dry arroyo networks, etc. We verified a big deposit of fossil ice that orbital radar had detected about twenty-six klicks southwest of the drill site. We found evidence of recent fluvial activity; some of the arroyos apparently were active during the Yaonis Estival twelve million years ago. Writing all that up will take the next few months.

"The drill broke a few times, but we penetrated a kilometer before we left. That's more than we had hoped. The rock was 100 Centigrade at the 400 meter level and 200 Centigrade at the bottom. We penetrated sedimentary rock back almost to the formation of the Hellas Basin. We'll try to drill all the way through next time we visit. The rock's pretty dry, the heat having baked the water out over the last hundred million years or so."

"And the seismic data?" asked Érico.

"Still being analyzed by Toru using his supercomputer. It looks like the body of heated rock extends to the base of the crust; there's a mantle plume underneath. The Ice Chimneys are twenty kilometers away along the same fracture running circumferentially around the Hellas Basin."

"That's a lot of hot rock," said Érico. "Can we extract thermal power from it?"

John nodded. "There are terrestrial organisms in the pores down a half kilometer, but they're the same species at the Ice Chimneys, and they're comparatively rare because the rock is so dry. If we drilled two thirty-centimeter shafts two hundred meters apart and cracked the intervening rock with explosives, we could pump water down one shaft and

get a steady flow of steam up the other. It'd take three robotic trucks two months to haul enough ice from the deposit, and we'd have to recycle the condensed steam carefully. But it could generate tens of thousands of kilowatts of electricity."

"Good!" Érico looked delighted. "It take a year to get the system functioning. We'd have to make the steam condensers and pipes here and haul them eight thousand kilometers. But it'd be less work than a nuclear reactor."

"That's true," agreed Lal. "John, what about the consequences to the biota at the Ice Chimneys?"

"We'll have to study the matter more, but right now they appear to be located in a separate, more active, thermal vent, so I don't think harvesting heat from one will affect the other."

"Good. I worry about the plan for a reactor," said Lal.

"I agree," said Érico. "We're doing fine with solar and wind power. Geothermal power might be useful though; we could beam it to Phobos as microwaves and redistribute it from there. But nuclear is more expensive than necessary."

"How much will the microwave distribution system cost, though?" asked Shinji.

"A multiply-redundant system is three hundred million redbacks plus transportation and installation. But we'd need the system for reactor power as well, at least until we could make reactors for every major outpost."

"I'd use the geothermal power to manufacture silane and export it via robotic truck," said John. "That'd cost a lot less. You'd use up half in the transportation, but microwave transmission loses forty percent as heat."

“I’d devote the three hundred million to solar and wind,” replied Lal. “It’s scandalous that we have sixty-five wind turbines in storage after completing them almost two years ago!”

“We do?” asked John.

“Yes, we made 100 at once; it was more efficient. But we’ve set up only thirty-five of them.”

“We also spent four hundred million redbacks to refine and shrink the solar cell manufacturing system the moon has. We can now manufacture a thousand square meters of 25% efficient solar panels per month. That’s about five hundred kilowatts of continuous power output we can create every year. It’s plenty to meet our growing need for power, and it can be expanded easily.”

“The wind turbines can meet it, too,” said Lal. “Basically, every additional person here would need four wind turbines to meet his or her power needs. We can set up two hundred a year pretty easily. It’s not like Mars will run out of good wind sites!”

“I’m glad we have solar and wind, but the nuclear reactor represents a different capacity, doesn’t it?” said Shinji. “It seems to me it represents a huge, lucrative export: enriched uranium, plutonium, americium, and dozens of other isotopes that are needed in space. Solar power is impractical for most of the moon, the asteroids, and the outer solar system, and wind is unavailable on the moon, Mercury, and in jovian space. Nuclear power is essential beyond Mars and may make our flights to and from Earth faster. Even with the Swift shuttle’s immense reliability, using it to launch radioactive substances remains politically risky and emotionally charged. We’re the potential source for the entire solar system beyond Earth.”

“Including the U.S. military,” replied Érico. “They have said again they won’t pursue a star wars defense system, but I don’t believe them. Martian uranium cannot be used to pursue violence on Earth; we have a moral obligation to prevent that at all costs.”

“At all costs?” asked Shinji. “Would you reject exploration of the outer solar system?”

“If the alternative is the possible incineration of millions of human beings, yes.” Érico spoke quite forcefully and there was silence around the table, as well as around two or three nearby tables that were listening to the escalating conversation.

“But Érico, don’t you think there are other ways to remain vigilant?” asked Helmut. “For example, getting all the pledges in writing, and making sure the penalties are strong enough?”

“Perhaps, but that might be a slippery slope, Helmut, and one that could cause our lights to go out. Keep in mind that fission is required to make radioactive isotopes, and fission makes heat that has to be disposed of. They want to make fifty thousand kilowatts of electricity; that’s how much you have to make, to produce a dozen kilos of plutonium annually. Our total power generating capacity now is under two thousand kilowatts. What would we do with it all? We’ll be like a lean goose suddenly force-fed a tonne of truffles! We’ll get dependent on it, and we’ll neglect solar panels and wind turbines because they’ll suddenly seem like a wasteful duplication of infrastructure. Five years, ten years after adjusting to the availability of fifty thousand kilowatts, how will we fight the U.S. military if they want to change the rules and use the plutonium for powering weapons? If they stop, our lights go out! We’ll be co-opted.”

“Then we need to be sure the U.N. is involved,” said Shinji. “And that any nuclear facility here has safeguards beyond anything we can insist on.”

“That would help,” agreed Érico.

“We should take the matter to the Mars Council,” suggested Lal.

“The Council? That might embarrass the Commission,” said Helmut.

Érico shrugged. “What’s a government for? If the Mars Council is the future Mars legislative body, it should get involved. Nuclear power on Mars is a big issue; the residents should have a say, as should the landowners.”

“I agree,” said Lal. He pointed. “We can approach Will now, if we want.”

“No, we need to plan first,” replied Érico. “Besides, he’s heading onto the stage.”

“I guess we’re getting a speech,” noted Clara.

Will Elliott hopped up onto the stage and stepped to the podium. He waited for the microphone to be activated and for the crowd to quiet. “I don’t want to take a lot of your time, but this occasion seems an appropriate one for a comment. Welcome home to the members of the Hellas and, above all, the Meridiani expedition. Hellas has advanced our science and possibly our power supply significantly. Meridiani had so much fun they extended their work from six months to eight and revolutionized our situation in the Central Highlands. Let’s give the members of both expeditions a hand.”

He paused to let everyone applaud. “In a few weeks we have two new expeditions going out. The Elysium expedition will investigate thermal vents and potential geothermal power in that area. The North Polar expedition will drill the cap to reach the bottom of the ice.

“I received some good news earlier this sol. The French government has decided to make a gift to Mars similar to the Statue of Liberty. Called ‘the Spirit of Mars,’ the eighty-meter monument will be made of aluminized and painted mylar with metal reinforcements. It will be erected one kilometer from Embarcadero next year, attached to its own station-keeping unit. Our own Madhu Gupta-Anderson is the chief designer.”

That generated strong and sustained applause. “So Mars is doing well. The Caravel project is taking shape nicely and the biome expansion is moving along on schedule, in spite of being short of personnel. We’re building an entire world here, and the successes are very concrete and promising. They are the result of your hard work, so thanks to all of you.”

Will stepped down off the stage to applause. He spotted Lal and headed for his table. The others there looked at each other a bit nervously.

“Hey, Lal,” Will said. “I want to thank you personally for all your work on the Meridiani expedition. It was probably the longest, most complicated expedition we’ve ever sent out, and it accomplished 150% of its objectives. The science will be remembered for a long time and it made history by founding two new outposts. I can’t think of anything we’ve done to which to compare it, except maybe clearing the Circumnavigational Trail.” He offered his hand.

Lal shook hands. “Thanks, Will. But thank Johnny Lind as well. He ran half the expedition and he often had the harder half; he was in charge of the construction for the last five months.”

