THE MARS FRONTIER

Vol. 9

Foundations for Expansion

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1.

Pax

Late Aug. 2052

The image was a ghostly black and white, unlike the photography one usually expected in the mid twenty-first century. But the outline of the crater was clear enough. The western rim opposite, silhouetted against the stars, was often bouldery. The basaltic walls of the south side exposed cliffs of strata bent and upturned by the cataclysm that had blasted the great hole. Several pinnacles stood high enough to escape the polar shadows and reach the sunlight. They were so bright in Mercury's sun that they looked on fire.

The camera panned toward the north where the rim had been erased by later forces and the crater floor came into view. "My God!" said Will Elliott, Governor of Mars operations, who was watching the event on television. "Are my eyes deceiving me, or is the entire floor covered with ice!"

"I think so," agreed Alexandra Lescov, his director of construction. "That's what the orbital radar showed."

"Still, it's amazing." Will rose from the couch and walked closer to the living room's wall screen to scrutinize the image more closely. "You know, you can see parallel cracks in the ice sheet!"

"Huh. You're right. Glaciers at Mercury's north pole."

"Amazing. There's nothing like that on the moon. When astronauts land there in nineteen months they'll be able to do something we haven't done and the personnel at the lunar south pole can't do; go skiing!"

Yevgeny Lescov, Mars's director of exports, chuckled. "Pax crater's filled with ice up to fifty meters thick, and the sheet flows very slowly northward, where it escapes gradually out of the shadow formed by the southern rim and evaporates away, leaving a pile of carbonaceous black residue."

"So, it really is a glacier," said Alexandra. "And it's replenished by comet impacts?"

"Mercurian volcanism is the main source. The planet's more active than Mars."

"That's not saying much. Why did they name it 'Pax'?"

"Every crater in the area is named for 'peace' in the different languages of the world. There's a Salam and a Shalom," replied Will.

The camera had panned back around to the south, revealing the just-landed Hermes shuttle, fourteen meters tall and seven meters in diameter, standing on its landing legs. The cargo bay door was open and they could see the interior filled with thirty tonnes of cargo, mostly scientific and construction equipment. A mast with a solar array had been deployed upward from the top of the shuttle several hours earlier; its top glowed brightly in Mercury's intense sunlight.

"The ranger can deploy most of the cargo automatically; even the hab," said Will. "The software's a lot more intelligent than anything we had at the beginning of Mars settlement."

"Columbus Zero was eighteen years ago," replied Ethel, Will's wife. "Artificial intelligence has come a long way since. Mission Control says the ranger can clear a road robotically to the top of the south rim around all those boulders and deploy solar arrays in

the perpetual sunlight! That would be a challenge for a mission with a crew on hand. Then it has to haul the habitation to its deployment site, deploy it, and bury it."

"Some of those tasks could await the crew," said Will. "I never would have thought I'd live to see the day humans will walk on Mercury."

"Well, we made it possible," replied Alexandra. "They're using modified Project Columbus hardware."

"And the new Sunfire 2 solar thermal engine." Will nodded. "The European Union can be proud of this achievement. Now they have an entire world to explore by robotic rover; exotic minerals to discover, Helium-3 resources to develop, vast sheets of ice to exploit, and who knows, there may be colonies there some day."

"That worries me," said Alexandra. "We're short on money as it is; more competition will make things worse."

"I agree, short term," replied Will. "But I doubt Mercury will ever be a major player in the solar system. They're deep in the sun's gravity well, so transportation will remain more expensive. And we have the power of myth behind us. No one pines for Mercury or dreams of Mercurian civilization."

"And myths can be pretty powerful," agreed Ethel.

"Especially if you foster them," agreed Yevgeny. "But remember, they do have some advantages: a lot more solar power than we and three launch opportunities per year to Earth, which is six times more than we have."

"We plan our launch opportunities carefully," replied Will. "Besides, Mercury may hand us a new advantage; there's always an excellent Mars to Mercury to Earth

launch window within three months of the arrival of ships from Earth. Once we master the technology, that could become the preferred return route."

"It'll be quite a 'fry-by,' quipped Alexandra.

"But the caravel design can handle the intense sunlight, and we can already handle the radiation," replied Will.

"That relates to what I think Mercury will mean to us," agreed Yevgeny. "A new export market. They'll buy our nitrogen, aluminum, specialized plastic products, steak, and who knows what else. We supplied Magellan Station with twenty tonnes of water for radiation shielding and five tonnes of carbon dioxide and nitrogen for the greenhouse. As Venus goes, so will Mercury. It'll be the same for the asteroid belt and the outer solar system as well, if we're smart. Mercury's at the dead end of the solar system; for us, the frontier extends outward to the stars."

"The stars?" said Ethel, smiling. "My, Yevgeny, that's ambitious!"

"I think he's right, though," said Will. "Mars as a nation can and probably will be a major force in space exploration. We're founded on it and have huge expertise."

"True, and I think the High Commissioner of the Mars Commission has to be careful throwing around the term 'Mars nation,'" said Ethel. "You've used it several times in the last six months, dear. It'll come back to bite you."

"We're among friends here," replied Will. "You're right, though; I need to be discrete in public."

"Still, the signs are all there that you're right," said Alexandra. "We're part of a plan to open the Asteroid Belt and Jupiter to human beings within a decade."

“Saturn will probably follow in another decade,” replied Will. “Assuming we can develop faster propulsion, Uranus, Neptune, and Pluto will follow after that, perhaps a decade apart.”

“Or less,” said Alexandra. “We need one propulsion breakthrough. Then it’s a matter of will.”

“Politics may take time to catch up,” said Will. “I’ve seen enough to know how weird it can be. As for the stars; they require *another* propulsion breakthrough, eh Alexandra?”

She nodded. “Twenty-second century.”

“It’ll take that long for humanity to agree how much economic surplus it wants to devote to the solar system,” agreed Yevgeny. “It won’t be cheap to maintain colonies of, say, one or two hundred on or near each planet. And if we think transportation to the Earth is slow now; imagine the supply and passenger traffic to Pluto!” He chuckled at the thought.

“And where will they be?” asked Will, pointing to their children. Marshall Elliott, twelve, was sitting near the adults, watching the first robotic vehicles roll onto Mercury. Elizabeth Elliott, who was almost ten, was sitting on the living room floor a few meters away and playing with Boris Lescov, who was just fourteen months old.

“I hope they stay here, with us in our old age!” said Ethel.

“That’s what your dad says every time we videomail him,” replied Will. “And it didn’t keep you in Scotland.”

“It’s too soon to tell what Boris will be interested in,” said Alexandra. “But Marshall’s becoming quite a good geologist.”

“Thanks,” replied Marshall, with a smile. “But dad still won’t take me out on an expedition!”

“A few more years; you’re too young. Besides, I haven’t had time for an expedition almost since you were born.”

“Then another decade I’ll go there and core Pax glacier,” said Marshall.

Yevgeny looked at his own little boy. “Lizzie’s really good with little ones.”

“She helps at day care two afternoons a week,” said Ethel.

“And she’s quite a dancer!” added Alexandra.

“Madhu has organized a pretty impressive dance class,” replied Ethel. “Lizzie has real talent.”

“They need to do more with jumping and leaping to take advantage of Martian gravity,” said Alexandra.

A communications icon on Will’s tablet began to flash and Will saw it out of the corner of his eye. He walked over to the table and pushed play. The audio went to his ear piece so no one else could hear. The face of Brian Stark, an American nuclear engineer who had spent two and a half years on Mars, appeared on the screen. “Hi Will. I’m here at the New Mexico spaceport supervising my cargo launch—it goes up to orbit tomorrow morning—and watching the Hermes Zero expedition on tv. Isn’t the robotics incredible? The buggies and the ranger rolled out of the cargo bay so fast, I thought people had to be driving them! I’ve already contacted the universities that developed their software for more information. Anything that can place, inflate, and bury a hab can repair a reactor. Sad to say that the U.S. didn’t develop this stuff. But thanks to you again for managing

the hearings at Aurorae so well; at least I know we're coming to a place that is just skeptical, not hostile.

"What did you think of the premiere of Skip's Mars documentary? The audience loved it. There was a long line of admirers seeking to bend his ear at the reception afterward. He wasn't pleased by some of the technical aspects; he edited the tape on the flight to Venus and was limited somewhat by the equipment available. It looked great to me, though, and Skip told me everyone up there was pleased. His movie *Survival: Mars* premieres in early October just before I leave for Mars. I'm looking forward to that. It may make the entire fifteen month voyage home worth while!

"Say hello to everyone I know. Bye."

Will smiled at that and hit reply. "Hey Brian, thanks for the message. Ethel, Alexandra, and Yevgeny are sitting in my living room watching the whole thing live on our tv and marveling at the robotics, too. Marshall says he wants to core Pax Glacier, Lizzie's playing with Boris, and Boris is entirely oblivious. It makes you wonder why Marshall should bother; the equipment can core the glacier without us! But I suppose there will always be a role for us somewhere on Mercury.

"No news here. The Antarctic Expedition heads south once the dust storm season ends, to complete the Antarctic Trail. John and Vanessa are taking their toddler; the first kid on an expedition! We'll see how that goes. We're building housing for Columbus 9's arrivals and making as much of the first caravel as we can. The Meridiani outposts are putting out lots of gold. The *Ascraeus* and *Elysium* are closing on 2031KL12 and will explore the dead comet nucleus next month. So materially, all is well on Dusty Red. Best wishes with all your work down there. Bye."

Will sent the message and walked back the couch. Alexandra smiled, amused. "'Materially' all is well?"

"Well, you don't want me to talk about our spiritual condition, do you?"

"I don't know if I have a spiritual condition!"

"I'm sure it's fine; but I'll leave that to you," replied Will.

2. Balancing Act

Nov. 2052

Madhu's ballet class ended with a burst of noise from the ballerinas as they rushed to change shoes. Will entered as the girls left the dance floor. "Will, she's a natural," Madhu said, referring to Liz.

"Really?"

"Oh, yes. Her height, her proportions, and her coordination and balance. . . I just wish I could teach her better. Ballet is not my main area of training, and Martian gravity requires that we develop different forms. It'll be a few years before we begin to figure it out."

"I love it, Auntie Madhu!" said Liz.

"Well, keep attending the class, then," said Will. "Are you just about ready?"

"Dad, can I go to the patio with Corrie?"

"I suppose. Mom's running a little late; she has a teleconference right now."

"Marshall and the other kids are there, and I don't have that much homework. I'll do it after supper."

"Okay. I'll walk you over to Yalta."

"No, Corrie and I can go by ourselves."

"Okay, suit yourself. I can run back upstairs to my office. But I'll be there in fifteen minutes or so for supper."

"Alright, thanks dad!" Liz turned to Corrie—her closest friend, born only a sol later than she—and the two of them headed for the door. They were gone in a few

seconds. Will shrugged at Madhu, waved goodbye, and headed out the door himself. But rather than returning to his office, he headed to Ethel's office in the Vandevelde Industrial facility. She had invited him to sit in.

He found her sitting, sipping her late afternoon tea, and waiting. "Is the call over?" he asked.

"No; we're between rounds. Where's Liz?"

"She and Corrie wanted to go to the patio *by themselves*. I'm not sure I should have agreed, but it was a short walk through one pair of airlocks."

"They're so proud to be ten and have airlock privileges! They can get pretty excited and run around in Yalta; they need supervision. But I suppose we can both go over. The remaining round of exchange will be pretty quick." She folded her tablet and began picking up a few pieces of electronic paper. Will looked at a big sheet displaying a schematic.

"The plan for the new nickel-iron processing facility?"

"Yes; Jim Leong sent it a few hours ago. It'll be attached to the eastern side of Vandevelde, overlooking the solar power units and the water wells. It'll use five times the power of our current fractionator but have ten times the capacity; ten tonnes of nickel-iron per sol."

"Which will flood us with processed nickel-iron; it'll be years before we can use 3,650 tonnes per year."

"Yes, and it'll produce only 100 kilograms of Platinum-group metals annually. But they'll be worth six million redbacks."

"A lot of hassle for a return of that level."

“That’s what Jimmy and I are discussing at nauseam. I’m worried about the robotic regolith mining machine. I can guarantee it’ll break down every other sol; it’ll take months of modifications to get something that can work in our gravity and temperatures. We’ll be lucky to process half that much per year.”

“So, we’ll lose money?”

Ethel nodded. “Guaranteed. The salary for me and my assistant will be covered, plus electricity and other inputs, but the one hundred fifty million redbacks for developing, building, and flying the equipment here will take thirty years to recover. Of course, this machine is really the prototype for something that can process a hundred tonnes a sol, which will lead to larger units that will be profitable.”

“As long as we’re still alive to see the profit.”

Ethel laughed. “I think so! Jimmy’s operating the prototype on the moon as well. Two operating fractionators will be better than one.”

“We may make a profit on the stock. Everyone’s pretty confident in this plan long-term and the stock’s value keeps going up.”

“If that’s a hint we should sell, forget it!”

“No, no, I’m committed to this project, too. I’m glad we managed to be a major investor.”

“Ten million redbacks; half our fortune. But don’t worry, I think this will convert it into a billion eventually.” She headed out of her office with Will right behind. “How was your sol?”

“Tedious. Brian called; he’s terrified he’ll get here in January and the new Democratic president and Congress will eliminate his funding. I assured him that fiscal

year 2053 is already approved and he shouldn't worry about fiscal 2054 yet. I've been busy making courtesy calls to various Senators—mostly Democrats, but some Republicans as well—summarizing progress on Bioarchive, the caravel, Ceres, and preparations for nuclear power, just to remind them we're moving forward on our commitments. No one's acknowledging my calls, either; I don't know why anyone thought this was a good time! And the budget is driving me crazy."

"As always."

"Yes, as always. Half our revenue comes from gold that fluctuates in production and market price and the other half comes from fickle governments. It's a balancing act; we can't ever rest, especially with caravel costs climbing fast."

"What about the reserves?"

"Spent. We're borrowing against future revenues, and at high interest rates."

"They should go down as the economy recovers. But when it recovers, gold prices may drop and the cost of technology workers will go up."

"I think the price of gold is permanently up. India is prosperous and they love gold; demand for jewelry is incredibly strong in spite of the price. Gold production on Earth is up, too, from incredibly poor ore because that's all that's left. So we may be alright."

"I hope so." Ethel paused a moment for the airlock door in front of them to open, and they entered the tunnel into Catalina. They crossed the biome and entered Yalta, which was now full of people eating supper. They rounded up Marshall and Lizzie and headed through the food line, then went to their table.

“So, Will, what do you think about the elections?” asked Érico, who was seated with his family at the next table.

“We’ll be fine. The conservatives favor space exploration as part of their nationalist agenda and the liberals favor it as part of their internationalist agenda.”

“Even so, Will, it’s easier to cut when you are one country in a partnership out of many,” replied Roger, who was sitting at a different nearby table.

“If the Americans don’t want to participate, the Chinese, Indians, and Brazilians can replace them,” replied Érico. “Heck, China alone can do it; their economy’s larger.”

“Depends on how you measure it,” replied Roger. “The dollar’s undervalued by thirty percent right now. If it strengthens by even five percent, the U.S. would be the biggest again.”

“You aren’t the world’s superpower any more,” replied Érico. “China and the European Union have bigger economies and India’s only twenty percent behind you. The U.S. will be number four at the end of the century.”

“Dream on, Érico. The dollar will recover, now that the economic foolishness is over, and the U.S. will be the biggest economy again. And unlike Europe and China, the U.S. has a relatively young population; one that’s still growing.”

“Roger, the United States can’t stay in the lead, you’re number four in population and the economic differences are closing.”

“And the European Union isn’t even a country.”

“Never mind, gentlemen,” said Will. “What is clear is that the gap used to be large and it is closing. Earth is much more multilateral than it used to be, people are getting used to working together, and the rule of law continues to spread.”

“So far,” replied Roger. “The human capacity for evil is undiminished, Will. Two nukes in the last decade is proof of that.”

“I agree with you on that,” said Érico.

“Well, I don’t,” replied Will. “As I’ve said many times, we’ve given up a lot of behaviors people thought were basic to their societies, like cannibalism, human sacrifice, slavery, and poisoning rivals. New York and Pennsylvania don’t go to war; they sue each other in court. What we see on Earth is the spread of regional blocks, and they’re all imitating the European Union.”

“True, even South America’s talking about a common currency,” said Erico.

“A continent that used to be torn by wars and dominated by dictators. It’s coming along, Érico,” said Will. “So I’m not going to worry about an American election, long term.”

“But Will, what about the short term?” asked Roger.

Will smiled. “It’s a balancing act, as always. That’s what I’m paid to handle.”

3.

The Solis

17 Feb. 2053

The sleek new Hermes-class shuttle descended to the Martian surface on a hundred meters of thundering orange-tinged blue flame, throwing a cloud of dust and snowflakes high into the air. The flame cut out and the vehicle bounced slightly as it landed at the center of the bulls eye of landing pad number six. The *Ma'adim* was on Mars.

"Isn't she beautiful?" Will asked Marshall, who was in back of the control room.

"Beautiful!" agreed Marshall. "How much taller than the old shuttles?"

"Four meters; twenty-four instead of twenty. It's all in the longer cargo bay."

"It does look different; more like a bullet and less like a capsule."

"Yes, that's a good way of putting it," agreed Will, impressed by his son's observation.