“Alright, I’ll go find Johnny. So, you’re vacationing for a few weeks?”

“Yes, then writing it all up. I should be available for field work again next year.”

“Excellent. Enjoy the break.”

“Thanks, Will.” Elliott turned and headed across the Patio to Johnny Lind, who was standing next to the coffee machine. “Johnny,” he called, as he approached. “I want to thank you for your dedicated work on the Meridiani expedition.”

“Oh, thanks, Will, I appreciate that.”

“Seriously, you accomplished a tremendous amount. The science was first rate; our understanding of this world’s formation and development was moved forward significantly. The trail will revolutionize transportation and the two new outposts will expand our exports. The three mining companies will be paying us a total of two billion redbacks over the next three columbiads for the mineral rights, plus fifty percent of the profit. Your expedition has made the Caravel project financially possible.”

“Really? I’m delighted, because I want to do more exploring, especially to asteroids.”

“It sounds like Lal will be giving you an excellent review. Let’s plan to talk after the review is completed.”

“Alright.” Johnny was beaming. “I hope you don’t hold a grudge against me for running for Aurorae Council.”

“No, no, you didn’t do anything illegal. Don’t even worry about it.”

“Good. Because I’d like to start thinking about my next assignment. I’m taking some vacation up at the Dacha, then maybe a week or two here.”

“Okay. Let’s talk when you’re ready and after I’ve heard from Lal.”

“Sure. Thanks, Commissioner.”

“Thanks.”

A week later was a Bahá'í holy day, the Birth of Bahá'u'lláh. Because of Tomas Racan's personal efforts to invite practically everyone at Aurorae, Clarke Dome was crowded for the program. After sacred readings, recorded music, and singing a few songs, everyone turned to the tables of food that Mars's seven Bahá'ís provided. As Father Greg approached the coffee pot, he was surprised to see Ruhullah nearby drinking tea. "Oh, good afternoon. This has become quite an ecumenical occasion."

"Yes, it has; I'm surprised," replied Ruhullah. "Tomas is Anna's cousin, right?"

Greg nodded. "Yes. He shocked us by converting to Bahá'í back in the spring. It seems to have really fired him up; he may be the most active member they have here."

"I think so. He invited me to come, so I did."

"I'm a bit surprised; aren't Muslims hostile to Bahá'ís?"

"Some are. Iran has imprisoned thousands of Bahá'ís and executed hundreds purely for their beliefs. Of course, the third Iranian Revolution changed the situation and the Bahá'í religion is now legal in Iran. In my opinion, the Islamic Revolution of 1978 did more damage to Islam than a thousand years of corrupt Muslim kings." Ruhullah smiled. "I'll tell you a secret I've never told Will. My first name, 'Ruhullah,' the 'spirit of God,' was given to me in honor of Ayatollah Ruhullah Khomeini, the architect of the Islamic revolution! And my last name, 'Islami,' reflects the religious zealotry of my great grandfather. He had Bahá'í neighbors in Shiraz with the last name 'Naha'i' and that angered him, so when the time came to select a family name, he chose 'Islami.'"

"Really? It's sort of anti-Bahá'í, then?"

Ruhullah nodded. “I’m not proud of these facts. I find them ironic, because Mars is a different sort of world. Here, religions must compete, and that means being tolerant and exemplary of good deeds and compassion.”

“Yes, it’s interesting, isn’t it? Interfaith activities are assumed to be natural and normal, everyone is willing to pray with everyone else, and religion is not seen as automatically suspect and evil as long as it is tolerant and positive. Since we have a scientific society, anti-evolutionary notions are regarded as bizarre, as are most interpretations of prophecy, so we have little Fundamentalism.”

“Exactly. We have a sort of liberal religion here, though most religious people take their scriptures seriously. It’s difficult to explain to one’s acquaintances on Earth; they’re embedded in a different culture. I suppose you have that problem as well.”

“Yes, and I get interviewed a lot by media people as a result. I always stress that they have to be here to understand. Yet we do have our share of people with very strong religious opinions, not to mention believers who don’t like interfaith activities.”

“And a lot of agnostics and some atheists,” added Ruhullah, with a nod.

“If I had been elected to the Borough Council a few months ago, do you think I should have accepted the post?” asked Greg.

“Yes, why not? I’ll tell you why. The issue of conflict of interest between priestly and secular positions, in my opinion, is less than the issue of conflict of interest between serving on the Mars civil government and being an employee of the Commission. I feel a lot of unease over that conflict.”

“Yes, I suppose you do, especially with people questioning the Commission’s plans for nuclear power, working with the U.S., etc.”

“Exactly. I’m bound as an employee of the Commission to be loyal to its goals and purposes, but as Borough Clerk and as a member of the Mars Council, I have to keep Aurorae’s and Mars’s interests first. When an issue like nuclear power comes along, what do I do?” He shook his head.

“If it’s any comfort, there are only two people without a close tie to the Commission living in Aurorae—Madhu and Silvio—and they’re both on the Council already, so someone has to fill the other three seats.”

“And as a priest, you have a good reason to override your status as an employee of the Commission. But Greg, how will civil discourse ever develop under these circumstances?”

“Give us time! Gradual privatization will change the employment statistics. So far the Commission has been careful not to interfere.”

“Yes, and thank God for that,” said Ruhullah.

They suddenly heard applause from the other side of the dome. They turned to look; a small group of people gathered in a corner were clapping. Everyone else stopped and watched. Robert Wairimu was there and he was nodding thanks humbly.

“Is he getting married?” asked Greg.

Ruhullah shrugged. Then Anna, who had been in between Greg and the crowd, walked over to him and Ruhullah.

“Robert just became a Bahá'í,” she said, a bit startled.

“Oh?” Greg was startled, too.

“What was he?” asked Ruhullah.

“Catholic,” replied Anna.

“Really?” exclaimed Greg. “We’ve never seen him at mass.”

“Not long after he arrived, I was talking to him on the Patio, and he told me that was his family background.”

“Oh.” Greg frowned at the enthusiastic hugging that he could see. “Maybe they should be a bit more discrete.”

“I think he surprised them,” replied Anna.

“Conversion’s always an ambiguous event in a small community like this,” observed Ruhullah. “When Rosyln Tremaine became a Muslim last year and started wearing the hijab around the Outpost, it raised eyebrows.”

“Especially among Protestants; she had been Baptist,” added Greg. “Of course, when Fatima Hijazi started to attend my Bible study classes three years ago, that was hard on the Muslim community.”

“Our beliefs make it pretty hard to accept that,” replied Ruhullah, uneasy.

“Like you said, change is never easy,” said Anna.

15

Teamwork

Jan. 2052

The *Apollonaris* and *Tharsus* blazed into the Martian atmosphere at high speed, slowing enough to enter a looping orbit around Dusty Red. They climbed to an apoapsis high above both moons, then fell back toward the surface. The second pass through the atmosphere brought them to a landing at Aurorae and a hero's welcome.

The next morning the Quirinus crew had an appointment with Will Elliott and Ruhullah Islami.

"Welcome," Will said. "Come in."

Hutan Hijazi nodded in thanks and entered the conference room, followed by Daichi Furukawa, Kurt Hollingworth, and Andrea Shelton.

"I hope you had a chance to rest?"

"Yes; it's good to be home," replied Hutan.

"Please sit," said Will, directing them to seats around the table. "We're relieved you returned safely and very grateful for what you accomplished. Thanks to your efforts, the courts have ruled that Quirinus is under the jurisdiction of the Mars Commission."

"It'll be a while before it'll be profitable to mine it, though," said Daichi.

"They'd have to compete against us, the moon, and soon Mercury," agreed Will. "But the sol will come."

"At least we found the perfect spot for a station," added Andrea. "The next mission, whenever it is, will have full water tanks and plenty of methane and oxygen."

“And the caves,” added Kurt. They had found several massive fractures in the asteroid that were a hundred million years old and thus highly stable; one was large enough to house a station.

“Your exploration was thorough and creative,” continued Will. “Furthermore, the four of you worked as a team incredibly well. That impressed us more than the technical aspects of the mission.”

“We had excellent leadership,” said Kurt, looking at Hutan.

“That’s true. But the four of you had a lot to do with it. Gradivus did an excellent job at exploration, but the team dynamics were not of the same caliber. Teamwork is harder to achieve than building reliable and efficient machines. Maybe our training programs are getting better.”

“That’s why we want to give the four of you an award,” said Ruhullah.

Will nodded. “This Satursol evening at the big welcoming dinner. The Commission is establishing an annual award for teamwork called the Crimson Circle Medal. A circle stands for a lot of things: unity, cooperation, feedback, closed cycles. Crimson is for Mars and the red color of life. Your team will get the first metal.”

Hutan was surprised. “Thank you, Commissioner! But we just did our job.”

“No, not ‘just,’” replied Will. “That’s why we want to honor you. So, what next for the four of you?”

“Rest!” replied Hutan. “And after that, we wouldn’t mind going out to another assignment.”

“Though Deimos might be more convenient for our families!” added Andrea, who was the mother of a two year old.

"Or the poles," added Kurt. "We could run a polar station for six months."

"That's a possibility, though more than four people would be involved," said Will. "If we had proper radiation shielding, as we are considering, maybe your families could go along."

"That would be interesting!" said Daichi.

"But give us three or four months here, first," said Hutan. The others nodded.

"Alright, we can accommodate that," said Will. "I hear all of you are going to the Dacha together with your families next week, and after that there's a lot of science to write up. We'll talk again in three months."

"Thanks, Will," said Hutan. They shook his hand and headed out the door.

"They're good people," said Ruhullah, after the team left. "I wonder when we'll send the next mission to Quirinus."

"Not for several years. It'd last a year and do extensive mining and recovery of platinum-group metals. It's a shame we aren't in the position to send families. It would make the work so much easier."

"A caravel might make that possible," noted Ruhullah. He glanced at his watch. "Your next appointment will be here in fifteen minutes."

Will nodded. "Johnny. I'll wait here for him. Come in when he arrives."

"Alright." Ruhullah stood and walked across the hall to his office. Will turned to his attaché. He had a video message from someone named Dharmapala Peres. He right-clicked on the name and popped up a biography: forty-six years old, from Sri Lanka, in the NASA astronaut Corps sixteen years, with a doctorate in lunar geology and certificates in piloting, life support systems management, and propulsion systems

maintenance. He had led two three-month expeditions on the moon, had commanded NASA's new astronomical station at the lunar north pole, and had accumulated a total of sixty-seven months on the moon and eighteen more at the International Space Station II and the new Salem International Station. He was married, with a son; his wife was a professor at Rice University. Intrigued, Will pushed play.

"Good sol, Dr. Elliott," he began. "I'm Dharmapala Peres. My wife Maya and I already have our names in for Columbus 10 via the early entry process. I'm a geologist with extensive lunar experience and a long list of publications that I won't describe right now. Maya's a professor of English literature and a poet. We're interested in Columbus 10 because our son, Rahula, will be graduating from high school in June and will be a student at Rice after that, so we will be free to emigrate.

"We were just looking at the Columbus 9 passenger list and see that you are having a lot of trouble filling some of the simplest positions: day care providers, kitchen workers, sanitation workers, and agricultural workers. Robots can only do so much. So I have a suggestion: why not consider the college-age children of astronauts? There are quite a few couples who have one or two children completing high school and starting university who are old enough to fly to Mars but lack the qualifications to apply. Couples like us have raised families on Earth and have accumulated a lot of space-related skills and experience. Our parents mostly have passed on and no longer anchor us here. We would consider emigrating to Mars if our children could come; we could watch them go through university there and could provide grandparenting to their families. We have at least twenty years of adult work left. So I am calling you not to ask for a favor, but to suggest that you consider a new program to attract experienced middle-aged immigrants.

Your seniority system would have to include lunar and other space experience. But you'd get more experienced hands as well as more youth and more entry-level people. Bye."

Will watched Dharmapala's face fade from the screen. He thought about the suggestion for a minute, then hit reply.

"Good sol, Dr. Peres. I'm intrigued by your suggestion. We are indeed having trouble with the jobs that don't require a Ph.D.; we try to get spouses of astronauts, but there aren't enough of them applying. The post-university personnel we get promise to serve as day care or kitchen workers, but switch out of those vocations as fast as they can. If we had a dozen late high school and college-age kids arriving every two years, that would indeed help a lot. We haven't done a study of the minimum age for flight here. I think the youngest person to arrive here was twenty-six. Until Columbus 8 the flight took six months. Now we're planning for 4.5-month flights and we have more radiation protection on board. Certainly eighteen year olds could come; maybe with special radiation precautions we could lower the age to sixteen.

"So my suggestion is, why don't you add your son to your Columbus 10 application? And while you're at it, the three of you can still apply for Columbus 9. We'll be filling last-minute vacancies for three months yet. Let the personnel office wrestle with the proposal. The issue will trickle up to me eventually. It's easier to consider a modification of our existing policies when there's a specific case.

"Thanks for calling. Your resumé is very impressive. I hope we can attract people with the sort of experience you have. I suppose Sebastian will be furious at us for snatching so many qualified people from the Lunar Commission. Right now space specialists fall in two career tracks: they have children on Earth and work for the Lunar

Commission, or they postpone starting families and work for the Mars Commission. There are exceptions, of course; every flight here involves a few specialists who plan to stay only a columbiad or two. Our retention rate is 83%. Both Commissions have veterans from the other. Bye."

He sent the message and turned to his email. He answered a few routine matters, looked up, and saw that Johnny Lind and Ruhullah were at the door.

"Come in." Will rose and extended his hand. Johnny looked nervous; he shook Will's hand. Will pointed to a chair. Johnny sat; Ruhullah sat next to him and pulled out his stylus and electronic pad. "A few weeks ago Lal and I had a long talk about the Meridiani expedition, and he told me how effective you were with both the geology and the construction teams. The quality of the work, in both cases, was quite high. He said you were writing up the geology for your dissertation."

Johnny nodded. "The dissertation focuses on ore formation in the Pretoria Formation, Cassini. The processes in the Ashanti Field are very similar, so I'll be including some about it."

"When will you be finished?"

"Pretty soon, I hope, because the deadline is March for the June graduation! It'll be a joint Mariner Institute of Technology and Caltech degree."

"Good. The timing is good. We've scheduled a July 15 launch to 2031KL12. It's not much of a destination: a burned out comet nucleus about 500 meters across. It passes a half million kilometers from Mars on September 21. The shuttles will fly out, land September 1, take off on September 15, and aerobrake back into Mars orbit on September

21. A fast expedition, but no one has landed on a comet nucleus before, so there's some good science to be done. Do you want to command it?"

"Command it? Yes, sure!"

"I thought so. You've been here three years and have accumulated excellent experience. Above all, you've demonstrated an ability to build a team. We're giving the Quirinus team our first Crimson Circle Award this Satursol evening for their close and creative collaboration. Your team will be eligible to earn next year's award. We'll finalize the team—four people—in late March so that you can train together for three and a half months, including a one-month visit to Deimos."

"Who chooses the others?"

"You do, in collaboration with Roger and Érico, based on certifications."

Johnny nodded. "Thank you, Commissioner. I really appreciate this opportunity; this vote of confidence."

"Call me Will; people have gotten away from that in the last year or two. I am confident in you. We've got to improve our techniques for creating strong teams. There's an expert coming on Columbus 9 and she has already started collaborating long distance with us. Sit down with Hutan and get his advice; he was very successful. Lal was, also."

"I'll do that."

"The teamwork we create here has to influence our politics as well. It's hard to overcome old habits; on Earth, and particularly in the U.S., people view politics cynically as a gigantic game of buying influence and selling image. Elections and separation of powers were supposed to limit corruption, but have become an enormous source of it; consider how American elections involve two huge influence machines that spend vast

amounts of money to fool the public into voting for them and against the others. Truth is disguised in the process, images of politicians are created, and huge lies about them and about what they will do are told by both sides. Up here, we have to do better. If we can elect honest people and create a culture of governing that reduces temptations to lie and sugar-coat the truth, that is based on honest consultation with the public, we will have accomplished something that has never been accomplished on Earth before."