"Welcome to Mars, *Ma'adim,*" exclaimed Rostam Khan.

"Thanks, Mars Control, we're delighted to be here," replied the captain. "Initiating shutdown of the propulsion systems."

"We copy."

They sat in the control room silently, watching the data come back from the shuttle's systems. A team in one corner began to inspect the exterior of the vehicle via cameras on a mobilhab nearby to make sure it looked safe to approach.

A half hour after landing, Rostam gave the "all clear"; the propulsion systems were totally deactivated and the exterior was clean. Two mobilhabs—large mobile

habitats—approached, one docked to the shuttle's cargo bay door, and the other docked to it. Meanwhile, inside the shuttle, the twenty-four passengers unstowed their luggage and waited, for the transfer did not need a pressure suit. Once the docking was complete they began to enter the mobilhabs.

"Let's go," Will said to Marshall. "Time to greet the first arrivals."

Marshall nodded and jumped out of his seat. They headed for the control room door. "So, this is the first of four passenger flights, right?"

"Right. These new Hermes Shuttles could hold up to fifty-six passengers, but we're flying them with a maximum of twenty-six until we're confident in them. The *Solis* complex has fifty-six people on it; the *Hellas* complex arrives next month with fifty-two more. The *Ma'adim* will make two flights and bring down 50 altogether. The *Hellas* arrives with two Hermes shuttles, the *Kasei* for cargo and the *Nirgal* for passengers, so it'll make two round trips and bring down fifty more. The remaining eight people will come down on the cargo flights."

"Dad, when will I be able to fly in a shuttle? I want to go to Phobos."

Will had to smile. "Shuttles are rated for adults, so you'll have to be eighteen. Just five more years now."

"Five years!" Marshall sounded disgusted.

"Hey, kiddo, be thankful you can use a pressure suit! We don't live in Houston."

"I know." Marshall did not hide his disappointment.

They crossed Riviera Biome and entered Yalta, their oldest biome. In the last year it had been renovated to accommodate the larger population; the cafeteria kitchen was doubled in size, the food serving area was more than doubled to accommodate the greater

volume and variety and was reorganized, and “the Patio” where the tables and chairs were arranged in open air was expanded. On the south side of the biome, Silvio’s Store had tripled its floor space. A tailor shop, beauty salon, craft shop, and a lawyer’s office rounded out the services available in their nascent commercial center.

They exited Yalta and walked along two underground tunnels until they reached the debarkation area. They didn’t have long to wait for the two mobilhabs to approach the facility and dock to the outside. The hatches opened and Mars’s newest residents began to step through the airlocks. Will stood next to the nearest hatch and shook hands with each arrival, formally welcoming them. The persons coming out of the other hatch came over and stood in line to shake hands with “the Commissioner,” as he was often called, the person in charge of the entire Mars Commission. Marshall stood and watched, drinking in the scene excitedly, wondering about the young man standing nearby with an older man and woman of similar skin color and appearance.

When Will finished shaking hands, they approached him. He looked at them, then smiled. “Dharmapala, Maya, and Rahula Peres, I presume?”

“Correct, Mr. Commissioner,” replied Dharmapala, the father. “It’s good to meet you.”

“I’m delighted. It took a series of small miracles, but all three of you are here!”

“Thank you, we’re very grateful,” added Maya, the mother.

“And how do you feel about being on Mars?” Will asked the son.

“Oh, delighted!” Rahula replied. “Who would have thought that, one month before departure, the three of us would suddenly get the call! It’s a marvelous opportunity!”

“And a historic one; you won’t be the last family to emigrate,” noted Will. “This is my son Marshall, by the way. He just turned 13 two weeks ago.”

“So, are we the only teenagers on Mars?” Rahula asked Marshall.

The younger boy nodded. “For eleven months until my best friend Sammie turns thirteen.”

“Nice to meet you.” Rahula extended his hand and Marshall, excited by the attention, shook hands gleefully. Dharmapala and Maya shook hands with Marshall as well.

“Where’s your flat?” asked Will.

“Cochabamba,” said Dharmapala. “Unit 6C.”

“We’ll walk you over,” said Marshall. “Okay Marshall?”

“Sure!”

Will walked to a corner and grabbed two metal luggage carts. The Pereses were surprised that they looked like standard carts at a terrestrial airport. They loaded their luggage onto them and began to push their possessions to their new home.

“The corridor that goes around Yalta and Catalina is the most direct route,” Will said, pointing to a ramp leading to a new underground corridor.

“And the sign even says Cochabamba!” added Dharmapala. He steered the luggage cart down the ramp; Will followed with the second cart, which he had taken from Rahula.

“How was your flight?” he asked.

“Pretty good, I guess,” replied Dharmapala. “It had lots of nagging problems; I think every single docking unit leaked at one time or another. The *Solis* complex lost about a tonne of oxygen.”

“Yes, it was an embarrassment. We switched to cheaper manufacturing processes and saved two hundred million new redbacks on the flight hardware, but they leaked.”

“It was worth it. I wouldn’t want to fly to Saturn in the *Solis,* though.” Dharmapala shrugged. “I’m still impressed that we could get to Mars in 150 days; that’s really amazing. Of course, the aerobraking made for a pretty rough arrival. We kept busy; everyone was almost constantly training. The zero gee gym was very popular.”

“So were the zero gee bedrooms,” added Maya.

“I think every couple signed up,” said Dharmapala.

“And it was nothing exciting, either,” noted Maya wryly.

“So, do we have a lot of marriages on the way? The flight out often gets called ‘the love boat,’” noted Will.

“Some engagements can be expected,” said Maya, nodding. “We also had some nice cultural events; plays, skits, poetry, concerts. It’s a talented bunch of arrivals.”

“And younger than us,” said Dharmapala. “I think two thirds of them went straight through to a Master’s degree or a doctorate, worked for the Commission for four years while training for a flight here, and now at age twenty-eight to thirty are on their way to Mars.”

“Yes,” agreed Will. “That’s been the pattern for the last few flights. We recruit from our dedicated ground support team, so when they arrive they know exactly how our

operation works. Meanwhile, half of them have married other trainees or get married here, so two years after they arrive they start a family."

"What is our population, anyway?" asked Maya.

"Two years ago it was 226. Since then we've had 20 children, so before your arrival it stood at 246. Add 108 from Columbus 9 and it'll be 354."

"Wow!" said Dharmapala. "You've now blown away the moon."

"Well, the worldwide depression slashed their tourist income. That's recovering. But they have no children; we're a settlement, they're a base."

"I'm looking forward to experiencing the difference," said Dharmapala, who had spent sixty-seven months on the moon over the last sixteen years.

Will turned to Maya. "I'm delighted we finally have someone here with a doctorate in the humanities, and a professional poet as well."

"Thank you," replied Maya. "I'm the entire Department of History and Culture of Mariner Institute of Technology! I plan to write a lot of poetry, and I'm trained as a horticultural specialist."

"Rahula's trained as a welder and riveter," added Dharmapala.

The eighteen year old nodded. "I'm taking two courses at MarTech and will be working thirty hours a week in construction."

"Good. Take care of yourself," said Will. He paused outside the airlock leading into Cochabamba while the door opened automatically for them. They stepped inside and the outer door closed, then the inner door opened.

A sunlit open space appeared before them. Dharmapala looking out, impressed; Maya said “Wow.” Rahula stood a moment, then pushed past his parents into the open area. “Fantastic,” he said.

“They’ll never have anything like this on the moon,” exclaimed Dharmapala. He pushed the cart onto the concrete pathway. Cochabamba Biome was their first “B-75,” a pressurized enclosure seventy-five meters in diameter and forty meters high. The sun was just three hours above the eastern horizon and slanted across the space; the western third of the dome was still covered by a silvered blanket that bounced extra sunlight downward onto the vegetation.

Will pushed the other cart out of the airlock. “It’s still rather bare in here. The trees, grass, flowers, and vegetables were planted just three weeks ago. A third of the building sites are bare, too.”

“Those are the places for the annexes we brought, right?” asked Maya.

Will nodded. “Some of them. The *Solis* and the *Hellas* are bringing a total of eight annexes and each has building bubbles for three condo cylinders. We have five construction sites in here and seven more in Columbia Biome. The other twelve building bubbles we’ll use for Columbus 10, two years from now.” He pointed. “The condo cylinders are in numerical order; the first cluster here has 1, 2, 3, and 4.”

“Then let’s go!” said Rahula, and he ran down the sidewalk. Marshall hurried close behind. Will smiled and pushed the cart along the sidewalk as well. The biome floor sloped downward to the north, which was the direction they were moving. The northern escarpment marking the edge of the Mariner Valley system reared up before them, a kilometer and a half tall and raw with landscape scallops and building-sized boulders

barely visible from twenty kilometers' distance. They all feasted on the view as they strolled toward the Peres's new home.

The second cluster consisted of four cylinders, two in front and two in back, with a narrow passage between the front two and a garden in the middle. All four shared a rooftop agricultural area with a skylight to bring sunlight down to the central flower garden in the center of the four cylinders. They crossed the garden and approached a light green cylinder ten meters in diameter and ten meters high with a central door, which opened automatically when they reached it. In front of them was a tiny lobby with a door on the right, a door on the left, and a spiral ramp behind them. The doors were labeled "A" and "B" so they pushed the luggage up the ramp to the second floor, where they found "C" and "D".

"Dharmapala Peres. Open please," exclaimed Dharmapala, and door "C" immediately unlatched. He smiled, pleased that the outpost's computer had his voice print in it already. They pushed the door open and entered a living room with a kitchenette in the far corner. A spiral ramp led up to their second and third levels where they had bedrooms and offices. Dharmapala turned to the wall and tapped it; it was drywall, like most terrestrial construction, bolted to metal supports.

"We'll leave you now," said Will. "Enjoy your new house. See you tonight at dinner."

"Thank you, Commissioner," said Dharmapala.

"Please call me Will. Delighted to be of help." Then Will turned and headed back to his office, with Marshall at his side.

They went back to Mars Control, where Marshall said goodbye to his father and went to find Sammie, who was playing in the yard between the two buildings with Marshall's sister, Lizzie, and her friend Corrie. It was Satursol—the first sol of the weekend—and thus they had no school. Marshall and Sam hung out, talked, played a computer game, and worked a bit on homework together; they constituted Mars's entire sixth grade. About the time Sam had to join his father, leaving Marshall alone, Rahula entered Riviera Biome.

"Hi," said Marshall.

"Oh, hi. I've been exploring the outpost."

"Did you go all the way to Columbia?"

Rahula nodded. "And I went via the agricultural biomes. Wow, the air in there is thin! I had to walk very slowly and breathe hard."

"Yeah, it has one half the oxygen of the residential areas. It takes some getting used to. The people who work in there, though, don't wear pressure suits; they've adapted."

"Really?"

Marshall nodded. "It's rough the first few weeks and, they start out working in there no more than an hour or so. I've been going in there a lot lately; dad and mom said I couldn't explore them alone until I was thirteen."

"And when was your birthday?"

"Seventeen sols ago."

"Say, which way to the Patio; that way?" Rahula pointed to the airlock at the eastern end of the biome.

“Yes. I’ll show you.”

“Okay.”

Marshall jumped up and walked next to Rahula. He was obviously excited to have the older boy’s attention. “What was the flight like from Earth?”

“Oh, how do I answer that. . . exciting. The Solis had an axial ‘middeck’ cylinder thirty meters long and ten meters in diameter that served as a zero-gravity gym, and we had four intramural volleyball teams. You have to hit the volleyball through the small circular opening in a doughnut-shaped net. My team didn’t do so well. We had four annexes—big inflatable habitats ten meters in diameter and ten meters long, housing twelve people each. One annex had our cafeteria, another our exercise area, another our sick bay, and the fourth had a repair facility. They were arranged like two pairs of spokes off the middeck. Finally, attached to each annex was a Mars shuttle. The capsules provided most of the air recycling and their cargo bays had extra accommodation with the highest gravity and the most radiation shielding. You reached then through a pressurized tunnel, and they leaked a bit, which was a big problem. We rotated which rooms we had so everyone had the gravity and radiation shielding part of the voyage. We also had a spare annex attached to the end of the axis that provided additional housing, and it was in zero gee. Finally, we had an experimental Sunfire solar thermal engine attached to the end of the zero-gee annex with an absolutely enormous mirror system—a quarter kilometer across!—that shortened our flight to Mars from 175 days to 150.”

“I heard about the leaks.”

“They were a constant problem! And two small solar flares that forced us into shelters a day; that was a pain. And constant training; when we weren’t playing volleyball, we were watching videos or discussing how to do things.”

“Like what?”

“Everything. We spent half the time on safety training, including some drills. We also made some spacewalks the last week when the rotation was stopped and when the annexes had to be deflated and stowed in the cargo bays; that took almost everyone. And we spent a week after arrival on Phobos and Deimos; almost everyone was getting trained to do construction or geology on them.”

“And at Embarcadero,” added Marshall. Embarcadero was Mars’s transit point for interplanetary flight.

“Yes, most of us spent time there as well, doing routine maintenance and preparing for zero-gee construction tasks.”

They entered the airlock tunnel between the biomes and a moment later opened the door into Yalta, by the swimming pool at the western end. The cafeteria was at the far end, forty meters away. “So, what are you here for?” asked Marshall.

“You mean, my career? I’m probably the only person here who doesn’t have one yet! But I plan to major in geology and do construction to earn my keep. That’s what everyone wants; construction workers. The alternative is cafeteria work or horticulture, and I don’t think I like either! By the time I get a geology degree I’ll have paid my dues. Dad says I should be able to go out on summer trips while in school.”

“Really. Oh, I wish I could do that! I’ve never been farther away than the Dacha.”

“Up on the rim of the escarpment? I want to go there.”

“There’s a robotic bus twice a sol, after breakfast and before supper. It’s a forty-five minute drive. I really want to see the rest of Marineris, or the polar caps, or Olympus Mons! And I really want to go to Phobos!”

Rahula chuckled. “I’m sure you will, some day.”

They entered the cafeteria. Rahula looked around and was disappointed by the snack choices. He grabbed an orange and filled a glass with diet Coca-Cola, then looked around for the checkout area.

“Over there,” said Marshall. “You put everything on a tray and push the tray through the checkout tunnel. It scans the stuff, figures out what’s there, and calculates the bill, then you just swipe your i.d. card.”

“Oh, damn, I left it at the house!”

“We can put it on mine. Dad won’t mind.” Marshall grabbed an apple and a glass of diet Coke as well, and they took the tray to the checkout tunnel, which was a bit wider than a tray and a meter long. The price popped up: 25.00. Marshall pulled out his card and swiped it.

“Wow; it’ll take a while to get used to the prices.” They walked to a table nearby and sat. “So, what’s it like to grow up on Mars?”

Marshall considered. “It’s great! We have lots of friends, good teachers. . . and I guess I don’t know what the Earth is really like anyway. Dad keeps telling me it isn’t like television.”

“No, it isn’t. Do you miss Earth?”

“I want to see it sometime. But I’d also like to see Mercury, or maybe Callisto. Everyone here says we’ll be exploring the solar system and I should plan to be part of it.”

Rahula laughed. “That’s definitely a difference between Earth and Mars! Earth teenagers usually don’t aspire to go to Mercury *and* Jupiter!”

“I suppose not. If there’s one thing I’d like to see, it’s an amusement park; maybe Disneyworld. A mall would be interesting, and then maybe a park like Yellowstone. I can’t imagine what it’d be like to be outside and not having something wrapped around you; either a pressure suit or a dome, that is.”

Rahula smiled. “One thing puzzles me; your accent. I’ve heard a few people here speak with the same accent. It’s very clear and educated; no dropped syllables. You said ‘dif-fer-ence’ rather than ‘dif-rence,’ for example. And the vowels are very clear.”

Marshall chuckled. “Oh, that’s Fatima! She was our elementary school teacher; she’s the principal now. She insists we speak very clearly and precisely. I guess it’s trickling outward to the adults, too!”

Rahula laughed. “I guess Mars is acquiring its own accent.”

“You speak with a standard American accent, I think. You don’t sound like other people from south Asia.”

“Mom and dad became American citizens over twenty years ago so dad could apply for the NASA astronaut corps. We’re citizens of Sri Lanka, too. We didn’t get to Sri Lanka more than once every two years, but when we decided to apply for Columbus 9, the Mars Commission approach the Sri Lankan government and convinced them to pay some huge sum to have Sri Lankan citizens on Mars. So we tape interviews every month or so, and do little programs for high school and university classes. It’s fun.”

“And Peres; that’s a Portuguese last name, right?”

"Right. Dad has some Portuguese blood from five hundred years ago when the Portuguese were sailing in the area. But we're Sri Lankans and Buddhists, and I guess now we're Marsians!"

"I think so," agreed Marshall.

Rahula had been peeling his orange; he offered a few sections to Marshall, who took one. Rahula took a sip of his Coke and made a face. "Ooh, this Coke will take getting used to, also!"

"They say processed foods are never quite the same as on Earth. Sometimes the Diet Coke has saccharin, sometimes nutrasweet, sometimes some sugar in it; it depends on what's available to make it! But everyone says the fruits, vegetables, and meats are much better here, since we don't use pesticides and can control the climate exactly."

"That makes sense." Rahula took another sip, trying to get used to it. "Do you know of any good hiking routes outside?"