"Do you really think that's possible?" asked Johnny, skeptically.

"I do. We can't afford revolutions, riots, terrorism, and all the other spin-offs of the terrestrial governing process. They are unthinkable. Why can't we use techniques of teamwork in our elections? Why not stress the individual's right to vote his or her conscience unfettered by outside influence—corrupting influence—rather than stress the right of candidates to their free speech?"

"But Commissioner—Will—you're taking away free speech when you block campaigning."

"When you campaign, you take away my right to vote my conscience. It does no good to vote for the person you believe has the best personal qualifications—based on experience, honesty, fairness, the ability to listen, and a dozen similar qualities—if you know they won't be elected because the choice is really between two other people who are essentially lying to you about who they are and what they will do. If the right to vote ones conscience is to be respected, everyone must modulate their speech. A debate of ideas is needed, and a demonstration of one's character through that process."

"I've never thought about elections that way; in fact, I'm not sure I can. Half an hour after I leave this room I'll have trouble remembering your argument."

“People aren’t used to thinking this way. It’s a different set of cultural values. But it’s also teamwork because it values people, treats them honesty, empowers them to think about the future, and it doesn’t tear down other members of the team.”

“Huh. I see your point about tearing down; any leader needs respect to lead.”

“Exactly. Suspicion of government can do more damage than good, sometimes. Anyway, talk to Lal, Hutan, and this consultant who’s coming here next year. I look forward to reading about your plans.”

“Thanks, Will.” They both rose and shook hands.

The next three sols were devoted to preparation for a large semiannual heads of staff meeting. Will convened it at 10 a.m. “Because of the time delay, I’m conducting two separate meetings,” he noted. “We meet here this morning. Late this afternoon—early afternoon Paris time—the terrestrial heads of staff will meet, review our discussions, and give their input. You’ll be able to view a compressed version of their meeting this evening. We’ll have a joint meeting tomorrow morning to finalize plans together. Let’s start with Alexandra.”

“The Construction Department has two priorities: biomes and caravels. We are slightly behind schedule with the biomes because of the caravel work. Kauai was supposed to inflate before New Year’s, but is now, ten sols late. But Columbia and Cochabamba, the housing biomes, will be ready when Columbus 9 arrives in twelve months. Tentatively, 2053 will see two biomes for bioarchive—both B-75s—and construction of an annex to the Vandevelde Industrial Building.”

“When will we shift from B-75s to B-100s?” asked Érico.

Alexandra shook her head. “That’s postponed because the Caravel Project will soak up too much design and planning staff.”

“Let’s turn to the caravel,” said Will. “Sibireco, Muller Mining, and Consolidated are paying two billion redbacks for the mineral rights of the Meridiani region. It’ll be devoted to the caravel. We’re also earmarking some of the ten billion redbacks we got for last year’s gold. The U.S. administration is poised to lose big in November and we don’t know who we’ll be working with next year.”

“Just as well; it serves them right,” added Érico.

“They’re learning a lesson about international cooperation, aren’t they?” said Will. “But the consequence for us is a delay in Project Odyssey and its funding.”

“What does that do to the economics of the caravel?” asked Yevgeny.

“We’ll get the details this afternoon. We’ll have to pay a larger fraction of the project cost, which means the caravel may be more expensive than our current system. That may be controversial.”

“But the current system can’t expand further,” said Alexandra.

“Exactly,” agreed Will. “Louise, how’s caravel going?”

“Very well.” Louise Tremblay pushed a button and a slide of the flying saucer-shaped caravel appeared on the wall screen. “The vehicle’s dimensions have been refined. The outer shell will be thirty-four meters in diameter and its thickness will vary from nine meters on the outer edge to fifteen meters at the center. The interior wheel, which will rotate at four rpm, is a meter smaller and will have 2,150 square meters of floor surface. The non-rotating central docking module will be six meters in diameter and ten meters high.

“It can accommodate 100 on the Earth-Mars run and 25 to 28 for a five-year exploration mission. It’s divided into six airtight compartments and has three life support nodes, each able to serve half the vehicle, so each vehicle has built in ‘lifeboat’ capacity. A caravel on the Earth to Mars run would come with six ITVs or another caravel to provide additional redundancy. We recommend two caravels and 48 personnel for asteroid expeditions, four caravels and 96 personnel for expeditions to Jupiter or Saturn.

“The basic design phase is over, thanks to very capable terrestrial contractors and support from the Mars Construction Institute in Moscow. The timetable is very tight. Alexandra will cover that.”

“I’ll only hit the highlights; you can read the rest,” said Alexandra. She projected a slide with a timetable on it. “We recommend a high-speed cargo flight to Mars as late as possible—late September 2053—to maximize our ability to import manufacturing equipment and a January 2054 cargo flight that will get here in April 2055 via the asteroid belt for last-minute items. Vandevelde can accommodate most ordinary terrestrial manufacturing equipment.

“Vandevelde needs expansion, so we’re adding a B-60 biome named ‘Pittsburgh.’ It’ll have a twenty by twenty by twenty meter airlock. We’ll even be able to bring shuttles inside.

“Columbus 9 arrives on January 2, 2053, with 100 passengers, sixty of whom will be construction and fabrication specialists. By February they’ll be oriented and trained, some cargo will have arrived, and we’ll start construction. We can make the entire forty-tonne hull here, fold it into a Hermes shuttle’s cargo bay, and launch it into Mars orbit. The Swift shuttle’s twelve-tonne launch limit precludes a similar approach at Earth.

“The first workers will live in Phobos’s existing shelter. They’ll assemble the hub where the caravel’s rotating interior joins to the nonrotating exterior; it’ll largely be made on Earth because of the precise machining and exotic materials. The crew will set up the life support system, start the rotation, more workers will arrive and move in, and they’ll complete the interior in a gravitied shirtsleeve environment. The thermal protection system goes on last.

“Our goal is to complete a prototype by March 2054; twenty-six months from now. That’s when it needs to leave for Earth, so that it can fly back to Mars as part of Columbus 10. Our eventual goal will be to build two caravels every twenty-six months.”

“When will Project Odyssey need one?” asked Érico.

“Who knows,” replied Yevgeny. “They’re still arguing about the propulsion system. They don’t expect purchasing a vehicle before 2057. At that point Mars will have twice the population it has now and a lot more experience.”

“So, we’re talking about developing a capacity that increases immigration by 200 people every columbiad?” asked Will. He scribbled a crude addition on his computer screen. “With natural increase, Mars will have about 350 in 2053 and 480 in 2055 with our current system using ITVs. Then it increases to 630 in 2057 when we have one caravel, 1,000 in 2059 with three caravels, 1,600 in 2061 with five caravels, 2,400 in 2063 with seven caravels, and 3,500 in 2065 with nine caravels. How we will make Mars economically viable with a population of that size!”

“Gold won’t be enough,” agreed Yevgeny.

“We can export platinum-group metals,” added Louise.

"And meet internal needs; manufacturing mobilhabs, for example," said Alexandra. "It'll be impossible to import two tonnes of supplies per person, even with solar sailing vessels. But I doubt we can really expand that fast, Will."

"We'll see," replied Will. "What are the per-unit costs?"

"We'd charge NASA a billion redbacks each, to cover development costs, which is a third of the cost they'd manage. Our cost would be 500 million and if each makes ten flights with 100 passengers each time, that's only half a million redbacks per passenger."

"If you include five million redbacks to import two tonnes of equipment per immigrant and add staffing and fuel costs, we will be able to fly an immigrant here for less than ten million redbacks," added Yevgeny. "It's a cost revolution."

"Arrival will be the hardest," said Will. "Even with the Hermes it'll take months to land everyone and their cargo."

"We'll have to upgrade Dawes spaceport, to share the load," noted Yevgeny. "We'll export and explore more. Caravels could be used for asteroid mining."

"A lot of implications," agreed Will. "Louise, Alexandra, anything to add?"

"Just that working on this project is an incredible privilege," said Alexandra. "In fifteen years people may be living in caravels on Callisto and Titan."

Will looked around. "Questions?"

"How much staff are we talking about?" exclaimed Ruhullah.

"Initially, seventy, between fabrication and construction," replied Alexandra.

"A third of our workers," noted Ruhullah. "That'll impact everything."

"And delay everything," added Lisa. "Building Pittsburgh delays completion of Cochabamba, so housing will be tight. Biome construction will fall behind."

“It’ll cut into bioarchive, not our essential needs,” responded Alexandra.

“But we have obligations; bioarchive is expecting the equivalent of two entire biomes in the next two years,” continued Lisa. “Your schedule gives them one and promises a second just before Columbus 10 arrives, but the construction schedule for the caravels is sure to slip. It sounds like bioarchive will be sacrificed.”

“With my regrets,” added Alexandra.

“We’ll have to import greenhouse bubbles,” exclaimed Will. “We’ve delayed bioarchive to the point of damaging our reputation.”

“We can catch up after we fly another hundred people here,” replied Alexandra.

“No.” Will shook his head. “Yevgeny, figure out how to add greenhouses to our cargo quota. Alexandra, you have to stretch your schedule and free up a few workers.”

“Perhaps I can obtain more people from other departments or lengthen work hours for a few months.”

“You can’t have my people,” replied Roger.

“And people work too long already,” added Ruhullah.

“Then I’ll stretch out the schedule.”

“Thank you,” said Will. “Roger, give us your exploration report.”

“Sorry, I don’t have slides,” replied Roger. “Exploration priorities are about to change because of two developments: redesigning expeditions to accommodate some children and a change in priorities from road clearing and geological surveying to oasis construction and detailed local study. Road clearing is almost finished; we’ve completed four east-west trails and three north-south trails, 120,000 kilometers altogether. No part

of Mars is more than 700 kilometers from a trail. Except for another 5,000 kilometers of Antarctic Trail, scheduled for later this year, the system is complete.

"From now on, most expeditions involve two mobilhabs, two conestogas, two rangers, and sixteen adults. One mobilhab will include a clinic, a tonne of radiation shielding, and extensive scientific equipment. Child care providers will also run lab tests. The expedition will usually be based at an oasis with a shelter. The other vehicles will range from base for as much as two weeks at a time."

"We can do this," said Will. "But do we *want* to?"

His words hung in the air a moment. "I wouldn't take Boris," said Alexandra. "Besides the safety issues, I can't imagine being stuck in a mobilhab with a screaming baby."

"Sammie's thrilled by the idea," added Roger. "But there's no way I'd take a ten year old into the field!"

"I agree," said Will. "Marshall's eleven, but he's too active to confine to vehicles and too young to take outside all the time."

"Vanessa's torn. She thinks babies and toddlers are manageable if they're reasonably quiet. Maybe that's true," said Alexandra. "But this is a feminist issue. Right now, usually the men go out in the field and the women stay home with the babies."

"But that's the arrangement each couple has made," replied Roger. "Madhu has raised Sam more than I have. She's satisfied with that arrangement."

"Is she?" asked Alexandra. "Isn't there something wrong with our culture if most couples agree that the man can explore and the woman stays at home?"

“Is there?” retorted Roger. “Women have a natural connection to babies that men inevitably lack.”

“Yevgeny has made up for that pretty well.”

Will raised his hand. “Alexandra has raised a legitimate cultural issue, but let’s not discuss it now. I take her point to be that we are providing choice. It will be possible for women, men, or couples, to go in the field with their child or children. That’s the reason to do this.”

“Has your task force considered how many kids will be allowed on an expedition?” asked Yevgeny. “I assume we won’t send Eammon, Irina, and their five.”

Everyone chuckled. Roger nodded. “We’d limit expeditions to two children. Two adults must be present at all times and another vehicle or a shelter has to be in close proximity. We haven’t developed rules about noise and child care collaboration yet.”

“Finalize the regulations. They’re essential,” said Will. He looked at the others. “Yevgeny, how are exports?”

“Improving. Gold production has hit twelve tonnes per month and may reach thirteen; the rich deposits in Meridiani have helped. Even so, gold production will be less than in the last columbiad because the remaining deposits are not as rich. Fortunately, the price of gold has declined only slightly and is still three times as high as it was two years ago. We’ll be exporting one hundred tonnes of argon, fifty tonnes of nitrogen, and one hundred tonnes of methane. Demand for cryogenics has grown remarkably in spite of the economic downturn. The moon is buying most of the nitrogen and methane, the latter as a carbon source for their platinum group metal extraction efforts. We’ll export half a tonne

of platinum group metals. Finally, Muller Mining is negotiating to buy options on the mineral rights of Quirinus for one hundred million redbacks."

Will glanced at his watch. "Anything else?"

"One thing, Will," said Érico. "Nuclear power is still a hot topic and the report about Hellas geothermal power has heated up the discussion further. We already had the capacity to make all the solar and wind power we needed. It's going to be very hard to justify a fifty-thousand kilowatt nuclear reactors."

"Not to mention the suspicion of the United States," added Alexandra. "In the last two years they have behaved like no civilized nation should. No one trusts them with nuclear power in space."

"Well, one can't go to Jupiter and Saturn without it," replied Will. "And no one can stop them from trying."

"I don't agree," said Alexandra. "One can easily get to Jupiter, even Saturn, from Gateway on chemical propulsion. And we don't have to help them."

Better that other nations get involved so they can keep an eye on them and moderate them," replied Will. "Our future as a nation—and I use that word deliberately—lies in human expansion outward. We have to be involved."

"But Will, what are we going to do with *fifty thousand kilowatts?"* asked Érico. "Right now we can't use a twentieth of that output! If our population increases ten fold we still won't be able to use it all!"

"And a fifty thousand kilowatt reactor won't produce enough plutonium," added Alexandra. "What they need is even bigger."

“We have to trust international mechanisms to prevent nuclear powered space weapons,” replied Will. “Such weapons have been promised for seventy years and the U.S. still doesn’t have any, even if the costs have fallen drastically. We’ll maintain the option of pulling the plug on them. That’s one reason I pushed the Hellas and Elysium Geothermal Expeditions; they can provide backup sources of power.”

“Will, we don’t need geothermal either!” replied Alexandra. “We can make all the solar panels and wind turbines we need, and much more cheaply.”

“True, but we’ll need a large power source we want to produce platinum-group metals; those processes are power hogs.”

“Will, I want to bring this matter to the Mars Council,” exclaimed Érico. “Public opinion is not behind nuclear or geothermal power. Both are controversial. The Council should have a say over the establishment of nuclear power reservations and the parks. Geothermal areas are potential parks.”

“This is a matter the Commission has negotiated with the United States government for months, without involvement of the Council.”

“That’s true. But this isn’t just a company town. It has its own civil society, Will; you know that, you helped build it.”

“But our hands are tied.”

“We can’t leave out the people, Will,” urged Ruhullah.

“And what if they so no?”

“Don’t underestimate your powers of persuasion,” replied Érico. “People trust you and you are articulate. But right now they don’t trust your decision. You can’t run this place without public approval. It’s become too big.”

“Teamwork. It’s what you talked to Johnny and Hutan about the other sol,” said Ruhullah. “Consultation is an essential element of it.”

“Well, that’s true,” replied Will grudgingly. He sighed. “I guess we serve two masters: the Commission and the Marsian public. Okay. Take it to the Council. Hold public hearings. I agree, this matter has to have public consensus, and it doesn’t right now.”