"Oh yes, lots! And I can go outside with you; I can go outside with an adult!"

"Well, maybe." Rahula was hesitant to take on such a responsibility. "But it sounds like there are some things we can do together. I'd like a little help to get adjusted to this place."

"I can do that!" agreed Marshall. "That'd be fun!"

"Good. I'd like it, too," said Rahula.

The next morning, refueled, the *Ma'adim* blasted off for Embarcadero Station, where the *Solis* was docked. Over the last two weeks, the arriving crew had taken apart the four annexes that arrived with them; they were now packed into the cargo holds of two cargo

shuttles that were ready to carry them to Aurorae Outpost. Another shuttle had cargo that the *Solis* had brought to Mars. The *Ma'adim* loaded twenty-four more passengers on board and brought them down on Monsol morning, leaving four people at Embarcadero to dispatch shuttles and prepare for the arrival of the *Hellas* in three weeks.

Monsol evening the outpost witnessed the traditional big welcoming dinner. Rosa Stroger, director of Nuclear Science on Mars, kept a close eye out for Brian Stark, the newly arriving director of the American nuclear power team. When he entered the biome, she waved and he came to their table. "Rosa, good sol," he said. She stood and they hugged like old friends, even though their relationship had been occasionally frosty last time he had been on Mars.

"Welcome back; the first man to return!" said Rosa.

"Thanks." Brian turned to Neal Stroger and shook his hand. "How are you?"

"Very well, thank you. Dick, Sarah, do you remember Mr. Stark?"

"I do," said Dick, and he extended his hand.

"It's good to see you, Dickie. My, you're big now! You must be ten!"

"Next month," he said. "And dad says I can go out on an expedition with him this summer."

"If I can go," added Neal. "I have to have the eye surgery first."

"Cataracts?" asked Brian.

Neal nodded. "The new ophthalmologist has about twelve of us to do."

"I hear the new conestoga design will be 'child friendly.'"

"We'll see," said Neal, with a smile. "I think Dick will be out for just a week or two."

“Would you like to go out, Sarah?” asked Brian.

“Ah. . . I don’t know,” she replied.

“And you’re. . . seven?”

She nodded shyly.

“Get your food and come join us,” said Rosa.

Brian nodded and walked to the food line. He went through quickly, loading up his plate; arrival dinners were always free and bountiful, in contrast to their usual fare. He returned a few minutes later with a heap of food. “I stopped at your office this afternoon, but you weren’t there.”

“I was outside,” replied Rosa. “I looked for you after that; I should have just left a message for you. So, you left here 25 months ago, flew to Venus, stayed at Magellan six months, flew to Earth and arrived less than four months before flying back. It must have been disorienting.”

“It was. I was on Earth just long enough to see my parents and brother, make a publicity swing for Skip’s various movies, and get briefed about my new mission. I left here thinking I’d never be back and we’d never be developing a big nuclear power project here. Venus was a real pain; the tourists and crew got into it, but I was not interested in wheeling around the surface in virtual reality. If it weren’t for Skip’s movies, the whole trip would have been a waste.”

“Interesting. You all did some great science; this Magellan got twice as much done because so many people were there!”

"True. And I will concede this: Venus is *beautiful* from orbit. It really is, just like Earth and Mars, but very different in appearance. It'll also make your eyes water if you don't look at her through sun glasses!"

"So, now you're here and you're building a U.S. Navy-NASA-Department of Energy Nuclear Science Facility," said Neal. "You have enough experience of this place to know about half the residents are unhappy about it."

"I know. Everyone says we can't build our facility a hundred kilometers away for security purposes, and I agree; I want it right here, just a few kilometers away, visible to everyone, so that the workers live here and mix with everyone here on the Patio. And we plan to be as transparent as we can reasonably be. We have to be separate from your team, Rosa, so that your team can be an impartial source of advice and can provide inspection. The International Atomic Energy Commission has sent an inspector, too."

"Good," said Neal. "The first phase is uranium enrichment?"

Brian nodded. "The *Solis* and *Hellas* each are bringing three personnel and we have twenty-five tonnes of cargo on the cargo flights. There are also four Mars Commission mining specialists coming to mine uranium and other ores. We have both the latest centrifugal separators and experimental laser separation equipment. We should be able to make a hundred kilos of enriched uranium this columbiad, and eventually ten times that."

"How enriched?" asked Neal.

"The exact amount is classified. We're not talking about bomb grade, but more than standard light water reactors on Earth. The new space reactors will use a higher concentration."

“And plutonium synthesis is a later phase?” asked Neal.

“Probably. That’s controversial. In my opinion, it’s a crucial asset for the future of this place. It’ll put Mars in the center of exploring the entire solar system. Launching uranium and plutonium from Earth will always be controversial. It can be launched safely, but there are too many emotional people who won’t believe it. Here, our life support system and ecology are separated from the Martian atmosphere, and this planet has vast areas that will be uninhabited for centuries. We can handle accidents better here than Earth can, if we ever have any. So I am hoping the emotional side can be managed better here.”

“Well put,” said Neal. “Because a bunch of scientists with Ph.D.s can be pretty emotional, too.”

“I know. I know this place and I’m committed to it long-term, just like you all.” Brian nodded to the children in particular.

“Well, Brian, I think if anyone can sell the facility to the residents, you can,” said Rosa. “But it’ll be a challenge. The last few years, the United States has developed a terrible reputation on Earth because of its foreign policy, and the reputation here is even worse.”

“I know, I was here, remember! But none of us have any control over any government’s foreign policy. What we have control over is the plan and making sure it’s implemented legally and ethically. So to people who are suspicious of the U.S. and its motivations, I say: good, keep an eye on us, because we have an agreement what we will do and how we will do it.”

"That's a good answer," said Neal. "That's fair." They ate in silence for a moment.

Other old friends of Brian stopped by and chatted, then Brian introduced his three colleagues to Rosa and her family. The dinner proceeded smoothly as the sun dropped below the biome's rim, then set. Everyone was drinking their after-dinner coffee when Will Elliott walked to the stage.

"Good evening everyone," he said. "To all our new arrivals, welcome to Mars. To the crew of the *Hellas,* who are watching us, greetings; we look forward to your arrival. We'll have a dinner for you as well, and the cultural program afterward will be different! But I can't guarantee my remarks on that occasion will be new.

"Every columbiad I give a welcoming speech where I set out the agenda for the next two years. This arrival is distinct in two ways; we have two passenger waves instead of one; and we have made more of an effort to involve the arrivals in Mars society from the moment of Earth departure. The Living Well Conference two months ago gave all of us food for thought about our real purposes here—personal development and building strong, stable relationships with others—and allowed the future arrivals to participate fully. The Mars Science Conference, conducted on the Earth, moon, Mars, and on both the *Solis* and the *Hellas,* also gave us a common vision of our work here. Our goals are fairly clear.

"But that doesn't mean they aren't worth repeating. We are receiving four polar researchers who will be setting up permanent facilities at the north and south poles. The North Pole will see a deep drilling project that, over the next five years, hopes to recover a core all the way through to the Noachian basement rock. Our exploration and science

team will expand to sixty people and will be visiting thirty locales in six regions over the next two years. Each region will receive an oasis, a facility where researchers can be based. In a decade we hope to have one hundred oases scattered about the planet, making research easier and facilitating the creation of future outposts. Notably, we are scheduled to clear only two thousand kilometers of primary roads in the next two years; our road network, for now, is complete.

"Our largest team here is the construction team, which will embrace one hundred twenty people once the *Hellas* arrives. Its principal goal is to build our first caravel, the new generation spacecraft that will bring settlers to Mars and that we will sell to nations wishing to explore the outer solar system. The design is finalized and many of the materials have already been fabricated. We should have a caravel completed in eighteen months. The construction team also must make all the enclosures and structures we need for Columbus 10, which will arrive about twenty-six months from now. They will also be making solar panels and wind turbines to expand our power output significantly.

"Environmental management is growing significantly, to thirty people, so that they can devote more resources to the Bioarchive project. Next month we will have twenty different ecologies here. In the next two years we will be setting up two biomes exclusively for bioarchive, with divisions into quarters in order to establish four ecologies in each. We anticipate a rapid expansion in our ecological research here, with a larger scientific support team on Earth. The environmental management team is also looking at expansion of its research in two exciting directions: genetic engineering of crops to boost yields, research we can do without fear of contaminating the Earth's ecosystems; and genetic engineering of species so that they can survive in Martian or near-Martian

conditions. The latter effort will allow us to raise food and other useful crops with minimal construction of domes and could lead to terraforming.

"Exports will expand and diversify. We are importing a record quantity of items over the next few months: 350 tonnes. The last columbiad saw gold exports reach almost three hundred tonnes. We hope to do better this columbiad and add to it a hundred tonnes of nitrogen and argon and as much as a tonne of platinum-group metals. Our carbonyl fractional distillation equipment will make that possible. New supercritical CO_2 equipment will allow the gold mining operations to recover silver, copper, cobalt, and other valuable elements, strengthening the diversity of our manufacturing base.

"One new team here isn't ours at all: it's the American nuclear team, whom we also welcome warmly to Mars." He paused to make sure everyone heard him. "They will be establishing a nuclear facility to enrich Martian uranium for purposes of space exploration. Eventually the facility may include a reactor for making plutonium and other useful isotopes, including isotopes we will need for nuclear medicine. I can't emphasize enough the complementarity between our caravel project and the nuclear team's projects, because the caravels cannot explore the outer solar system without nuclear electricity to power and propel them. Nuclear facilities also offer the possibility of expanding our production of platinum-group metals—an energy-intensive effort—and holds out the possibility of eventually generating quantities of power sufficient to pursue terraformation via manufacture of greenhouse gasses.

"In summary, one or two centuries ago, humanity became a Type 1 civilization: a civilization spread out across the surface of a single world. In the last two decades we have become a Type 2 civilization: a space faring civilization, spread out over the

surfaces of two or more worlds. The permanent settlement of the moon and then Mars moved us into this type. Now humanity is poised on another major expansion to the outer solar system. Mars will play a major role in that expansion. We can make sure that humanity doesn't suffer another pause in the pace of expansion, like it did in the late twentieth century. Our creativity, dedication, and hard work will move humanity forward into the unknown and change our species forever."

4

Beginnings

8 April 2053

Dr. Mercedes Frick examined Will's eyes thoroughly and was matter of fact in her diagnosis. "You have a cataract in your left eye, Will. It's pretty small; you probably haven't noticed a diminishment of your vision yet. You'll need surgery in a few years. I recommend that you take care of it before I leave in two years. Arieh's assisting me with every operation and he already had experience, but he won't have the experience I have."

Will nodded. "Okay. I had the cataract in the other eye removed a few years ago, so I know how it goes."

"Good. There's a causal connection between cataracts and cosmic radiation—even a lot of Apollo astronauts developed them, and they weren't in space very long. I've already diagnosed cataracts in 22 residents here, mainly in those doing extensive field work, lunar exploration, or deep space work. The wives who've stayed home with the kids have been spared. The kids are alright, so far."

"What will the new plan to accommodate kids in conestogas do?"

"Hard to say. Keep them in radiation-shielded shelters as much as possible. We need to shield everyone as much as possible. There's no reason why we can't build more shielding into the pressure suits and conestogas. The human body was not designed for constant exposure to fifteen to twenty times the level of terrestrial background radiation."

"True, but I thought we were compensating pretty well."

"Perhaps. The operation is routine, recovery is fast, and the cure is permanent. Since your eye will have a plastic lens at that point, and you'll no longer have to worry about bifocals, since the plastic lens will flex better than the aging natural lens it's replacing."

"Yes, I know. Many of our medical procedures actually improve us, now."

"The same is true with the cancer rate here; we're suffering from almost twice the terrestrial level of cancers, but with semiannual body scans, the newer computer analysis of the anomalies, and simple laparoscopic procedures, the death rate is lower than it on Earth. I suspect life expectancy here will be about 85. Of course, no statistically significant population has lived long enough here to test the model!"

"So, do you recommend I wait a year?"

"I'm booked for the next four months. I don't want more than one patient at a time, since we have a small medical staff. But you can wait longer. In another year you'll notice some vision problems and you will want to resolve the problem."

"Alright. I'll talk to Ethel and I'll email you with a possible date."

"Thanks. Have a good sol."

"Well, I'll try, but this obviously will take some getting used to!"

"Of course. No one wants an eye operation. But you're 52 years old and you've been on Mars seventeen years, and I don't know how long you were on the moon before that. You don't live forever, and you've been pushing your luck. Be thankful it's just a cataract, and be careful about everything else. Ignorance is the biggest killer."

"I know. Thanks again, Mercedes." He rose from the chair and headed for the door as fast as he reasonably could. His mortality had intruded, and it bothered him. In

fact, he was surprised that it bothered him so much. He believed in an afterlife, but he rarely thought about it; his family was healthy and he was enjoying life too much to worry. He walked from Catalina to Riviera Biome the longest route he could think of so as to reconcile himself to the relatively minor insult his body was suffering from. He said a few Bahá'í prayers he had memorized on the way.

When he reached his office twenty minutes later he was feeling a bit better. He was surprised to see Dr. Nigel Stanfield waiting for him. He glanced at his watch. "Oh, Dr. Stanfield, I apologize deeply! I was just delayed in getting here and forgot about the appointment!"

"Were you delayed, or forgot?"

"Both. My medical appointment ran over and the diagnosis is cataracts. That drove my daily schedule from my mind."

"I'm sorry to hear it. It's a hazard of astronauts and polar scientists alike."

"Polar scientists, really?"

"The glare. Bright light sometimes can cause cataracts. Ionizing cosmic radiation is worse."

"Yes, as we know. Come in." Will opened the door of his office and they stepped inside. Will headed for a table near the door and directed Stanfield there as well. Will set up his tablet. "Welcome to Mars again. I hope your flight on the *Hellas* was both comfortable and stimulating?"

"It wasn't bad. We had many fewer leaks than the *Solis,* but the flight was three months longer in order to visit to 2015AB17. Not much of a rock to look at—400 meters

long, 250 meters wide, 200 meters high—but it's seen a lot of action. We walked every square meter in a five-week period."

"And did good science. Your reputation for precise research at the lunar north pole and at Antarctica is pretty remarkable. Rock glaciers on the moon! People thought you were crazy, but you were right."

"Of course I was. I'd like to go to Mercury to study the glaciers there; since I'm a British citizen as well, maybe that'll be possible. I've been fascinated by what I've seen so far. But the Galilean moons are the ultimate challenge for glaciologists. A new subfield of geology, 'cryogeology,' has emerged for studying geological processes in a predominantly ice crust. But right now my sights are on the Martian North Pole, and as soon as possible."

"Yes. The expedition is scheduled to leave in ten sols, if I recall; April 10. The timing's good; you'll have eleven months before the autumnal equinox, at which point you can come back here for a month, then head for the South Pole."

"Exactly. I really don't want Dr. Jen Tan along, though."

Will shrugged. "China has great glaciologists as well, and they're interested in the Galileans, just like the U.S. My advice is simple: make friends, because you may be racing each other to get to Jupiter and the friendship could save someone's life."

"I suppose you are unaware of our prior history."

"On the contrary, I've read your papers contradicting some of his findings, and vice versa. You're rivals in the field. I'd call the publication battles a draw. No offense meant."

"That's alright; everyone's entitled to their opinions, however mistaken."

"So there won't be a problem? Obviously, we can't mount two polar expeditions, one for the Chinese and one for the Americans. Eventually, when people are wintering over at the poles, maybe we can separate the expeditions."

"Won't be a problem. . . I wouldn't put it that way. I must say, Dr. Elliott, your reputation for being reasonable is exaggerated. You are a stubborn man."

"Well, perhaps you're a bit stubborn as well?"

Stanfield was taken aback by that. "At what point do you think it'll be practical to winter over at one of the poles?"

"We might be willing to give it a try in two years. Rescue capability is nearly zero because of the high winds, the darkness, and the snow storms. The station would need two nuclear reactors—one for backup—and I'm not sure we could spare them. Our reactors are getting old and we won't get replacements any sooner."

"I've been thinking about the problems. Methane and oxygen are very storable at polar temperatures and there are strong winds most of the time, plus half an annum has constant sunlight. We can generate and store solar power during the summer and use it in the winter, supplemented by wind power."

"Have you figured out how big the tanks need to be? A polar station needs about twenty-five kilograms of methane and oxygen *per hour.* That's 600 kilos per sol and 250 tonnes for a long winter, 300 tonnes when redundancy is included. And the tanks will have to be hauled overland from here. That's not an easy or cheap task."

"True. But what about silane? We'd be talking about only fifty or sixty tonnes, since we don't have to store CO_2 oxidizer. Silane's denser than methane and liquid at temperatures just a few degrees below the polar norm."

“But silane’s difficult to make. We’re developing silane technology as fast as we can afford the research. A new silane synthesizing unit arrives from Earth next month; it’s more reliable and efficient. We’ve been flying sunwings using silane fuel for four years now and the motors have proved themselves. We’ll be trying a silane powered conestoga later this year; if it works well, we may switch our long distance robotic trucks to silane, because their range will be five times more.”

“That would eliminate the need for refueling.”

“It would on the route from here to Cassini via Meridiani and Dawes. For crewed vehicles, the water exhaust can be electrolyzed to make oxygen. We won’t be ready to make silane the principal power source at the polar stations for at least three or four years. But the technology’s coming along.”