16

Hearings

Mar. 2052

In spite of the late hour, the hearing room was still full. For three sols, much of Mars had taken vacation to participate or watch. The last speaker of the sol was not a moderate or pleasant fellow. Colin Hack was an Australian and an environmentalist. “I own ten square kilometers of Aurorae Borough,” he said, concluding his videotaped testimony from Canberra. “So my voice must be heard. I have a lot of friends who agree with me. None of us want our land dusted with radioactive fallout. Mars must not have large nuclear reactors and the small ones must be retired. They really aren’t needed; solar arrays and wind turbine farms can meet all of the planet’s power requirements, and the microwave relay on Phobos can capture, store, and rebroadcast it anywhere it is needed. The geothermal project is also a folly, interfering with the last environment where native species can survive. They are Elliott’s fantasy, his dream for glory and immortality. But they will just earn him a reputation for mindless expansion and reckless destruction of Mars’s precious resources. These double erections must be stopped and sanity must reign. Otherwise, along with my friends, we will sell our lands and precipitate a collapse in Martian property prices. Thank you.”

Father Greg, who was chairing the Mars session, rolled his eyes slightly. He glanced at the nine members of the Mars Council. Madhu appeared to be nearly asleep. “Are there any questions from the Council?” he asked.

No one spoke or even shook their heads. Greg turned to the audience. “Does anyone here have anything to say?”

No one did. Greg turned back to the screen. A member of the audience in Australia had risen to attack the speaker, who defended himself loudly. The local chair told both men to shut up and sit down. He began to give closing comments for the sol.

"Okay, that ends sol 3 of our hearings," said Greg, cutting off the procedure in Australia. People could watch it later anyway. "I should probably remind everyone that it is now 5:05 p.m. on Wednesday, March 31 in Canberra, Australia, and the hearings are ending for the day. Here in Aurorae it is 3:20 p.m. on Frisol, March 30. Because our sols are 40 minutes longer than terrestrial days, March is one of the months that is shorter on Mars than on Earth. On both Earth and Mars, the morrow is April fool's day. It will be Satursol here, and we will have no hearings on Sunsol either. At that point it's the weekend on Earth, so our next hearings will occur on April 5, 2052; Monday on Earth and Wednesol on Mars. They will be based in Beijing and will begin at 11 a.m. there, which will be 9 a.m. here on Mars. The April 6 hearings will be from New Delhi and the April 7 hearings from Moscow. Have a good, long weekend, everyone. This meeting is adjourned."

Greg banged the gavel and everyone rose. Érico walked over to Will. "I'm sorry that last speaker was so nasty to you. The attitudes of some landowners is shocking."

"It is distressing," agreed Will. "I don't mind being attacked that much; I've gotten used to it. But the hearings have underlined the need for better communication with the landowners. They've invested a lot of money in Mars and often they aren't well informed about things. Our work is cut out for us."

"I think so. Have a good sol, Will."

“Thanks, you too, Érico.” Will turned and walked out of the room, chatting briefly with a few others as he went. He took his time to walk back to his office because he was hurt by the various comments hurled at him. He took advantage of the peace and quiet of the rooftop farm around his office to face west—toward Earth—and say his daily obligatory prayer, which made him feel better. But once in front of his attaché on his desk, he no longer felt quite so good. The messages from Earth looked ominous.

Louisa Turner was burning the midnight oil in Houston. “The press release about 2031KL12 hasn’t generated any coverage at all. Everyone’s covering the hearings, and with the venue slowly moving around the Earth, every national media is involved. It isn’t helping our reputation with the public; most are distrustful of the U.S. I’m working on some new talking points; we have to stress that Mars is about exploration, we need nuclear power for it, and we are developing the caravel for our use. It just so happens to meet the exploration needs of other countries as well. But it’ll be pretty hard to draw attention away from the nuclear and geothermal issues. Ideas needed, Will. Bye.”

Will felt too tired to tackle that request. He reluctantly hit “play” on a message from NASA’s Administrator Kern that had arrived four hours ago. “Good day, Will. We need your help calling several freshmen Senators about Odyssey. I’ll attach their names and contact info to this videomessage. The new Congress convenes in ten days and we’re expecting rough treatment. At least the recession has bottomed out and the economy is beginning to grow a bit, so calls to shut down the project are less likely.

“I wish you could have stopped the hearings! We get a bloody nose in the media every day, especially overseas. Opposition to the use of nuclear power in space has been emboldened. The irony is that right now everyone’s oogling over the spectacular images

coming down daily from the Russian-Chinese Titan balloon, of methane ‘waterfalls’ and wave-cut cliffs, and no one is complaining that a twenty-kilowatt reactor on board is making it possible. You can’t do the outer solar system on solar power. We’re facing serious congressional hearings about nuclear reactors in space. We may need to consider drastic changes to our plans. If there’s anything you can do to divert the media in another direction, it would be welcomed. Bye.”

Will was tempted to reply by noting that he wasn’t a magician. He was certainly too tired to deal with that message, and he was out of ideas. He closed his attaché, attached it to his belt, and went for a walk.

The thin air of newly inflated Oregon Biome made him pant a bit. He looked at the barely greening ground—they had planted the first crop of sorghum to pull heavy metals and other undesirables from the future soil—and contemplated Mars’s very complicated future. The Europeans had their hands full with Venus and Mercury and with an aging population that was sucking government coffers dry. The Americans were busy saving the moon facilities from bankruptcy—though tourism was now picking up—and continuing Project Argo to explore near-Earth asteroids, while pinning the future on Project Odyssey. Their support for Mars was limited to reconstruction of the Mars Commission’s ruined headquarters. The Chinese were expanding their moon base and contemplating a leapfrog over the asteroid belt to Jupiter. The Japanese, in the midst of a demographic crisis far worse than Europe’s, were cutting back on space and asking for a lot for their money. India and Brazil were starting their own national exploration projects to near-earth asteroids. Mars, with its gold, was being left on its own. Some small nations

were paying for a citizen to go to Mars, but many of them lacked skilled workers to represent them there.

Mars's economics were highly unpredictable. The price of gold was likely to fall to prewar levels, shrinking its main source of income. Platinum group metals and deuterium were expensive to harvest, except with a massive infrastructure. The Swift Shuttle C offered the promise of cutting the cost to low earth orbit below 500 redbacks per kilogram, undercutting Martian exports of methane, nitrogen, and argon. The demand for Martian land was largely filled; releasing more land to the market would cause its value to fall and increase demand for services that were already inadequate.

As a result, Will feared they were grasping at straws. The caravel project would import people to Mars who might not be employable and would build a vehicle the U.S. wouldn't want. The geothermal project would provide energy they couldn't use. The nuclear project would build massive reactors the Martian population didn't want or need. Bioarchive would store and study American biomes and species in artificial environments they couldn't build. The result was a looming disaster.

On the other hand, he didn't see an alternative. They were in the position to drop the geothermal project if they had to, but it was a useful political counter to the Americans. The caravel project could always be slowed down. They could speed up bioarchive various ways. And they could keep working. He turned and headed out of the biome, to go home. No need to toil the rest of the afternoon.

He flopped down on the couch and watched television for two hours; something he hadn't done in ages. When Ethel came in, she stopped at the door, surprised. "What are *you* doing?"

“Vegging out and ignoring the world.”

“How many times were you attacked this sol?”

“Three times in nasty ways, but that didn’t bother me as much as the rational arguments against everything we’re trying to do.”

She frowned. “I doubt that! Since when do we make irrational plans. You have available to you one of the best group of brains ever assembled.”

He sighed. “True. I guess we have to stay the course. The reactor worries me the most. Érico’s right; we don’t need it. Anything we could do to use the power takes staff we don’t have.”

“That’s a problem, I agree, but the answer is growth. I’m more worried about bioarchive.”

“So am I. I’ve reminded Alexandra and Lisa that we can’t relay it any more.”

Ethel walked over to him and sat on the couch next to him. “Don’t worry. This isn’t as bad as other crises, I think.” She put her arm around him.

“Thanks.” He leaned over and kissed her. They sat together on the couch silently, cuddling, for a few minutes before heading out to find the kids and eat supper.

The next sol Will called Rosa Stroger, Lisa Kok, Alexandra Lescov, and Ruhullah Islami to a meeting. “I’m concerned about the nuclear plans,” he said. “They’re designed for efficiency in making plutonium, but not for our needs. We can’t use fifty thousand kilowatts; it’s impossible for the foreseeable future.”