“I see.” Stanfield sounded disappointed, almost disapproving. “I’m looking forward to the deep drilling project. It should answer a lot of questions about the history of the Martian climate.”

“It’ll give us more data than we can analyze quickly. It’s very ambitious, especially if we get below the recent polar deposits to the Hesperian and Noachian sedimentary layers below. I think you’ll like the polar station we’re building. You’re getting two shelters, so you’ll have 120 square meters of interior space, and with two meters of ice and snow on the roof you’ll have no radiation problem. We’re giving you eight wind turbines, and with the winds there, you should have 40 continuous kilowatts of power. It’ll be a chance to test the equipment at polar temperatures, too.”

“The oasis will almost be big enough for wintering over, so I’m grateful. We’ll do really good science, I’m sure.” Nigel rose. “Thank you for your time, Commissioner.”

“Delighted. Good luck.” They shook hands, then Stansfield left. No sooner had he disappeared around the corner than Brian Stark appeared with Lisa Kok. “Oh? Good sol to both of you.”

“Thanks; can we talk right now?” asked Brian.

“Sure, sit down.” Will gestured to two of the seats at the table.

“Lisa was telling me about the plans for the B-160 low pressure biome. It struck me that one would make an excellent containment around our nuclear facilities, would give us space for expansion, and would define an inner security zone.”

Will nodded. “Clever. Would you inflate it?”

“Just to standard agricultural levels. We wouldn’t use the interior, for security reasons.”

“Though Brian says we might be able to use the interior for some biological experiments that require very limited intervention,” added Lisa.

“Until there’s radioactive contamination,” noted Brian.

“It sounds like a good plan. But I don’t know when can we get you a B-160.”

Brian looked at Lisa, who spoke up. “Will, you’ll have to talk to Alexandra about the B-160s. The caravel is consuming all our construction and fabrication resources. The schedule for the Cochabamba and Columbia Biomes slipped by two months and the schedule for the Columbus 10 and bioarchive biomes has already been stretched out. I’m constantly being forced to do more with less space. Expanding our manufacturing capacity is important, but we have to expand our environment as well.”

"That's true, and I've already talked to her about this several times. I guess I'll have to be more forceful, to the extent that caravel construction slips. How are the bioarchive people feeling in Washington?"

"They're finally beginning to believe me when I say we plan to create certain ecologies at certain times, so I'd like to preserve our credibility!"

"So would I, especially since the bioarchive people talk to the Project Odyssey people."

"Project Odyssey has a bigger credibility problem than you, though," noted Brian. "Congress remains skeptical and may postpone it."

"At least they can't cancel it; it's got too much momentum, and the race with the Chinese has started," said Will. "How's your site selection process?"

"We'll have a final decision next week," replied Brian. "My team has inspected all the sites. They didn't reveal anything unexpected. Yestersol we dropped site 26—that's the one on top of the escarpment in the big crater—as too far away and unnecessarily difficult to reach. The same criterion eliminated site 64—Sentinel Mesa—which is 45 minutes away. There's no reason to be more than twenty minutes away."

"So that leaves Hanford Flats and right here?"

Brian nodded. "I don't think we'll favor a facility that's physically attached to Aurorae Outpost. There are security issues, contamination issues, and encroachment by future outpost growth. Aurorae's growing northward and westward. We can't put the facility south of Aurorae because that's too close to the spaceport. Due east of the outpost is the only possibility, but any radioactive leakage could be blown over the outpost if

we're too close. Hanford Flats is twenty kilometers northeast; it's way away from the development and downwind, but close enough to reach it easily."

"And the flats are a security plus," added Lisa. "There's nothing even a meter high on that plain. Nothing could approach the facility undetected."

Will sighed. "I wish it were more practical to have your facility attached to the outpost; it would not feel like a distant, alien presence that way. But Hanford Flats will work. How much property has to be bought up?"

"About one hundred square kilometers. But even though it's some of the most expensive land on Mars, it'll cost us only about ten million redbacks. The owners will make a nice profit and that will encourage others to buy land here."

"I'm glad you see the advantage of buying land back at a markup. The Aurorae Council will have to pass an eminent domain resolution, and that will require hearings. So it'll take a few months."

"It'll be a few months before we have any uranium. And the B-160?"

Will shook his head. "Six to nine months is the best we can manage, I'm sure."

Brian scowled. "I suppose that's realistic. Any idea when we can launch the uranium mining expedition?"

"Next month. They've already started some mining in the copper-uranium deposits north of Cassini. We've already started transporting the pieces to build an oasis there. It has some very high uranium concentrations. We shouldn't have trouble extracting a few hundred tonnes of yellowcake over three or four years."

"Good. If this process works well, Will, I don't know why Mars can't export concentrated uranium to Earth."

"How will you convince the environmentalists that an accident during atmospheric entry won't spread radioactivity? If you can persuade people to allow uranium to be landed, you've also persuaded them to let it be launched!"

Brian shrugged. "We'll see. I'm hopeful."

"Ever the optimist," replied Will.

Within a few weeks of the arrival of the *Hellas,* everyone settled into a routine, and that included eating arrangements on the Patio. One table usually had Father Gregory Harris, his wife Anna Racan, their two year old son John, their one-month old baby Esther, their close friend John Hunter, his wife Vanessa Smith, their two and half year old son Maaka, Helmut Langlais, and Clara Forsyth Langlais. Brian Stark had begun to join them as well. One evening in mid April Clara and Helmut came to the table beaming.

"I think if the lights went out right now, you'd glow in the dark, Clara," said Greg.

She smiled and didn't say anything. "How was your sol?" asked Helmut, changing the subject.

"Pretty good," replied Greg. "There were no major pastoral emergencies, and I no longer have to worry about tailoring torn clothes. After nine years, I've finally been replaced by a pretty capable machine."

"Really?" said Brian, surprised.

Greg nodded. "It does a very good job. You have to mark the spots needing repair with a special pen and it quizzes you about the repair, then does it!"

"Why did that come on the *Hellas,* and not on the cargo flights?"

He shrugged. "Who knows. It fit the mass allocation best this way, I guess."

“We got our expedition assignment this sol,” announced Helmut. “We’re going to set up the uranium mining oasis north of Cassini, then ride to the north pole to help complete the oasis up there. We’ll be bringing the wind turbines.”

“That’s exciting; congratulations,” said John. “I’m going to Deimos in June for three months; we’re re-deploying the seismic network to make it much more sensitive. We’re converting the moon into a meteoroid sensor; we’ll be able detect impacts as small as a large sand grain, 2 millimeters in diameter. It’ll refine the meteoroid flux rate.”

“That’s good research.” Anna looked at Clara. “I can see you’re quite excited.”

“Oh, not for that,” replied Clara. She smiled. “I stopped by the hospital this afternoon. Helmut and I are expecting a baby.”

Everyone smiled at once. Anna reached over and embraced Clara immediately. “Hey, congratulations!” said Greg. “What marvelous, happy news.”

“Thank you; we’re very happy,” said Helmut.

“You didn’t wait very long,” noted John.

“We lived together a year and a half,” said Helmut.

“We got married in November because it was opposition and the time delay with Earth was shortest,” added Clara. “It made the televised wedding much easier. We want to get our family started, so we’re still relatively young when the kids are grown up.”

“So we can go to Jupiter or Saturn,” added Helmut. “I can’t go anywhere now anyway; I have to finish my doctorate. I talked to Stanfield the other sol and he agreed to be my advisor. I want a topic involving the Martian poles.”

“An analogy with Callisto and Titan,” noted John.

"Or not; the thesis might be a contrast instead," replied Helmut. "There are craters that are smoothing out because of ice flow, but Mars is so much warmer than the outer moons that the flow occurs hundreds of times faster."

"You're not still planning to go on the expedition, are you?" Anna asked Clara.

The latter nodded. "The conestogas have been radiation shielded. They're rated for habitation by children. I'm the one who pushed for that. I'll probably come back here for the last two months of my pregnancy, but once the baby's born I plan to rejoin the expedition."

Anna stared at her. "Clara, as a friend, I have to tell you that I think you're crazy."

"Well, crazy or not, that's what I plan to do." She patted her belly. "I look pregnant now, even though I'm only two months along, because of this thick polyethylene radiation shield I'm wearing. I'll get used to it; it's really not so bad. In Martian gravity one can wear twenty kilograms of shielding. If anything, the mass is good for your muscles and bones. A lot of women have been wearing radiation shielding almost permanently, now that the new styles have come out."

"They look pretty good and they're comfortable, though they can make you sweat," agreed Vanessa. "More power to you, Clara. We're taking Maaka out this fall, and that would never have been possible without you."

"Thanks."

"I hope they can shield the caravels enough," added Helmut. "Because unless children can go to the outer planets, there will never be a substantial human population there. Jupiter takes at least a year; Saturn two years, Uranus four, Neptune even more. It'll be half a century before humans can get to them faster. The expeditions will stay five

to ten years. The ships will have to be self sufficient and child-rated. So who knows, maybe our son or daughter will accompany us to Callisto or Titan some sol."

"That's a tall order, but it's theoretically possible," replied Anna. "It's so hard to balance family and career here."

"Well, it's worse on Earth," replied Greg. "We can be thankful we have what we have here. But let's not discuss this any longer." He raised his glass of water. "To Helmut, Clara, and their future child; may they explore the solar system together."

"Here, here," agreed the others, clinking their glasses together.

5

Settlers

25 April 2053

The wall screen in Mars Control showed a schematic of the Hippogryph cargo vehicle heading toward a large circle representing Mars. But more important that the simple diagram was the lengthy readout next to the schematic. The solar panels were still stuck.

"Can we try again?" asked Will.

Rostam hesitated. "Maybe one more time. We have twenty minutes before the Hippogryph encounters the atmosphere. But the mechanism's not reliable, and that means we could get a partial retraction only. That would be worse."

Will considered. "You'd recommend jettisoning the panels?"

Rostam nodded. "We have a shuttle in place to rescue the Hippogryph before its fuel cells die."

"We can't afford to lose that Hippogryph, and aerobraking with the panels is problematic." Will bowed to the inevitable. "Jettison them."

Rostam nodded. That was the recommended procedure. He and the two others in the control room initiated the procedure. A few minutes later the screen showed separation. "They're jettisoned."

"Let's check the video."

Rostam nodded. They switched on the Hippogryph's camera system, even though it used precious power. They could see the solar panels spinning away.

"It's a shame, but what can you do," said Will. He glanced at the screen; atmospheric encounter was sixteen minutes. "I'm going to the conference room to make a call or two. Shout if there's trouble."

Rostam nodded. The Hippogryph otherwise was ready for aerobraking; the panels had been the sole problem. It was the first major glitch they had had with a Hippogryph in six years. No doubt they'd find the smashed pieces of array scattered across the desert north of the Outpost if they looked. They could now make solar panels, so they could build a replacement.

Will walked across the hall and sat at the conference table to check his mail. He expected a message from Louisa Turner, Director of the Mars Commission's Public Relations. Sure enough, she had sent a videomail with an attached schedule of publicity themes for the next two months. They often weren't able to follow the plan, but in normal situations it helped enormously. He approved the schedule and then spotted a videomail from Sebastian Langlais. He hit play.

"Good sol, Will. I hope all is well with you. I'm at Peary, but will be returning to Houston next week. Tourism is almost back to the same level it was two years ago. The painful restructuring has also cut costs in half, so people can make a two-week trip to the moon for 1.5 million redbacks. It helps having Hilton and Marriott here competing for business, and United Spacelines and Lufthansa Space Express providing transport from Earth orbit. You would not recognize the flight to the moon any more, Will. It's amazing how much progress has happened in twenty years.

"So I think I can now leave the Lunar Commission in good hands. I'll be announcing my retirement in Houston; maybe you've already heard the rumor. My plan is

to retire to where my family is, and that's Aurorae Outpost. Maybe you've heard that Helmut and Clara are expecting a child in six months. My other son, Kristoff, is in low Earth orbit right now and has applied to work for the Mars Commission, with the goal of coming to Mars as well. What you think; I used to run the place, after all, and I don't want my presence to be difficult in any way. I'm not planning to run for office or anything; I'll probably be a grandfather. Who knows how long I'll stay; maybe the boys will both go farther out and leave me behind with the grandchildren; or maybe they'll take the kids along and I'll fly back to Earth!

"Hope all is well with you and the family. Looking forward to hearing from you. Bye."

Will glanced at his watch; no time to reply. The selection process was run by an independent task force over which he had no direct influence. There was a very good chance Sebastian would be selected because of his experience and tenure in spaceflight. Will forwarded the message to David Wright, who was in charge of the selection process, then headed across the hall.

The Hippogryph was just seconds above the atmosphere. There was even an image of it from the Outpost's telescopic camera. Will sat silently next to the others and watched. Rostam was watching and occasionally making a small adjustment, but the Hippogryph's computer was doing all the work.

The heat shield began to glow, then within seconds the Hippogryph was enveloped in plasma. It fell like a rock across and through the Martian atmosphere, leaving a spark-filled plume behind it that glowed faintly for a few seconds. Will watched the numbers, as they told the story that the camera could only suggest: velocity, 6,300

meters per second and dropping; deceleration, 5 meters per second and rising as the vehicle bit deeper and deeper into the atmosphere; altitude, 64,050 meters and dropping fast.

The Hippogryph flashed into the atmosphere, dropped to an altitude of five kilometers, then shot back out in less than six minutes. But it came out moving at 5,200 meters per second, which put it in the same orbit as Embarcadero, except for a lower periapsis. “Aerocapture complete,” said Rostam. “No problems.”

“Twelve point three hours to the periapsis burn?” asked Will.

Rostam glanced at his screen again. “The delta-v was 1.3 meters per second too small; we’ll adjust that in a half hour or so once we have all the GPS data processed.”

“Okay, I’ll be across the hall.” Will went back to the conference room. He hit reply to Sebastian’s videomail. “Thanks for the message, Sebastian. It’ll be good to see you again after fifteen years, assuming you’re here in 2055, that is. You’ve done an incredible job with the Lunar Commission. I don’t think anyone would have imagined that the moon would have five permanent facilities, 200 personnel, and 300 tourists per year in just two decades. It’ll be good to have all that talent, experience, and energy here; I’m sure we can use it somehow when you’re not babysitting! I’m delighted you’re coming back and have no reservations.

“We’re fine up here. As you may know, Marshall turned thirteen about three months ago. He has started to develop the funny, unpredictable voice of an adolescent, though thank God he’s a good kid; well, most of the time. Lizzie’s growing fast, too; she’s now ten and a half and is very good in math and ballet. Her ballet teacher says she dances very differently because of the gravity and it’s hard to teach her as a result. Ethel’s

managing our carbonyl separation facility; in fact, we just aerobraked a Hippogryph and part of its cargo is an upgrade to the plant. So we're fine. I heard about Helmut and Clara and already have expressed my congratulations to them. Clara's quite a presence here, always pushing for something to be done differently, and generally her ideas are good. Maybe you should encourage her to go into politics!

"Anyway, have a safe trip back to Houston. Let's keep in touch. Bye."

He sent the message, then sat and thought. He was upset about Sebastian's plans. Sebastian was a presence, persuasive and influential, very concerned about details, and nine years older than Will. It was difficult to think what job they could give Sebastian that wouldn't bore him, and a job big enough for him would incite the jealousy of other senior staff.

He was pondering the problem when Wright replied. It would be a welcome distraction, so he played the video.

"Hi Will. Yes, I heard from Sebastian about a month ago; he was asking about the application procedure, so I was expecting him to apply. It'll be good to have him part of the team, assuming his health isn't an issue.

"Say, I received a very strange call about five weeks ago, and I haven't been sure what to say about it. I was planning to ask a few people here, but since you called, I'll attach it to this message. It's from one Dr. Tree Rivers, a strange name, but that really *is* his name; I checked. He's the head of the Green Earth Community of southern British Columbia, and he wants to send people to Mars. The message is self-explanatory and I'm just not sure how to say thank you, but no thank you. Let me know what you think. Bye."

Wright's face faded from the screen, leaving an icon at the bottom. Will pushed it and the face of a blond-haired man in his mid forties appeared.

"Good afternoon, Dr. Wright. You don't know me, though we have a mutual friend, Tina Walker, who gave me your address. My name is Dr. Tree Rivers. I have a doctorate in ecology from the University of British Columbia. I'm the head of a group of people—some call us a commune—titled the Green Earth Community. We're located on two hundred hectares of beautiful forest and farm land on an island about sixty kilometers north of Vancouver. There are 150 of us and we practice a communal lifestyle that aims to be Earth-friendly; we use solar and wind power, grow all our own food in the open and in greenhouses, and support the community through our sales of preserves and crafts; we make elegant and solid furniture as well.

"We have long been strong supporters of the settlement of Mars. The community even owns land on Mars. Six years ago a wealthy patron willed us one hundred million Canadian dollars, money we invested in the companies mining Martian gold. As you know, the events of the last three years have caused the value of those companies to increase about twenty-fold. Consequently, our community has been discussing seriously the idea of relocating to Mars. We are inquiring how we would purchase four to six berths on Columbus 10 so that we can send an advance team to Mars to do preliminary work to move most of our community. I'm sure this conversation will be a lengthy one and this is just the preliminary phase, so I look forward to your reply. Good bye."