"It also requires a massive construction effort," added Alexandra. "The Swift Shuttle can't launch even the reactor vessel in one piece; it's too heavy. We'll need an entire caravel load of experts to put the reactor together."

"And we can't use the waste heat," added Lisa.

"Beaming the power around Mars is technically complex," added Ruhullah. "And we'll lose forty percent of it."

"I'm skeptical of the 5,000 kilowatt space reactor," added Rosa. "Each reactor requires two launches and space assembly. The estimated cost of each is very rough, but is so high it's too much for our use. The research and development cost keeps going up. The timeline is too long to be politically sustainable."

"What would you suggest?"

Rosa considered. "It's incredible how much emotion was involved in finalizing their plans. I'd build a 1,000 to 2,000 kilowatt reactor for space use; it can be finished on Earth, it'll fit in one Swift launch, and provide plenty of power for a base on a Jovian moon or an asteroid. For propulsion, I'd drop VASIMR and stick to lox-augmented nuclear thermal rockets. We have so much hydrogen-oxygen propellant from the moon and Phobos, and it's so cheap, LANTRs are plenty to go to Jupiter and Saturn."

"I wish the U.S. would give the money to us," added Alexandra. "I'd use it to develop a gas-core nuclear engine. That'd *really* give us propulsion."

"Rosa, you'd even use LANTR at Jupiter?" asked Lisa.

Rosa nodded. "Don't be fooled by its powerful gravity. We're not landing on Jupiter; the moons are skating closer to the rim of its gravitational field. Small delta-vs at periapsis make an enormous difference; 1.5 km/sec to 2 km/sec will send an orbiting

spacecraft back to Earth or put an incoming spacecraft into orbit. Gravity assists from the Galilean satellites can do the rest, except for landing. You don't need LANTR; chemical propulsion is plenty, which you need for landing anyway. You could send a mission from Gateway or Embarcadero to Jupiter in a year, refuel there, and return in a year with chemical propulsion."

"So why are they building these huge reactors and engines?" asked Lisa.

Because Kern's a bean counter, not an engineer. Lobbyists can give him a song and dance for their pet projects, dangling the glitter of a technological breakthrough and the prestige of new technology before him."

"NASA'a suffered from this many times," agreed Will.

"The Chinese plan to use LANTR, I think," added Alexandra. "And their plan's at least as far advanced as NASA's. We should sell caravels to them!"

"We should," said Will. "Kern has hinted major changes may be necessary."

"The hearings have fired up the critics," noted Alexandra.

"Then we should propose a practical alternative, because we're getting killed by the criticism," said Will. "If the engines need enriched uranium, then make enriched uranium on Mars, not it and plutonium."

"And argue against one big breeder reactor," added Rosa. "Ten 5,000 kilowatt breeder reactors would produce the same power, be easier to fly here, be easier to set up, provide redundancy, and could be placed at the outposts in pairs or triplets, eliminating the need to beam power. The space reactor could use the same basic design."

"Let's talk to Brian Stark and our other contacts," noted Will. "Rosa, can you make some video calls? I'll call Kern and find out what redesigns they have in mind.

Maybe if we threaten to pull the plug at our end, something cheaper and more practical will result, and it'll be more likely to survive Congress."

Helmut alternated his gaze between the television screen in his cubicle and the view outside the window. Venus's swirling yellowish clouds were receding from the camera on the ITV *Syrtis.* Carson and Stark were finally on their way to Earth after six months of cabin fever above the solar system's largest hellhole.

A half kilometer outside his window was one of northern Elysium's ice chimneys, a cylinder of ice thirty-five meters tall with a lazy curl of water vapor extending upward. Closer to the conestoga was the Elysium geothermal drill. A team of astronauts was struggling with a repair as he watched, because the heat at 1,200 meters had been high enough to damage the shaft. They were parked about two kilometers above an active magma body, one that might cause a surface eruption in a few thousand years.

His attaché beeped and a video message from his father popped onto the screen. The two of them were "spending" the afternoon together, in spite of a thirty minute time delay. "Well, they're finally on way. From what you've told me and what I've heard from the other tourists, a fifteen-month flight home wasn't worth the hassle, even if six of those months were spent at Magellan. So much for that tourist experiment.

"Say, can you adjust your position a bit? There's strong light on your face from the right. Is that a window over there? I'd love to be able to see outside when you reply. I miss Mars in many ways; so much more softly lit than the moon, so much more earth-like. I'd love to be able to explore it with you. Maybe I should just retire there. Of course, who knows whether you and Clara would still be there! Bye for now."

Helmut had to smile. He adjusted his position so as to lay on Clara's side of the cubicle and turned up the lights to compensate for the glare from the window. He hit reply. "Well, I guess Clara won't mind if I lay on her side, especially if I haul my pillow over. She'll smell my head on her pillow otherwise and complain. She's busy this afternoon doing inventory, so I don't think she'll see me here. They didn't have conestogas up here when you were commander in '38, right? Each vehicle has two pairs of loft cubicles, but Clara and I got permission to remove the wall between ours, so we have a single bigger cubicle two meters long, a bit over two wide, and about 1.2 meters high in the middle. We've got windows on both sides, but the left side had sunlight streaming in, so I closed the shade. Can you see the drill rig outside? That's the Elysium Geothermal Project. We've been drilling since early January, and we're almost done. We've hit some incredibly hot rock, too! In a few weeks they'll finish and then Clara and I will go the rest of the way around Mars on our way back to Aurorae.

"I'm glad to see the successful trans-Earth injection. As for retiring here, that'd be great. I'm sure you'd be welcome as an old veteran. Maybe Clara and I will be in the belt sometimes, but we'd be coming back. Back to you." He hit send.

The email icon flashed with an incoming message from Stark: *Home in three months!* Helmut typed a comment back, then switched the television from Venus—which was no longer interesting—to the German-Brazil soccer game, which he and his father had also been watching. Germany was still losing; the Brazilians constantly had the ball and were always taking shots. A commercial break started; he opened the cubicle's door, dropped down into the main cabin of the conestoga to grab a cup of tea, then climbed back up into their loft. He saw his dad had replied.

“Have you switched back to the game? Damn, when will we see some momentum! Germany’s had incredible teams in the past. Of course, I haven’t lived in Germany now for almost twenty years. Maybe I should root for the Brazilians; they’re closer to Houston! Don’t tell Érico I said that, though.

“Maybe I’ll apply for Columbus 10. At 62 I’d be on the old side, but I’d pass the physical. I’ll be flying back to the moon next month for six months, and I haven’t had any troubles. And don’t forget that even though there were no conestogas on Mars until Columbus 3—they were too massive—we had them on the moon by 2037. Last year I spent two weeks in a conestoga at Mare Moscoviense! If anything, you’re catching up with us. Your new designs incorporate ten centimeters of water shielding over much of the roof and selective polyethylene shields over sleeping areas. We’ve used that for the last decade. The radiation environment inside is pretty good. I admire Clara for pushing the issue about children, even if few families will want to take their kids.

“I’m still torn about continuing as head of the Lunar Commission. I suppose we should give the job to an American, and I’ve been doing it plenty long enough. Eleven years have flown by so fast. The situation is now improving, with the tourists returning, thank God. The restructuring has pushed costs down, so that helps. Marriott wants to build a hotel at Shackleton; there may soon be some competition for the tourist business. Water exports to low Earth orbit can make a thirty percent profit and still beat the price of the new Swift shuttle. In a decade we may be looking at two million redbacks per tourist for a two-week stay. So in another year it may be a good time for me to retire. We’ll see; don’t tell anyone. At that point the Imbrium Drilling Project will be finished and will move to other locations with more valuable science. We’ll have the lunar interferometric

telescope system set up and ready to be expanded to deep space, maybe to Mars eventually. Same with the interferometric radio telescope system. The Kepler Crater big dish will be done, also. It'd be a good time to move on to other challenges, like sitting back at Aurorae, working part time, and writing memoirs. Who knows. Do you really think both of you will be able to go on asteroid missions together? Bye."

Helmut paused the t.v. and hit reply. "I forget that the moon got conestogas first! I even read the summary of the expedition's geology, so I should have remembered. I hope you can come on Columbus 10. Even if both Clara and I can't go to the belt together, you could help whoever stays here with the kids. We're planning to start a family not too long after we get married; the longer we wait, the harder and riskier it'll be. The next four years will be devoted to our Ph.D.s and a family. We're hoping that ten years from now, the caravels will make it possible to do asteroid research with kids along; not babies or toddlers, since they can't handle zero gee, but older ones who know what to do in emergencies and when they get nauseous. The caravel's magnetic radiation shielding is supposed to be pretty good.

"You've really created a legacy, dad. Moon exploration owes a lot to you, not to mention popularizing land ownership and commercialization of lunar resources. I bet you could do a lot for Mars, too. I hope you come. Back to you."

He sent the message and turned back to the game. The German team seemed to catch on fire; they scored a goal, then another one, tying the game. Brazilian fans were bitterly disappointed and began to jeer their own team. Half time came and went, then Sebastian's reply arrived.

"I'm skeptical about taking kids on expeditions to the asteroids or Jupiter. Call me old-fashioned, but I don't see space travel getting that routine any time soon. It's too dangerous; the environment is too harsh. Even on Mars, under a thin atmosphere and inside sheltered buildings most of the time, your cancer rate is thirty percent higher than it would be on Earth. The kids have some health problems, too. It may be better than the nineteenth century, but in the twenty-first century some consider it unacceptable.

"I'll take the chance, myself; with all the body scans performed up there, cancer gets caught in time and cut out, so the death rate should be lower than on Earth with its smokers and drinkers and people who refuse to go see doctors at all.

"Say, the team's finally getting its act together! They may even win. We're cheering for them here.

"Speaking of caravels, during half time I got an email bulletin from the New York *Times.* The hearings on Mars last month forced NASA to reconsider its plans for Project Odyssey, and the new Congress is not in the mood to spend a couple hundred billion, even stretched over two decades. So NASA just announced a scaling back. No plutonium production on Mars, just uranium enrichment for flight reactors, and the flight reactors are being scaled back to 2,000 kilowatt, ten-tonne units that can be flown into space in one piece, eliminating space assembly. They're also a much more reasonable size for powering large bases on the moon, Mercury, and Mars, especially with the new industrial facilities coming on line. They're initiating rigid cost controls to keep the price of each reactor down. This gives me hope that Odyssey will happen; I was getting pretty skeptical. From conversations I've had with Will Elliott and Brian Stark, I gather the

nuclear power team on Mars had a hand in the redesign. So you can be proud of what Mars can accomplish, and those caravels are more likely to fly than ever, now."

The news of NASA's change of plans rolled across the big screen in the Patio on a lazy Sunsol morning during brunch. Within seconds conversations stopped as everyone listened to the BBC report. Then everyone started to applaud. Many turned toward Rosa Stroger, their chief nuclear engineer. Lisa and Alexandra walked over to her. Alexandra had a twinkle in her eye. "We won, Rosa."

"I guess so," agreed Rosa. "Of course, some will be convinced forever that Mars doesn't need any nukes."

"That's an extreme view," replied Lisa. "Two megawatt reactors are a good size; that's two thirds of our total installed capacity here at Aurorae. We can expand reasonably at that rate."

"It's a good size not just for us," added Alexandra. "A colony on Callisto or Titan will need about eighty kilowatts per person to support agriculture, so a two-megawatt reactor is the right size for a caravel crew of 25."

"We have to see whether Congress will authorize the funds," exclaimed Rosa.

"What did Brian think?" asked Lisa.

Rosa nodded. "He was behind this change."

Johnny Lind approached the table. "Hey Rosa, this must be a great sol for you!" he said.

"Yes. It's a great sol for all of us, actually. This version of the plan is more practical."

"Let's hope that's how the process works," said Johnny. "I wonder how disappointed Will's going to be."

"Disappointed?" asked Alexandra. She shook her head. "Don't you believe it."

"But he wanted big reactors, right? And I thought the hearing really hurt him badly," said Johnny.

"Johnny, he encouraged the hearing," replied Alexandra, lowering her voice a bit. "And when the opposition against Project Odyssey grew strong, he's the one who called us together to plan an alternative."

"And you'll read all about it in the *New York Times* in a few weeks," added Rosa.

"Have reporters been calling?" asked Lisa.

"Oh, yes," replied Rosa.

Just then a crowd of people began to enter the Patio. The interfaith service had just ended. Will, Ethel, and the kids came in a moment later. Rosa beckoned him to come over.

"What's new?" he asked.

"The BBC just reported that NASA has announced a scale-back in Project Odyssey," said Rosa. "No plutonium production on Mars, and flight reactors will be ten-tonne, two-megawatt models."

Will smiled. "Fantastic! Sanity has won."

"That's exactly what we said," added Alexandra, and she looked at Johnny.

"I think Columbus 8 has accomplished its greatest achievement," exclaimed Will. "The rest is a down-hill roll. Alexandra, we should plan to move forward on the caravel

full speed. These smaller, cheaper reactors will make Project Odyssey doable within a decade."

"Will they make enough power for VASIMR engines?" asked Johnny, skeptically.

"Yes, for cruise mode," replied Alexandra. "Not for transplanetary injection; they'll use chemical or nuclear for that."

"So, we're going to Jupiter?" asked Johnny.

Will nodded. "We're going to Jupiter."

Cargo leaves Mars for Earth: 5 Mar. 2050

Cargo leaves Earth for Mars: May 11, 2050

Autumnal equinox: May 28, 2050

Columbus 8 leaves Earth for Mars, 14 June 2050

Dust storm season begins, July 18, 2035

Opposition: 14 Aug. 2050

Cargo reaches Earth from Mars: 20 Nov. 2050

Columbus 8 reaches Mars: 14 Dec. 2050

Dust Storm Season ends: Dec. 31, 2050

Cargo reaches Mars from Earth, January 26, 2051

Feb. 1, 2051: Marshall's eleventh birthday

Columbus 8 leaves Mars 15 Mar. 2051 to Venus 20 Oct. 2051, stay until late Mar/early April 2052, arrive Earth late June 2052 (with Magellan return crew)

March 13, 2051: Spring Equinox, new years

Conjunction: 10 Sept. 2051

Earth 2051-11-14 193d Venus 2052-5-25 175d Mars 2052-11-16 8.66 368d

Feb. 1, 2052: Marshall's twelfth birthday

Mar. 29, 2052: Autumnal Equinox

May 15, 2052: Dust storm season begins

Columbus 8 heads home: 28 May 2052

Columbus 9 heads to Mars: 15 August 2052

Oct. 2, 2052: Dust storm season ends

Opposition: 28 Oct. 2052

Mars 1-2-2053 223d Venus 8-13-53 166 Earth 1-26-54 6.24 389d

Plot Summary

Greg and Anna are upset is Tomas attracted to the Bahá'í Faith. Will talks to Lal about Meridiani and its importance to development. President White is forced to moderate his policies. Charles Kern, head of NASA, calls Will to propose a joint asteroid project.
mid March 2051

Quirinus project returns and gets a teamwork award; Will invites Johnny Lind to lead the next asteroid mission. Will meets with heads of staff and they pressure him to accept involvement of the Mars Council in the nuclear issue.
Date: Jan. 2052

16. Hearing 220
Kerns unhappy about hearings. Will meets with some heads of staff and they brainstorm about a new plan for Project Odyssey. Carson and Stark leave Venus for Earth. Sebastian and Helmut “spend the afternoon” together, talk about Sebastian’s retirement to Mars, and they hear that Odyssey will be scaled back and will use 2 mw reactors.
Date: Mar. 2052

Volume 8 started Dec. 13, 2003. Rewrite started Dec. 24, 2008; finished January 1, 2009