Will watched the image of Dr. Rivers fade and puzzled about the request. Then he hit reply. "Dave, don't say yes or no. This is strange, but if they have two billion bucks, it's worth considering. I'm not sure we want a bunch of ideologically driven people here;

but then again, North America was settled by religious refugees and Australia by convicts, so I suppose we could accommodate them. Find out if they're serious."

It was a week before Dave Wright was able to get back to Will about the commune. When the reply arrived, Will scheduled a quick meeting of his senior staff to discuss the matter. "Listen to this," Will said, by way of introduction, and he pushed the play icon. Dave Wright's face appeared on the wall screen.

"Here's the update. I've spoken to Dr. Rivers three times in the last three days. I'm afraid I didn't reply immediately after Will asked me to, but Dr. Rivers didn't respond immediately either. I think he was assembling information. When he did reply, it came with a barrage of background that took two assistants two sols to review.

"The Green Earth Community is fifteen years old and has 154 members, though at the moment only about 100 of them will make a commitment to come to Mars. On the other hand, the community has a lot of friends and part-time members and when the word gets out, many may wish to join the emigration. According to a professor of 'Commune Studies' we spoke to, and some websites we visited, they have some strange beliefs. They believe that Mother Earth is a real being and that the Earth is alive. They view nature as the expression of God. The Community allows no private property. Children live in dormitories and see their parents at meals and on weekends. Tree and two assistants organize the labor of the Community very efficiently. They are elected annually to perform this task. The Community has a religious service every Sunday, which is not Christian or from any other religion, but of their own invention. One professor who has

studied the Community told me that it could be seen as a religious sect as well as a commune. A few anti-cult websites include them, but not many.

"Tree is their second leader; the founder died eight years ago and left him in charge. It seems that Tree is an organizer and he has not added to their philosophy very much. We checked with the Royal Canadian Mounted Police and they told us that there are no criminal charges against the Community or its leaders.

"In the six weeks since Rivers first contacted me, he has contacted both United Spacelines and Lufthansa Space Express about private transport to Mars. Both companies use Lyra capsules on their lunar flights; they could upgrade the life support systems for a Mars flight. Interplanetary transit habs have gotten reasonably cheap. Mars domes made by Ad Astra in Canada can be purchased on the open market. Rangers, conestogas, and mobilhabs can be purchased. There are four governments and five companies providing Swift Shuttle service to low earth orbit. So if Rivers can buy everything his community needs to come here and arrange their transportation, probably for ten to fifteen million redbacks per passenger. They already own Martian land. Last month they sold scattered holdings and bought 2,000 square kilometers in Aram Crater, right on the Meridiani Trail a thousand kilometers east of Aurorae. All the Green Earth Community lacks is our permission, which they would need to enter Mars space, to land, and to set up a borough government.

"So I see a real dilemma here, and don't know what our next step should be. Do we want to encourage them, or stop them? Bye."

Will looked at the others around the table. Then he noted that Louisa Turner had already replied; she had seen Wright's report previously. Will activated it.

"My two cents, for what they're worth, is that this could be hard to handle in terms of public relations. There are bigots on Earth who are already concerned that their own group's role on Mars is too small, or another group's is too large. We haven't had much trouble dealing with that, but if 100 or 200 members of a commune and what some may call a cult go to Mars, we could have some serious public relations and image problems. Of course, it is exciting that the private sector is finally getting involved with immigration, but something that is way beyond the mainstream will be controversial, and I don't know that we could deal with it effectively. It may be impossible to keep on message; reacting to controversy could become the long-term message, especially if River Tree or Tree River or whatever his name is likes to make outrageous statements and get in the limelight. Certainly, if this commune does this, everyone on Earth will hear of them; it'll be one of the greatest public relations acts a group like that could pull off. So we are almost guaranteed to have trouble."

Everyone looked at each other worriedly. "I suppose the good news is easy to find," said Yevgeny. "This would be great for exports. We would be selling stuff to people right here; no terrestrial transportation costs. It'd also increase land sales."

"And we'll be importing competition," noted Alexandra. "Is that so good?"

"We need labor, especially people lacking doctorates," noted Lisa. "It's devilishly hard to fill certain positions. The people who arrive to do them want to get out in the field as soon as possible, and seek a promotion to something more glamorous within months."

"It sounds like they're good in agriculture, Lisa," noted Alexandra. "So how would you like it if they decided to go into farming and undercut your prices?"

That shut Lisa up. No one said anything for a minute. “If the Green Earth Community can do it, so can the Mormons, or a Khaliestani prince could send 100 fundamentalist Wahhabi Muslims,” noted Ruhullah. “Think what that would do to our culture and community here.”

“It would make consensus and understanding much more difficult,” agreed Will. “I’m not sure which would be worse for Mars: creating scattered communities with radically different cultures all over this planet, or forcing them all to add their biomes to Aurorae so that we all have to mix together on a daily basis.” Will paused to see if anyone else had comments; no one did. “But consider this. Let’s say you had the money to come to Mars with your family and you wanted to live in two mobilhabs on a piece of land you bought that is located ten kilometers from here. Let’s say we said no and you proceeded to lease your own hab with a heat shield and arranged to lease a lifter to push it to Mars. What legal ground could we deny you the right to come to your own land?”

There was silence. “Safety,” replied Yevgeny.

“Is that a ground for denial, or a ground for insisting on maintaining standards of safety?” replied Will. “Couldn’t someone sue us in a court and say that we had to set reasonable safety standards, and if so, we were obligated to cooperate?”

“We’d have to ask Silvio about that,” replied Ruhullah. “But I see your point. It would be difficult to refuse them the right to come here if they were serious about it.”

“Even if we were legally in the right, we could get a black eye in public opinion,” said Yevgeny. “That might be hard to manage.”

“That’s what I’m beginning to think,” said Will. “This isn’t 2036, when Columbus 1 arrived here with six people; this is 2053, after Columbus 9 has arrived and Mars has

350 people. In the eighteen intervening years, the cost of reaching low earth orbit has dropped eightfold, the cost of equipment to fly people to Mars has dropped fivefold, the reliability of the equipment has improved drastically, and the cost of flying a person to Mars has dropped twentyfold. The situation is radically different. If the Green Earth Community isn't the first private group to arrive, someone else will be, and pretty soon."

"But they'll be pretty strange!" said Alexandra.

"Who else would come?" said Ruhullah.

"Groups like the sects that opened North America to settlement," noted Will. "Maybe history will repeat itself."

"In that case, a Marsian will be defined in terms of the Fundamental Law of Mars, just like the American Constitution defines that country legally," said Ruhullah. "That's what we'll have in common."

"Do you realize you're talking about dismantling a lot of what we have built, though?" exclaimed Alexandra. "We've created a culture here, inclusive, supportive, pluralistic, and family-oriented. A bunch of strangers will be hard to assimilate; we may assimilate to them as much as they to us."

"And there's the issue of competition," added Lisa. "We work hard here, but usually we aren't under intense time pressure. I'd hate to see our work become a grind and real income drop. It's too low already, from the point of view of consumer goods."

"We will be the larger population," noted Will. "The Green Earth community won't be sending 100 people here on Columbus 10; we have 120 berths and will fill 100 of them ourselves. They'll be lucky if they can fly out a dozen people. Mars will have

almost 500 at that point. Columbus 11 could include 100 of them, but there would be 200 of us on that flight as well, so we'd outnumber them on Mars about 750 to 100."

"There will be a dilution factor, especially if Mormons and Wahhabis dilute Green Earthers and vice versa," added Ruhullah, nodding.

"I think our next step is to talk to the lawyers," said Will. "We need to know what our rights are as well as our legal obligations to land owners. Mars changes every two years, and we don't always like the changes. But if our goal is to grow this place, we can't overlook any opportunity, even a strange one."

5

Keeping up with the Joneses

10 May 2053

The word of the Green Earth Community's interest in Mars leaked out and the Patio was soon abuzz with discussion. From the Patio it leaked to the media, who immediately called Tree Rivers, and his face was soon splashed across the screens of two planets. He had previously released press releases about his group's interest in Mars, but they had received almost no attention; now they became the focus of a media frenzy.

"I don't particularly like him," commented Helmut over lunch. "He seems self-righteous and arrogant."

"He's a very committed individual," replied Greg. "I recognize the type. He may be hard to negotiate with; tough minded and unwilling to compromise."

"In other words, he's like half the people here," said Anna. "I'm not sure I'll be comfortable with them, but Mars needs people, and I'm not comfortable with the idea that we can sell people land and refuse to let them come use it."

"That's the problem," agreed John. "We have a lot of diversity here already and we have managed reasonably well. This isn't to say there is no prejudice. A few people have told me they don't think long hair is a good idea inside a pressure suit."

"They've said that to you?" said Helmut. He looked at John's black braids.

"Yes, one or two people have said it, but there is no evidence it's a significant safety issue. It curls up on top of my head pretty well and I pin it so that it'll stay. But these are the sorts of comments that happen here. I am sure Fatima and Emily get

comments about their headscarves. Will hears comments about his fasting every March. These sorts of things happen in a diverse society."

"There's more serious trouble than that; people feel they have experienced prejudice," said Greg. "Especially the Muslims and the Chinese. The Americans get anti-American comments, but that's at a lower level. Some of the alleged prejudice is oversensitivity, but some is not. We aren't perfect here, where bias is concerned."

"I think women are discriminated against at least as much as Chinese," exclaimed Clara.

"And all of us are professionals with the same professional training," added Greg. "That establishes a certain professional culture that gets extended to the Patio and other public places. If we have a group of people with a radically different corporate culture here, there will be clashes and differences that are greater than those between westerners and Muslims or Chinese."

"So would you ban them?" asked Vanessa, scowling.

"Certainly not! You misunderstand me. I think we have an obligation to welcome landowners who can pay their way here. I'm saying we're going to have a lot to learn to make this place work if they come."

"That's what worries me," added Anna.

"Look, the Vatican pays a quarter million redbacks a year to cover my half time services as a Catholic priest," said Greg. "I'm already a representative of a movement that the Green Earth Community epitomizes. Silvio DiPonte now runs his store full time and works for the Borough as a lawyer and judge, not the Commission. Madhu's 'retired' from Commission service, is a full time artist, and works for the Mars Council as

Coordinator of Cultural Affairs. If someone wants to come here, it costs twelve million redbacks to fly here and another half million a year to cover support services like air, food, water, and health costs. We're better off letting them come."

"I think and hope that you're right," commented Anna.

Just then Will Elliott approached the table. "Good sol," he said to everyone. Then he turned to Helmut and Clara. "So, you leave for Cassini tomorrow?"

They both nodded. "We're looking forward to it," added Clara.

"Good. Take care of yourselves, and of your baby. And good luck with the trip." Will extended his hand to Clara, then Helmut, and they shook.

"That's very kind of you, Commissioner," said Clara. "As you can see, I'm wearing radiation shielding all the time, and I'll be back here in two months for a medical check. Everything is fine so far."

"I'm glad. I'll be praying for all three of you; or maybe I should say all four, since Sebastian's coming back on Columbus 10. You're on the Cassini expedition too, right John?"

"No, I'm on the North Polar Expedition, and we leave next week."

"Have a good trip and enjoy the snow." Will shook his hand as well, then waved and headed out of the biome. They watched him go.

"Politeness, or overprotective concern about a fetus going out to a high-radiation environment?" said Clara. "The doctors have said this is reasonably safe to try, after all."

"He loves families and marriages," said Greg. He watched Will open the airlock door to Riviera Biome, then close it behind him.

Will walked through the airlock tunnel between the biomes, then opened the door on the other side, stepping from their commercial biome to their government center biome. In another minute he was back in his office, where Silvio was waiting for him. "The lawyers all agree that we could delay the arrival of an unwanted group for years through the courts based on safety issues," he reported. "But ultimately, safety issues cannot exclude individuals unless they are mentally unstable; they cannot exclude groups unless they have a criminal record. The Mars Commission Treaty calls Mars 'the common heritage of humanity.' This is understood to mean that the land and minerals are available to all, and profits from the same must benefit all. The general interpretation of making the profits available to all has been that the profits must be used to subsidize transportation of representatives of minority groups and nations unable to pay their own way. The treaty clearly includes property rights."

"Of course; we've always understood that." Will nodded. "Thanks, Silvio. So how much did this legal advice cost us?"

"A hundred thousand for the preliminary, and they want to make studies in all the major legal systems to draw out the implications."

"Another million or so?"

"At least."

Will nodded. "We had better do it. Our commitment to sell land is a bigger revolution than anyone thought."

"I heard on the t.v. yestersol that a wealthy Japanese tycoon wants to establish a small Zen monastery here."

Will nodded. “And the Mormons are talking about sending twenty pioneers, a Saudi Foundation wants to send twenty Wahhabis, a South African businessman wants to set up a socialist colony—no numbers suggested—and the Vatican is talking about renegotiating their current arrangement to support more personnel. . . I think all the organizations are asking themselves: how small can the Mars team be to garner publicity on Earth and fire up their supporters? Meanwhile, both United Spacelines and Lufthansa Space Express have called to say they are interested in commercial passenger service to Mars and would like us to privatize our system. And there have been four serious calls from various companies inquiring about setting up construction outfits on Mars to provide for arrivals and assist in our own construction efforts.”

“Wow, this is a revolution!”

“With implications of competition, lower costs, laissez-faire conditions, lower wages, cheaper consumer goods, longer work hours, labor unrest, political movements, potential instability . . . some good and some bad.”

“We’re going to grow up and become a real nation?”

Will chuckled. “I suppose that’s the way to summarize it!”

It was a late Frisol afternoon when Rahula saw Marshall sitting at a table by himself on the Patio doing homework. He came over. “Good sol; what’s new?”

“Nothing. It’s my geometry homework.” He scratched his head.

“Geometry? What grade are you in?”

“Seventh.”

“We didn’t learn that until ninth in Houston.”

"We learn it in seventh here. I'm not great in geometry, I'm afraid. I'll ask Lizzie about it later; she may be only in fifth grade, but she can actually do this stuff! What classes are you taking at Martech? In a few years I want to take some classes there."

"You could probably manage, too. I've got field geology, geophysics, advanced chemistry, and English literature; the latter I'm doing via the web at Harvard. The lectures are really good, but my mom runs the discussion session with me!"

Marshall grimaced at the thought. "Field geology? Where are you going?"

"Around here; the course meets all sol Satursol. We're going to Gangis next month, though, for three sols. That'll be really cool."

"Oh, I wish I could go! I've never been past the Dacha!"

"Some day, Marshall. Maybe this summer you can convince your dad to take you along on a trip."

"I hope so. I just wish there were more kids here my age. Sammie and I are good friends, but he's the only one; and he's eleven months younger, which is a pain sometimes."

"Well, chin up. Every sol another group wants to send representatives here in the next few columbiads, and some of them want to include children. So you may not be alone much longer. You know, I was really the first kid in space. I rode the Swift shuttle to orbit a few sols before my eighteenth birthday. And the doctors say I only stopped growing taller a few months ago; they were worried that I was growing while in zero gee and in a high radiation environment."

"Did they make you wear radiation vests?"

Rahula laughed. “All the time, and much thicker than the one you’re wearing! It was about ten centimeters thick. I felt like a fat person. The hat I wore was so tall sometimes I bumped it into the ceiling. But you get used to it.” He tapped the radiation vest he was wearing at the time. “Now I put this on in the morning and forget about it.”

“It’s only four or five centimeters thick; I’ve got eight on right now. So, you think children will be coming here someday?”

Rahula nodded. “I think so. You won’t be alone too much longer. Would you ever like to visit Earth?”

“Everyone always asks me that! I don’t know; maybe. I like Mars and I’ll like it even more if I get to see more of it. I think I’d like to go to Callisto or Titan instead, or maybe Triton.”

Rahula smiled. “Me, too. Dad says that’s the future.”

“Of course. Mars is the future. We’ll probably send out the first starship.”

Will entered Pittsburgh Dome with a wide-eyed expression that made Alexandra Lescov laugh. “Will, you always look like a kid when you come in here!”

“That’s because I admire the work so much, Alexandra. This isn’t an ordinary B-60. Besides the fact that you used twice as much high-strength plastics, the translucent covering closes it in and makes this huge space into a giant closed room. It’s quite an experience.”

Alexandra looked around the dome, forty meters high and sixty meters in diameter, filled with all sorts of equipment around the circular edge, with cranes dangling from the roof. The caravel they were slowly building occupied the middle. “Yeah, it is

pretty impressive; the most complex piece of construction on Mars yet. But wait until you step inside the caravel; *that's* impressive."

"I can't wait."

Alexandra led Will up a long ramp that took them over a flying saucer-shaped object thirty-four meters in diameter and up to fifteen meters high. When they reached the vehicle's central hub they grabbed hardhats and descended a ramp into the spacecraft. Will was impressed.

"Wow, you've made a lot of progress!" He stopped to feel the fabric walls.

"In some ways, what we are building is much simpler than a shuttle; this thing basically is a big, rotating bag with a heat shield on the rounded side. The techniques aren't that different from making interplanetary transit habs or even our biomes. We've eliminated most wiring; every group of sensors has a redundant pair of transmitters powered by minifuel cells. The control room can be located anywhere and can be moved easily. The trickiest part to make is the hub." She banged on the metal collar defining an open ring six meters in diameter.

"It fits together well. When will you dismantle it?"

"A couple months; just before we fold the vehicle up to fit it in the cargo bay of the Hermes shuttle. Come on, I want to show you around a bit."

Will nodded and followed Alexandra. They walked on a future wall; the wall next to them was a future floor because "down" would be toward the saucer's outer edge once the interior started to spin. They followed a future elevator shaft to the outer edge.

"Incredible. This is coming along very fast."

“The outer protective hull and the inner pressure hull are finished, so all we need to do is add the circular floors—five of them—six airtight membranes to divide the interior into six tranches, and some of the basic interior fabric walls. The rest will be done on Phobos.”

“There’s months of work to do on Phobos.” They continued around the outer edge of the hull, walking on slightly spongy fabric walls and squeezing through doorways sideways. The ship’s great room—two stories high and expansive—was particularly impressive. “So, we’ll be done in time to send it back to Earth in mid 2054?”

She nodded. “Construction’s on schedule. We’re already making the fabrics for caravel number two and we’ve even started fabricating some materials for caravel three. Is there any progress on selecting their names?”

“No, and we should do that.” Will sighed. “It’s a shame we can’t send this vehicle back to Earth early. We have so many people who want to come here, it’s unbelievable. Now there’s an African Christian sect with a billionaire follower who wants to send twenty-four people here.”

“What would we do with them? But there’s no way this ship could be ready for Columbus 10. This caravel will take our team almost a year to set up and check out.”

“Opposition’s December 17, 2054. Usually we send people back to Earth on a six-month voyage that reaches Earth on January 17, 2055; a month after opposition. A four-month voyage to Mars leaves Earth about November 17. How much delta-v is needed to send a caravel back to Earth by November 1?”

“We can look it up; three or four kilometers per second from Embarcadero. We planned to test the vehicle with a few shake-down cruises between Earth orbit and the moon, and there is some equipment to install there.”

“The trip back to Earth could be the shake-down cruise.”

“We can’t send people back to Earth in a partially completed vehicle.”

“We’ll have people going back in transit habs; they can dock to the caravel and finish it during the trip.”

Alexandra smiled. “That’s intriguing. I know of four construction people who want to go back to Earth—”

“Already? They’ve been here only three months!”

“Most people who decide to return do so in the first few months. One has a mother who has cancer and she’s worried to death about her and feels guilty being so far away. Another has been reconciling with an ex-wife by videomail. A third is disillusioned by the long work hours and lack of male prospects. The fourth is just disgruntled.”

“We’ll have others returning, too, for various reasons, and we could find volunteers willing to fly back to Earth, spend a month or two there, and fly back.”

“Definitely. But there is a problem with environmental control; construction releases a lot of fumes into the air and on Phobos we can use large amounts of water to clean the air, or we can purge and replace it.”

Will thought about that. “How much mass are we talking about? Ten tonnes of water and extra air? Fifteen? That’s not a problem.”

“True. We could haul it along.” Alexandra looked at Will. “Are we really thinking about this seriously?”

“We have to consider all the angles. I’d worry about the caravel reaching Earth and being unable to aerobrake because of an accident or design flaw.”

Alexandra shook her head. “No, no problem. The caravel’s designed for arrival speeds up to 16 kilometers per second. But we could always send a lifter full of fuel so that it could slow the caravel down.”

“True.” Will looked at Alexandra. “I think this could work. How many people would have to go back to set the caravel up during the trip to Earth?”

“A dozen to finish wallpaper, painting, and decking. That’s fewer than we have scheduled for the work right now. On a long flight back to Earth they won’t have anything else to do. I’d fly two habs back to Earth to provide plenty of redundancy. The passengers flying here have little to do, so set-up work is a good use of their time. ”

“You’ll need that greater efficiency if we end up flying two hundred people here on Columbus 10!”

“Yes, that would be quite a challenge. With two additional habs, it might be closer to 230. We could build more housing in existing residential biomes, though; we have the space and could build five-story buildings. And the new B-100s would increase our agricultural areas quickly, if we can accelerate the design work.”

“All this will cost money, but the gold prices have held up pretty well, and if we privatize part of the operation we’ll have access to more capital.” Will nodded. “I think it’s feasible!”

7

Elections

early June 2053

The Patio filled with an unusually animated crowd, that Satursol afternoon in early June 2053. With Mars-wide elections coming up the next week, everyone was prepared to debate the major issues affecting their world's future.

"Remember our customs," Érico Lopes said, as he called the meeting to order. "Everyone can speak their mind, and everyone should feel free to speak frankly; but among other things, a frank atmosphere means we should avoid either insulting each other or feeling insulted. Frankness does not mean we can be uncivil; rather, true frankness requires a professional, mature attitude toward our speech and a respect for both people and ideas. By custom, no one campaigns for election here on Mars, but people who have things to say are often people worthy of consideration. Everyone knows that campaigning is sometimes disguised as the advocacy of a vision for the future of this world. I think that is fine as long as we are debating ideas, not people. I should add that I do not want anyone to think that any vision I share is a campaign; I've served my time on the Borough Council and I really don't want to be reelected. That's why I've been asked to chair our borough meeting about the future of Mars."

Many people laughed. "Elections are just a week away," continued Érico. "You will have to vote for a Borough Chair, a Borough Clerk, a Borough Treasurer, and two at-large members of the Borough Council. You will also vote for six representatives from Aurorae to the Mars Council; one more than last annum, when we had five. The increase

was authorized by the Council when it agreed to admit the new boroughs of Meridiani and Thymiamata to the Council with one representative each, raising the Council's membership to twelve.

"That ends the preliminaries; let's turn to the discussion. I give the floor to Father Greg."

Greg Harris rose. He wore his priest's collar that afternoon; it caused people to treat his words with greater seriousness. "I anticipate that this afternoon we will have quite a debate about the future of Mars, because we stand at an unusually fertile and controversial crossroads. One big issue is nuclear power and the fact that the Borough and Mars Councils both must vote, some time after the election, to either approve or disapprove the Hanford Flats site for the U.S. nuclear reservation. Another is the caravel and what it represents for our future, both in terms of more rapid expansion and in terms of our movement into the asteroid belt and beyond. The third issue—maybe the biggest—is immigration of large numbers of non-Commission personnel over the next few years, competing with us and with our culture to dominate the future of Mars. We have faced this third challenge several times in the past when nations were added to the Commission and when mining companies began to set up operations here, so in a way, immigration, though it appears to be the largest issue, is really a repeat, and seems to have been resolved satisfactorily before.

"My own views on all three of these issues are simple. Mars needs nuclear power whether it wants it or not, and I believe we can work out an arrangement with the United States that will be ethical, legal, safe, and respectful of our rights. We need the caravel and it will prove worth the investment; the challenges it will open to us will be positive

and beneficial. And we need more people here, regardless of their beliefs and practices, as long as they are willing to abide by the rules laid down in the Fundamental Law. Call my view optimistic; that people can get along and can be taken at their word.

"Beyond that, we all work too hard, and we complain about that every annum when we meet. Conferences on living well don't seem to help for more than a sol or two. But in spite of our long work hours, relatively low salaries, and lack of consumer goods, I think we do live reasonably well. We have lower rates of alcoholism, crime, and mental illness than most societies. We have a divorce rate that is not excessive. We have created a fairly caring, friendly society, one where we feel safe at night. We miss our friends and family on Earth, but we are also proud of what we have done here and have a confidence that our society and culture are advancing in positive directions. Let's remember those accomplishments this sol when we debate the details of where we will go as a community."

Greg sat down to applause. Érico had hoped Greg would set the tone of the gathering, and he had; everyone looked more relaxed.

So it was time to start the debate. Érico pointed to Johnny Lind. "Johnny."

Lind rose. He had been on Mars four years and was relatively young—33—and newly married, but he had a reputation for asking tough questions, and usually in a provocative manner.

"I don't want anyone to misconstrue my comments to suggest disrespect for the Commission or for any personnel in the Commission. My concern is for our collective future here. Like everyone else, I am excited about plans for expansion. Humans have been on Mars less than two decades, and we already have a population of over 350. But I

think we have to expand at a wise, sustainable pace, and not at breakneck speed. All my comments this sol are directed at that concern.

"First, nuclear power: it is not even clear that the United States will go to the asteroids and Jupiter; Project Odyssey appears poised on the edge of cancellation. We don't need nukes any time in the next decade. Why not wait? Why the hurry? The arguments just don't make sense. I call on the Borough Council to put the Hanford Flats application on hold.

"The caravel: It's a great design and holds a lot of promise for the future, but why now? We could use our construction capacity to build more agricultural and residential biomes, more space for bioarchive, and to make more consumer goods. Why do these tasks always get postponed? Because the Commission does one thing well, and that's develop Mars, which is measured in quantities of people and other statistics. If we slowed down a bit, we'd have a better quality of life. Let's relax more and postpone the caravel.

"Immigration: This is the biggest boondoggle of the three, and appears to have the potential to encourage greed. Why should we encourage every weird group with strange utopian dreams and a half billion bucks to come here? Can all the new people be employed? What will they demand of us after they get here? Will they vote their own into office? Will they have their own outposts scattered around Dusty Red? And are we being realistic about the costs of flying them here and setting them up? Rumor has it groups are trying to negotiate below ten million redbacks per person to fly here and ten million more for setup. What about ongoing costs? Rumor has it they're trying to avoid paying future fees as well. Could we be so greedy for people that we'll bankrupt ourselves and produce unemployment here at the same time? Rather than going slow, we're proposing to hurry a

caravel back to Earth to get more people here quicker! I'd at least postpone the caravel, so that we have four years to prepare for the flood of additional arrivals.

"In short, I think caution is in order on all three issues. Let's take our time and do it right, rather than hurrying and making a mess."

Johnny sat down to a scattering of applause. Almost everyone there—250 adults—raised their hands. Érico nodded to a middle aged man from Japan, one of the new arrivals. "I am concerned also about the plans, but perhaps not as concerned as Johnny. Space will never be opened without nuclear power, we can become the major supplier of the fuel for expansion into the solar system, and the plans are phasing in gradually. I think nuclear power meets the criteria of caution Johnny proposed. I worry about radioactivity just like everyone else here, but we are an educated group. A shuttle explosion might scatter radioactive fragments across a hundred square kilometers of desert, but it will be easier to clean up here than on Earth, and less urgent; there will be no powerful atmosphere and rainfall to spread the material around, no people exposed to the atmosphere to be contaminated.

"The caravel project, similarly, is marvelous and carefully planned. The acceleration in the last few weeks is a surprise, but can be done, and will actually give us more time for construction of biomes and housing. I am not too concerned about consumer goods; I can live without the latest gadgets. My apartment is not that much smaller than my brother's in Tokyo.

"As for immigration, I agree we have to plan cautiously, and the rumors worry me. I want to hear more about the problems and how they are being dealt with."

Érico nodded. He looked around. “Will, what can you say about immigration? I think this a question everyone will be asking this sol.”

Will nodded and rose from his seat near the back. He punched an icon on his communicator and was connected to the loudspeakers. “We are in negotiation right now with a dozen different groups, some of which know of each other and are coordinating their positions, some of which are negotiating independently. We are also negotiating new long-term deals with twenty nations, because the lower price of settlement has attracted new interest in sponsoring citizens on Mars. Some of these have been stimulated by publicity in that nation; for example, Japan is considering sending more astronauts here because of the Zen monastery proposal. If more Japanese come, the Chinese may want to send more, which means India may want to sponsor more, which may mean Pakistan may want to sponsor more. A single proposal can generate a lot of interest. Altogether, there are proposals to fly about 600 people here over the next three or four columbiads. Adding in our own plans, we’re talking about a growth rate of sixty percent every columbiad. It sounds high, but it was a growth rate of that sort that got us where we are this sol.

“As for the rumors, they are exaggerated, as rumors usually are. The costs of Columbus 9 averaged fifteen million redbacks per person for the flight plus five million per person for set-up cargo, plus one or two million per person for locally manufactured items. Different groups have different ideas for what they will fly out as cargo versus what they will buy from us, so negotiating positions are not uniform. We are indeed estimating twelve million redbacks in flight costs per person for Columbus 10, based on flying 120 people here; maybe a caravel will make it cheaper, but maybe not. Most groups do not want to give us a fifteen million redback deposit to cover future expenses

such as health and environmental costs; they would prefer to put the money into a trust they manage and that we will audit. Others don't want to deal with costs and prefer to pay us.

"I can't get into more details about the negotiations because they're ongoing. As for what the arrivals will be doing, that won't be settled for some time. Some groups are interested in agriculture, some in light manufacturing, some in specialized manufacturing. Many want to open businesses. We are encouraging some to consider consumer goods or basic materials. Others must plan for extensive, expensive, specialized training and purchase of equipment, even in the agricultural sector. Their decisions will effect our planning, too. Two years is not adequate to plan the immigration of large groups, but large groups are not planning to arrive in two years; just their advance teams. We should be able to accommodate them in that time."

Will sat. The audience was abuzz with conversation. But hands flew up anyway.

"Eammon," said Érico.

Eammon O'Hare rose and took the microphone. "I do hope the process is as smooth as the Commissioner implies, because I'm concerned about job displacement, longer work hours, stagnant or falling wages, and greed engendered by competition. I already worry about the dozen college graduates we have here who have tiny wages, cramped flats, and long hours in the kitchen or the daycare area every sol, all for the privilege of going to MarTech half time for their Master's degrees, where they sometimes get substandard classes. If we replace them with some zealous religious converts working for half as much and perhaps not for any education, what future will these people have here? What will the income and education disparity do to our culture and society? And

what will an increased level of zealousness do to the collegiality and courtesy that characterize our community? These are not trivial things to endanger or throw away."

Eammon sat to a scattering of applause. Érico pointed. "Enlai."

Their first Chinese resident rose and took the microphone. "I will not speak in defense of our utopia because we have never had one. Diversity is not a matter that will ever be solved here. It is not solved now and if we don't get a bunch of zealous immigrants, it still won't be settled. I won't list all the discourtesies I've suffered in my eleven years here, and I apologize to those I have in turn been discourteous to. But I think we can handle a much broader range of immigrants. We will have an entire six-month voyage to orient and train them; they will arrive with a sense of what Mars is like. That's better than can be said of the millions of poor, uneducated immigrants that flooded the United States, Argentina, Chile, Australia, New Zealand, Canada, and many other countries in the past. Yet those people largely assimilated and became important contributors to their societies. Let the Zen monks, the Green Earth Community, the Universal Church of Jesus Christ the Creator, and anyone else come here. We will benefit."

There was a scattering of applause to Enlai's comments. Will looked around carefully; it seemed to him that only a fraction of the audience was applauding, but the numbers applauding for and against the changes were roughly equal. Perhaps a few more people were opposed.

But the next three speakers all spoke against increased immigration in 2055, and after one positive comment, two more spoke against. The arguments were becoming

repetitious and people were losing a bit of interest at that point, so Johnny raised his hand urgently. “Mr. Chair, a point of order.”

Érico hesitated to recognize the troublemaker, but did. Johnny push the connect icon on his communicator and leaped up. “Mr. Chair, I recommend we vote on this matter. I move that we ask the Commission to reconsider its plans and postpone immigration as much as possible, and look at ways to stop some groups from coming here at all if their behavior appears beyond the bonds of civility.”

“That’s not a point of order,” replied Érico.

“I second!” exclaimed someone.

“Oh, hell, let’s vote,” growled Roger Anderson.

“It doesn’t have any standing in the Fundamental Law,” pointed out Érico. “It’s meaningless.”

“No; it’s a determination of the will of people,” replied Johnny. “Politicians can ignore it if they want,” he added with a hint of dare in his voice.

Érico looked around. There was a desire to vote. “Okay, let’s restate the motion. Johnny, is there a way to clarify it? ‘Beyond the bonds of civility’ is vague and may be illegal. Lawyers have said that the Commission Treaty indicates that if someone owns a piece of land and can afford to come here, any reasons to exclude the person must have valid legal grounds, such as criminal activity or psychological impairments.”

Johnny stood. “Fine, I’ll restate it this way: we move that the Commission reconsider existing plans and postpone immigration of paying groups at least until Columbus 11.”

The seconder, a friend of Johnny, nodded. “Okay, we have a motion. Any further discussion? . . . . No, all those in favor raise their hands. . . . Opposed?”

About three times as many people raised their hands against the motion as for it. Johnny was visibly surprised. “The motion is defeated,” exclaimed Érico. “Now let’s discuss nuclear power and seek a resolution about the topic.”

The borough meeting ended so late that supper was postponed and was eaten after sunset. In the north polar layered terrain, where everyone at the Polar Station had watched by video link, there was no sunset, just perpetual sunlight reflecting off fields of dry ice and water snow rolling to the horizon. They sat down to their supper around a big table in Mobilhab 1 once the meeting wrapped up.

“That was a good question, Helmut,” exclaimed Nigel between bites of chicken and potatoes. “They were discussing the Hanford Flats proposal without all the facts.”

“And I knew Brian Stark could talk about matters such as size of the reservation and of the security perimeter,” added Helmut. “I heard him discussing some of the information in the Patio.”

“I’m glad the public at Aurorae had the good sense to vote against restrictions on immigration and nuclear power,” said Nigel.

“It’s too bad we couldn’t vote from down here,” said Clara, discretely deciding not to contradict her boss. “All of us are legal residents of Aurorae, after all.”

“Yes, I’m surprised with all our technology, we can’t participate fully,” agreed Nigel. “Except I’m not sure I want to get involved in Aurorae politics anyway.”

“It can get turbulent at times,” agreed John Hunter, looking at Vanessa and Maaka next to him. The 2 ½ year old boy had been pretty good on the expedition, much to his relief. Vanessa had come around only at the last minute because the biological research was potentially very tantalizing.

“I was glad that En-lai spoke up about discrimination,” said Jen Tan. “It looked to me that people were surprised and listened to him. “He’s quite right; there are slight comments and discriminations all the time, and major infractions occur as well.”

Nigel Stanfield scowled. “I really find that hard to believe, Jen. This is a group of professionals, not a bunch of factory workers.”

“And you think professionals are free of prejudice?” Jen laughed.

Nigel flushed. “Look, this is primarily an American and European operation; they’re paying most of the bills—”

“Because they won’t let China expand its involvement and won’t let us build our own outpost.”

“You don’t have the resources!”

That startled Tan and his three Chinese colleagues. “What an idiotic statement, our economy is the largest in the world!” Tan shot back.

Nigel turned red. “I think you should be careful about using insulting terms!”

“I’m afraid you just made my point about insensitivity.”

“But let’s not make it worse,” exclaimed John Hunter, raising his hands. “As a Lakota, I can testify, Nigel, that we are not as fair here as we should be. Vanessa’s Maori and she can give you examples as well.”

“That’s alright, I don’t need to hear the examples,” replied Nigel. Clearly, he wanted to drop the subject. They all ate the rest of the supper in awkward silence. Finally, Maaka began to cry from fatigue.

“We’ve got to get him to bed,” said Vanessa, rising. Clara stood up as well. “I’ll help.” The two women walked into the neighboring mobilhab.

“I can’t believe Nigel,” exclaimed Clara, angry.

“He’s amazingly old-fashioned,” replied Vanessa. “I’ve met the type before. Jen’s not much better; their professional rivalry is out of hand.”

“I think I should talk to the Commissioner about this,” said Clara. “This is the sort of incident he’s trying to avoid.”

“With the diversity on its way here, that’ll be hard to do,” replied Vanessa. “I’d be careful, Clara. They’ll send down a team of psychiatrists to intervene.”

“I’ve only been here a week, but this isn’t the first time I’ve heard Nigel say insensitive things. It’s not good for morale.”

“No, it isn’t, and yes, he is insensitive. It has been a problem.”

“Then let’s try to fix it,” replied Clara. “But I think I will wait a bit and plan my email very carefully.”

“I’ll help,” promised Vanessa.

Clara thought several sols about the problem before writing Will Elliott. Meanwhile, Will was preparing for a trip with Roger Anderson and their two sons, Marshall and Sam. It was early Tuesol morning when the four of them headed westward with the geology class for Ganges Chasma.

“Now, how many times should I repeat the rules,” exclaimed Will to the two boys, who were staring out the front windows of the top floor of the mobilhab. “Hey, are you guys listening?”

“Yes, dad,” replied Marshall.

“Then stop looking for a minute and face Roger and me.” He paused until the boys turned around. “Okay. This is not a private vacation. We are tagging along with the field geology class. We don’t get in their way or interfere in any way. While we’re in the field with them, you boys can’t be running around; you stand and listen, and if you don’t understand, you stand patiently anyway.”

“Don’t worry, dad, we’ll follow the geology.”

“We’ll see,” replied Will, skeptically. “Roger and I will help you; you guys know a lot of geology for your age, so you’ll understand a lot and you’ll learn a lot. Dictate notes to your tablets; we’ll give you some reviews every night, if you want. You owe your teacher a geology paper after this trip.”

“We know,” said Marshall, bored.

“And Will and I are helping Lal with the class, so we can’t watch you every minute,” added Roger. “Keep an eye on each other and don’t go anywhere without us knowing. This isn’t a little half-hour walk from the Outpost. We’ll be as much as a thousand kilometers from Aurorae and as much as two hundred kilometers from Ganges Oasis. We won’t have access to quick medical assistance. You guys could witness a serious emergency, and we have to count on you not to panic.”

The boys suddenly looked very serious and said nothing.

“And don’t forget we won’t be doing geology most afternoons because we’re the cooking crew,” added Will.

“Why can’t they cook for themselves?” said Sam. “Half the students on this expedition work in the kitchen!”

“Which is why they’re not cooking on this trip!” replied Roger. “Besides, Will’s one of the best cooks on Mars.”

“And we have to help,” said Marshall.

“Except when we’re at Ganges Oasis,” added Will. “They have a cook there. But remember, behave well, or this will be your last trip for a few years. There’s another field trip to Aram Chaos in September, and we can go on that trip if you boys are good.”

They heard the *clump clump* of shoes on the stairs and Rahula Peres came up. “Hi; can the boys come down? We’re about to watch a video on the formation of the Marineris system and we thought you’d like to join us.”

Marshall looked at Sam eagerly. “Sure!” he said, delighted the older students were paying attention to him. Sammie followed more reluctantly. The two fathers watched them hurry down the spiral stair.

“This could be good for them,” said Roger.

Will nodded. “They’ll get a lot of attention from an age group they want to imitate, and it should be pretty good quality interaction. The students might even learn more; they may avoid confusing each other with too much terminology!”

“And now we get to find out how well it works to take kids into the field,” added Roger. “I gather the North Pole Station hasn’t had any trouble with Maaka on board.”

“Three datapoints won’t tell us much; every child is different. I’m glad we’re getting away, though, even if this isn’t much of a vacation.”

“You can’t take all your vacation anyway.”

“No, I can’t.” Will sighed. “This is an interesting time to be away.”

“I’m surprised you went, with the Mars Council convening to finalize the nuclear reservation.”

“They don’t need to hear from me. They’ll approve it; the election meeting and the elections themselves came out in favor, and most Council members are in favor.”

“Yeah, the election proved to be a good thing this year. The Mars population is on board with these changes.”

“Mostly; there’s a vocal minority that’s opposed. But I guess that’s the best we can expect anyway. I’ll be back in time to review the Ceres flight plans two weeks from now. The flight to 2011BA14 follows a month later. It’ll all work out.”

“Assuming Ceres stays in NASA’s plans.”

“Yeah, and it’s tricky; we can’t postpone the launch much, and we really won’t know whether Congress will approve the necessary funding. It’s a real problem.”

“With all the new equipment and artificial intelligence, I sometimes wonder whether humans will really be necessary, though they can do about one hundred times as much.”

Will was surprised. “You too, Roger? I agree with you, machines get better and better all the time. Fortunately, the cost of flying humans keeps dropping as well.” Will’s tablet suddenly beeped with an incoming videomail. He glanced at the screen; it was

from Clara Langlais. Curious, he pushed play and was surprised to listen to her message of concern about Nigel Stanfield's behavior. Roger came over to listen as well.

"Brave of her, to send you that message."

"Yes, and it seems well done; it's not just a blind attack on Nigel."

"Though he will interpret it that way."

"He probably will, unfortunately. But that may just prove Clara's point, right?"

Roger nodded. "He is too plain spoken, sometimes. I wish Lal had run the expedition instead."

"Yes, but he couldn't." Will sighed. He didn't tell Roger about complaints he had received from Beijing about Stanfield's treatment of their people, and Stanfield's unresponsiveness when he had asked about the charges. "I guess I'll copy this to Martha Vickers and Enlai Tang and ask them to fly down and investigate. They'd be a good team, don't you think?"

"Yes, and discrete, but I suspect this will leak to the media anyway, and will have to be dealt with."

"Unfortunately. It's bad timing, coming on the heals of all the discussion about immigration. We'll look like a bunch of bigots. I guess we can run counter statements and testimonies, though. I had better get Louisa Turner started."

"Better you than me, my friend," sighed Roger.

8

New Directions

Early November 2053

A Sunwing-D approached Aurorae's three thousand meter east-west runway. Its front set of thirty-meter wings, sprouting from the top of the fuselage, had all eight of its propellers turning at maximum speed, supplementing the fading late afternoon's solar power with energy from its silane engines. The central set of wings, sprouting from the bottom of the fuselage half way back to the tail, had four landing gears deployed, ready for touchdown. The rear set of wings, also extending from the top of the fuselage, had wide flaps extended fully to maximize lift and minimize ground speed in the thin air. Flaps extended from the front and middle wings as well, temporarily doubling the lifting area of the aircraft.

Dust rose from the wheels as they touched down on the clay landing strip. The pilot cut the engines and applied the brakes. They rolled past shuttle pads, most of which were occupied by gryphons and hippogryphs, and came to a stop half way down the runway where a conestoga awaited them. The conestoga crew approached, placed wedges under the wheels, and attached a flexible plastic tunnel to the sunwing's rear door. Once it was pressurized, the passengers exited: Vanessa Smith, John Hunter, Maaka Hunter, and Nigel Stanfield.

Fifteen minutes after touchdown, the passengers were able to exit the conestoga with their luggage at the main arrival hall of Aurorae Outpost. The Hunter-Smith family headed to their flat in Shikuku Biome while Nigel walked to his small flat in Columbia.

He avoided areas of heavy foot traffic. Fortunately no one spotted him. But as he approached his flat in Columbia's cylinder 4, Brian Stark exited from the main door of cylinder 3, where his flat and offices were located. "Hey, Nigel, welcome back to Aurorae! I didn't know you were coming back."

"Last week we hit Noachian bedrock, so the deep drilling project stopped, at least for a few months. We might reenter the hole next year and try for another thousand meters. So I'm taking a bit of a break."

"Good. How deep did it go?"

"Forty-three hundred meters; dirty snow on top, dirty ice underneath, then icy sediment—eolian and crater ejecta—for 1,500 meters, then finally basalt."

"Wow, in what; four and a half months?"

Nigel nodded. "Yes. We're staying at the pole another three or four months, then we'll be back here for a few months, and after the equinox we'll head for the south pole and another drilling project. How's the nuclear facility?"

"We've used our three and a half months since the Council's approval pretty well. Hanford Dome is going up—it's one of the new B-160s—and in the last week we've inflated three building bubbles, tested them, and started interior construction. We hope to start uranium separation in the spring."

"Good. Is it true you plan to refuel the oldest reactors here?"

"Yes, the oldest two have stopped making significant power but the vessels are still fine, so we plan to use our robots next year to remove the spent fuel. It'll be at least eighteen months before we can refuel them, but at that point they'll be as good as new. The spent fuel has plutonium and all sorts of useful isotopes. We'll have recovery ability

in three or four years." Brian looked toward the exit from the biome. "I'd talk more, but I have an appointment. Tomorrow night there's a big party in the Patio for the return of the *Ascraeus* from 2011BA14 'Amigo.' Sit with us and we can catch up."

"Yes, and commiserate about politics."

"Oh God, yes! Our political base is apathetic and the majority has fled to the other party. Congress can ignore us." Brian shook his head in disbelief.

"White should have resigned two years ago and let Hamlyn serve as President. Even if he is gay, he would have kept the evangelical base and his more moderate positions would have generated some support from the mainstream."

"That's true. It's sad. The party won't win back the Senate and House for many years, maybe a decade; until the Dems gloat too much and create a disaster of their own, that is." Brian smiled at the thought.

"I know. The party never should have embraced White; he was too extreme. People here are right; the Republicans have to go see the world, rather than thinking the United States is the only part of the world that counts. That thinking led to a disastrous war, a monstrous act of terrorism on U.S. soil, trade protectionism that ruined the economy and cut the value of the dollar in half, astronomical oil prices, a vast deficit. . . it'll be a while before anyone can pick up the pieces."

"True enough, but the Democrats have the responsibility for picking up the pieces and we'll blame them when they fail. Let's just hope they preserve Odyssey."

Nigel shook his head. "I doubt it."

"Well, I have grounds for optimism." Brian smiled. "Maybe I can tell you a bit more tomorrow, Nigel."

"Okay. See you at the party." He gave Stark a salute and walked inside the cylinder.

His flat was on the second floor. He went up the stairs and ordered the door to unlatch, which it did. He pushed it open.

Dust everywhere. It wasn't too bad; the air was well filtered. But he hated it when a place was so dirty he could feel a layer of grime on flat surfaces.

He walked to the windows and raised the blinds. He had a one-room efficiency, small but adequate. A bathroom occupied the rear corner and a simple kitchenette covered the wall between it and the rest of the half-circle of space. His bed folded in half to make a sofa; he also had two easy chairs and a rug. The floor was "wood" parquet. The walls were bare because he hadn't been on Mars long enough to decorate.

He put his suitcase on the bed and set up his tablet on his desk. He collapsed into his chair, depressed. He had an appointment with the Commissioner the next sol and it was going to be difficult. He really didn't want people to know he was back because they'd ask why. The conversation about politics soured his mood even more. It would be a double disaster if the funding for his polar research was cut, leaving him stuck on Mars with no money to continue.

It was quarter of five. He didn't want to go to the Patio for supper. He got up and checked the cupboards; they were bare, as he knew they would be. So he sat at the tablet and pulled up the Patio's supper menu; they had a vegetarian lasagna that sounded good. He ordered a meal and was pleased to see a robotic cart could deliver it at 6:45 p.m. An extra hour of hunger would be worth the wait.

John and Vanessa couldn't wait to go to the Patio and see their friends over supper. As soon as they arrived, friends swarmed around them, shaking their hands, hugging them, asking them how they were doing. They were particularly happy to see Helmut and Clara, who were holding their baby, Charles.

"Oh, he's so cute!" said Vanessa. "How old?"

"A month," replied Clara, smiling. "It was a rough labor."

"And he's fine?"

"Yes, very healthy, feeding well and crying a lot."

"Let me hold him." Vanessa took the baby and cuddled him. "He has Helmut's nose."

"Yes, and my eyes."

"It's my turn," said John, taking Charles and giving him a kiss. "Congratulations to both of you. Are you actually managing to take classes?"

"Mine are moving along; Clara cut back to one this semester," replied Helmut. "Charlie's taking a lot of our time. But we're very happy to have him."

"Good," replied John, looking at three year old Maaka.

"And when are you due?" Clara asked Vanessa.

"Four months; we're back here for his birth," replied Vanessa.

They went to get their food, then sat with their friends. Once conversations swung away from the last six months of exploration to other matters, Vanessa rose from the table to get some coffee. On her way back she stopped by the Commissioner's dinner table, where Will and his family had arrived. "Welcome home!" said Will. "How was your trip?"

“Oh, well worth it. Maaka did fine; the two mobilhabs and the oasis shelter provided him plenty of space to run around in, and I was able to work with the sediment cores closely every sol.”

“Yeah, you got down to the Noachian.”

“We sure did! All the way to the bottom of the polar deposits and into the original crust, which tells us about the collision that carved the lowlands in the first place. We have the cores to trace the history of Mars’s two polar oceans and the evolution of prebiological chemicals, then the rise of life on Mars.”

“We’ll have the whole story?”

She nodded confidently. “I’m pretty sure. We could use more cores to flesh it out, but we will have the basics.”

“I hope your team gets the Nobel Prize for that! You’ll deserve it.”

“Thanks, Will. And thanks for the support.” She didn’t mention Nigel, but he understood the allusion.

“Oh, of course. We’ll see how the story ends. How’s Maaka’s health?”

“We’ll be sure after he sees the doctor on Monsol. He won’t like it, either; he has to give a lot of blood. But his radiation exposure was pretty low because of the ice cover over the oasis’s hab. This won’t give us a true measure of life in a mobilhab.”

“That may be just as well; I don’t like the medical experimentation aspect of this new policy.”

“I’m hesitant, too, especially since I’m due in February.” She looked at Marshall. “I understand Marshall brought good luck to two field geology classes!”

Marshall smiled, embarrassed. “I didn’t do anything!”

“He was a good boy on the Gangis trip, so we took him and Sammie to Aram in early September,” said Will.

“And the class discovered two new species on each trip!” added Vanessa. “I would have enjoyed that!”

“It was exciting,” agreed Marshall. “The Gangis strata were from a late phase lake; it was upper Hesperian. The Aram strata were middle Hesperian.”

“They help to fill in some gaps,” said Vanessa. “I saw your name on the author list in *Nature*.”

“That was exciting,” agreed Marshall. “Even if I was the sixteenth author!”

“His first publication,” added Will, with a smile.

“Well, I’ve got to get back. Clara said I could hold Charles.”

“What a beautiful baby,” said Will. “They’ve been blessed.”

“Yes, they have been, and they’re very happy. Bye.” Clara headed back to the table.

The next morning, Nigel emerged from his flat at 10:55 a.m. to walk to Elliott’s office for his 11 a.m. appointment. Will was waiting.

“Good sol, Nigel. Come in,” Will said, rising from his desk. He pointed to the table in the front of the office, where they could sit together. “I trust you had a good flight?”

“Yes, it was the usual. Thank God we had space to stretch out.”

“Those sunwings are impossible if the flight is long and the cabin’s full. We may get something bigger and more powerful in four years if the research funding continues. There’s not much money in Martian aviation. And you hauled back some of the cores?”

“Yes, 600 kilograms from the lower 300 meters of the shaft. The analysis has already started.”

“I’m sure.” Will leaned back in his chair. “Well, we’re not here to talk about travel or science, unfortunately.”

“Unfortunately. Commissioner, I have always been a frank man, and that can rub people the wrong way. The last six months have been difficult; the crew did not gel very well, we were in confined quarters with a loud child, we faced some serious technical challenges to get the driller to work properly, and we had some major differences over exploration strategy. I did my best.”

“Nigel, frankness can be a strength, but it can also be a weakness. In this case, near as I can determine, you managed to rub everyone the wrong way. The Chinese were alienated early, and they eventually complained to Beijing, so I heard about it from there. When I asked you about the matter, you weren’t very forthcoming. Your comments about women did not sit well with some of the women. Your treatment of the drilling crew has been called ‘imperious.’ There were strategies that could have produced compromises on the exploration goals, but they were not pursued. When I sent Martha and Enlai down, you rebuffed them and made their efforts difficult. As a result, Dr. Tan is now in charge and you are here.”

“It sounds like you’ve already tried and sentenced me.”

“No, I want to hear what you think of all this.”

"What do I think? Shit, in retrospect, I wish I had used more honey and less vinegar. But that doesn't come to me naturally. And my approach gets results; if I hadn't balled out the drillers a few times, we'd still be in the lower Amazonian."

"An extra month of drilling wouldn't have done any harm and might not have been necessary. As I see it, right now we have three choices."

Will paused and waited for Nigel to respond. "Okay. . ." he finally replied.

"One, you stay here and do your research from Aurorae. That doesn't seem very practical or a good use of your time."

"We are agreed on that, Mr. Commissioner."

"Two, you return to the station and work there under Dr. Tan. You would get your research done, but the results may be a bit humiliating."

"Ah-hah."

"Three, you take some courses on personnel management and communication. Martha Vickers runs them; they use video and computer assisted learning, with her assessment of the results. Then you go back as commander in three months."

"That long?"

"Let's see how Tan does as Commander. I think we'll be pleased. You'll be there for wrap-up and close-down of the facility, and will head the South Pole expedition shortly thereafter, unless you screw up again or Tan does very well. In the latter case, command will be rotated."

"Mr. Commissioner, this is no way to treat me. I think I had better make a few complaints of my own, to set—"

"You are free to do so, and remember Columbus 9 returns to Earth in August 2054; that's nine months from now. I'm not sure how that will look on your record."

Nigel opened his mouth, then closed it. "Very well. I'll call Vickers this sol."

"Good. Nigel, you have done incredibly good science in the past and I know you will in the future. But you're moving beyond science and into management. The mission to Callisto will demand close cooperation by a small crew that likely will be diverse. This is an opportunity, not a punishment."

"I concede your point. I'm not sure I can say thank you, but who knows, maybe I'll be able to in the future." Nigel sighed. "Anything else?"

"Good luck."

"Thanks." Nigel threw an ironic salute to Will, then rose from his chair and walked out the door.

That evening, the Patio filled early for the celebratory dinner. The *Ascraeus* had landed safely at 8 a.m. that morning, and the crew was rested and ready to be welcomed home in grand style. A free feast was laid out on the buffet tables, so everyone filled up.

"I just wish you had sent me on a more ambitious mission," Johnny Lind said to Will as the dinner came to an end. "Amigo was pretty small; a fast target to explore. It seems like we barely left Mars space."

"Three months is no quick jaunt. Amigo may have been only a hundred fifty meters by eighty, but we now can say where it came from in the outer asteroid belt, which class of objects it's a member of, when that class was created through destruction of the mother body, and what the class is composed of. Not to mention the Prospector-class

rover, drill rig, solar array, fuel synthesis unit, and MDAV you left behind. Who knows what probe or spacecraft will rendezvous for refueling or whether it will assist a future Columbus mission in trouble. Don't minimize your achievement."

"I wish I could have swapped missions with Emily; hers seems much more exciting! Keep in mind that I'd love to participate in a mission to Ceres, Pallas, or Vesta. The opportunity would be quite exciting."

"I'm sure. Who knows whether we'll have any say, though; you'll have to apply to NASA."

"And no one can predict when a mission to the asteroid belt will be launched."

"Exactly right."

"Any idea when NASA will decide?"

Will shook his head. "We've been considering our options for months. Our NASA subsidy appears to be safe, since it was negotiated twelve years ago when costs were much higher. They even paid us the subsidy they withheld three years ago."

"Is there any possibility I can participate in the Mercury support team?"

"Sure. We're trying to provide as much support as we can after hours, but we have some people here temporarily working full time for the Mercury-Venus Commission. Not for more than a few months, though."

"Thanks. Mercury's volcanism has some fascinating parallels with Noachian volcanism. They'll have that planet covered with Prospector rovers in a few months."

"Especially since they can't stir from the outpost very much. It'll be the first world mostly explored by rover."

“Yeah, Venus is getting explored that way, but incredibly slowly because of the heat, and Titan and the Galileans are glacially slow because of the time delays. We need people out there!”

“Well, we’ll have them there soon, won’t we?” said Will with a smile. He rose. “Coffee?”

“No thanks, I’ll get some in a few minutes.”

Will nodded and walked to the coffee. While filling his cup he felt his tablet, which was attached to his belt, vibrate. In his earpiece he heard an automated message, “videomail from NASA Administrator Kern.” He walked to a corner of the Patio, raised the tablet’s screen, and pushed the play icon.

“Good day, Commissioner. Elliott. I thought I should inform you that in a few hours we will to announce that Project Odyssey will skip the asteroid belt entirely and head for Jupiter. It has become clear in our negotiations with Congress that funding for asteroid missions will not be forthcoming. I am very disappointed and I am sure you are as well. I apologize if we raised your hopes for collaboration. Odyssey is still interested in your caravel project, however. Good bye.”

Will shook his head, sadly, then headed to the table where Alexandra and Yevgeny were seated. He beckoned to Ruhullah. The four of them huddled against the wall, out of earshot. “Kern just called me to say that Project Odyssey will skip the asteroid belt and go straight to Jupiter.”

Alexandra recoiled backward. Ruhullah whistled his surprise. “The SOB’s,” said Yevgeny. “Do they think we’ll do that ourselves, without them?”

“They probably surveyed the American public and found no one cared about the asteroid belt,” added Ruhullah.

“The Chinese will beat them to Jupiter otherwise,” added Will. “That’s one reason.”

“Give the billions to us and we’ll do more with it,” replied Alexandra.

“What do we do with the Ceres probe?” asked Yevgeny.

“Let’s talk about it. It’s to be launched on a free return trajectory that will bring it back here in two annums anyway. The Prospectors can explore the surface, the fuel making equipment can refuel the Hippogryph, and the habs and conestogas can sit there a few years, or can be launched back here eventually. NASA may reconsider.”

“So you say, launch anyway?” asked Alexandra.

Will nodded. “Yes.”

“Are you thinking we can launch a caravel with crew to Ceres without NASA?” asked Alexandra.

“I wonder. The biggest cost is building the vehicle. Fuel to send it to Ceres won’t be much, and ground support isn’t that much with all the automated systems we have now. We can approach nations for sponsorships to cover the cost of any of their citizens on board.”

“We’d use chemical propulsion and solar power, then,” said Alexandra.

Will nodded. “Fuel’s plentiful. Solar power will need special concentrators because the central asteroid belt gets ten percent the sunlight of Earth, but it’s adequate.”

"The biggest problem is that two caravels would need 40 to 50 crew, which is almost twenty percent of our adult population," said Alexandra. "But we won't send anyone for four years, and by then we may have over 500 adults here."

"We need to think this through carefully, but Mars is the logical center for exploring and developing the asteroid belt," noted Will. "We need five-year missions; the caravels would go to an asteroid, explore and refuel, then move on to another asteroid, repeating the process until they worked their way back to Mars. But a five-year mission means married couples will go, and ideally children as well."

"We're a way from that goal," said Alexandra. "Radiation dangers are still too great."

"Maybe not, if we can beef up the electromagnetic shield and add more water, methane, and oxygen tanks," exclaimed Will. "Let's get the Commission's formidable resources examining this matter." He looked around. "And I had better make my comments; everyone's ready."

Will headed toward the stage. On his way he passed Emily Scoville Rahmani. "Are you ready to go to 2020KZ?"

"Absolutely. Thanks for giving me a leave as commander of Cassini to do this."

"And we're grateful your family let you do this." Will nodded to her husband, Muhammad, and their four year old daughter, Amina. Then he headed up to the stage.

"Good evening everyone," he said, and waited for the crowd to quiet so he could continue. "We are gathered here to welcome the *Ascraeus* back from a quick but significant mission to an asteroid we have named 'Amigo.' Amigo flies from a bit outside the orbit of the Earth to slightly outside the orbit of Mars; in short, it flies along a path

very similar to the Columbus spacecraft. Some day a Columbus flight may parallel Amigo for several months on its way to Mars. Our rendezvous with it was an opportunity to practice a deep-space rendezvous with a Columbus vehicle, which might be necessary in a future emergency situation. Amigo now has a small, inexpensive fuel making system on it, which is accumulating water, oxygen, and methane. In a few years we might fly the fueled plant back here for maintenance, or we might fly the booster elsewhere, or a vehicle may stop at Amigo to be refueled. Next month there will be a meeting of national space agencies to discuss the establishment of a network of emergency stations on asteroids, and our work on Amigo will serve as an example.

"Our team also did some very important science that will help us understand the origin of chondritic bodies in the outer asteroid belt. Could they please stand up now to receive our thanks. Johnny Lind was Commander; Johnny, introduce everyone."

The six crew members rose and everyone applauded for them. Johnny introduced them, then they sat.

"In six weeks—mid December—Emily Rahmani will lead another crew in the *Hadriaca* to 2020KZ, a stony body about 300 meters across that will pass about ten million kilometers from Mars. Could they stand to receive our appreciation as well."

Emily and her crew stood and everyone applauded them. "Thank you ahead of time," Will said to them. "The Hadriaca mission raises the number of asteroids the Mars Commission has visited to nine, crews have flown past seven more, and we have visited five more via automated probes. In contrast, Project Argo has taken astronauts to six, the Chinese have landed on three, the Russians have visited three, and the Venus-Mercury Commission has flown by two. In short, we have landed on or flown by more asteroids

than everyone else combined. We are practically the Mars-Asteroid Commission. If the asteroid belt is ever settled, it will be settled from Mars, which will provide supplies to most missions there. We will launch a major automated mission to Ceres in a few months regardless of the decision NASA makes about sending an Odyssey crew to that world. That launch symbolizes our commitment to human exploration of the asteroid belt."

9

Hermes 1

March 2054

High above the baked and blindingly bright plains of Mercury, a shuttle separated from a mother vehicle and pulled away slowly. The six crew inside had a few minutes to look back at the transit hab, a cluster of fuel tanks, and the six big mirrors of their Sunfire 2 solar thermal engine, barely visible in Mercury's penumbral shadow. Then the shuttle fired its engines briefly and headed for the surface.

Twelve hours later the shuttle was skimming above crater rims and rolling plateau at 15,000 kilometers per hour when the main engines came on powerfully, pushing the crew deep into their seats. For three minutes the engines blasted out superheated steam and hydrogen at 16,560 kilometers per hour while liquid hydrogen and oxygen pumped into the engine and combusted. When the engines shut down the shuttle was a few hundred meters above the surface and moving at less than a hundred kilometers per hour. The pilot watched the computer carefully as the shuttle descended toward the landing pad that robotic vehicles had laid out on the floor of a small crater named Rahu.

The engines fired again briefly and shut down, and the shuttle settled onto the ground with a slight bump. The image was sharp and clear on the wall television in Will and Ethel's living room.

Marshall applauded. "They did it! What was the chance the shuttle could have crashed, anyway?"

"The *Caloris* is a Hermes class shuttle, just like the new ones we'll be getting," replied Will. "They supposedly will crash once every 1,000 flights, but no one is sure."

"We've never had a crash," added Ethel. "But the old shuttles have only flown 200 times, and these new ones only a dozen times."

"The view is very clear," said Will, looking closely at the screen. The camera is set really well."

"It's operating on what? Two or three times the light of a full moon?" asked Ethel.

Will nodded. "Something like that. Marshall, do you see the ice and snow on the ground around the shuttle? It's landed in a small crater and the floor's in permanent shadow."

"Yes, I see. How thick is the ice, I wonder?"

"Mercury has thick sheets of ice in the bigger craters at the north pole, so it could be a lot."

"And where is Concord, where they'll set up their outpost?"

"About two kilometers away," replied Ethel. "The outpost is already set up, though. The Hermes Zero flight that arrived two years ago brought a hab, greenhouse, ranger, four Genie-250s, and lots of equipment, and the genies set up the hab under remote control."

"Which is a capability way beyond anything we had, eighteen years ago," added Will. "When Columbus 1 landed here, we had to set up almost everything by hand."

"No genies," agreed Marshall, referring to robots able to perform a wide variety of industrial and construction tasks independently or under partial control. He listened to the banter between the crew and mission control in Paris. They were speaking French, but

a computer was simultaneously translating them into English and repeating the conversation using simulated voices of the speakers. “Are their habs like ours?” Marshall suddenly asked.

“They’re an improved version,” replied Will. “They’re twelve meters in diameter and have three full floors. The mass is a bit more because they have a micrometeoroid shield on top. The two habs they’ll have will comfortably accommodate twelve to sixteen people, so the six of them are set for some time.”

“And how will they run a greenhouse, with the sun up for months, then gone for months?”

“Concord is on a polar plateau and has sunlight almost all the time,” replied Ethel. “The shuttle’s bringing a ‘picket fence’; a series of silvered slats that they’ll set up outside the sandbags around Concord’s greenhouse, with the slats leaning inward toward the center and over the greenhouse. Sunlight will shine between the slats and get reflected off the slats on the other side and into the greenhouse from above.”

“The sun will never shine in directly,” added Will. “That protects the greenhouse from solar radiation. And the slats will protect the bubble from micrometeoroids, most of them anyway. It’s a simple and clever system.”

Marshall nodded. He yawned. “How much longer before they go outside?”

“Give them time to shut off the systems and suit up,” replied Ethel. “It took us an hour on Columbus 1.”

“What was it like, to walk on Mars for the first time?”

“Very exciting,” replied Ethel.

“Strange to think several billion people were watching us on television,” added Will. “We were thrilled. We set up the flags, then started doing geology right away.”

“You should have heard my great uncle talk about the Apollo 11 landing,” added Ethel. “He was a boy when the first men walked on the moon. He got to stay up very late to watch.”

“Just like me, now!” said Marshall.

They listened to the banter between ground control in Paris and Patrice Domkowski, the French-Polish commander, who had served on Columbus 3 way back in 2040-41. The crew was suiting up and soon the first two would step outside.

“Do you think Mercury will ever have as many people as Mars?” Marshall suddenly asked.

“I wouldn’t rule it out,” replied Will. “But I think it’s unlikely because of the great heat, the lack of atmosphere, solar radiation, excessive light half the time and pitch darkness the rest of the time, and the large delta-v necessary to get there.”

“They flew by Venus to reduce the delta-v,” added Marshall.

“It was the best way to get there without nuclear engines,” said Will. “But the Sunfire is a pretty amazing solar thermal engine, and it’s just as good as a nuke at Mercury’s distance.”

“I’m still amazed people have landed on Mercury only eighteen years after the first Mars landing,” added Ethel. “It’s a harsh place. But the science is really thrilling; it’s a planet almost as complex as Mars, with extensive mineralization, active volcanoes, and clues to help us reconstruct the origin and early history of the solar system.”

“I doubt they’ll ever have a real export, though,” said Will.

“There’s helium-3,” said Ethel.

“If we can ever figure out how to use it.”

“How much water?” asked Marshall

“Enough to support millions of people if carefully recycled,” replied Will. “I wouldn’t be surprised if, 400 years from now, Mercury doesn’t have a few towns.”

“We won’t live to see that, though,” said Marshall.

Domkowski and the chief geologist entered the airlock. The family listened as the airlock depressurized, then watched the door open. Patrice paused a moment, then began to amble down the ramp using a skipping walk that Martian explorers knew all too well. He slowly, deliberately placed a foot onto the untrod regolith of Mercury.

“We come as representatives of humanity to open another world to exploration, development, and settlement,” Patrice exclaimed, his words in French being immediately echoed in English.

“A good line,” said Ethel.

“And see, he’s already looking ahead toward settlement,” noted Will. “We would have never dared say that on Columbus 1!”

“It’s a measure of how far things have come,” agreed Ethel.

The chief geologist stepped down next and uttered her first words in Spanish, noting that they had come in peace to a place where everything was named for peace, for every major crater and feature in the area was named for ‘peace’ in the welter of terrestrial languages. She got to work, picking up icy-cold samples with special tongs and dictating a description of each while the other four crew stepped out, uttered their first words, and began to explore.

Once the last two stepped out, Patrice went back to the airlock and grabbed a flagpole on which was mounted seven flags; that of the European Union on top and those of the six nations represented by the crew below. They drove it into a patch of ground and cheered while *Ode to Joy* was played. When it was over, Will turned to Marshall. "Okay, astronaut, it's 1:15 a.m. You can watch the rest via webcast tomorrow."

"Aw, dad, can't I stay up a little longer?"

"No," replied Ethel. "You'll never get up in the morning as it is. To bed."

"Oh, alright." Marshall rose reluctantly, but he also yawned as he headed for his room.

Ethel rose as well. "Are you coming?"

"No, I'll stay up a bit longer. It's a historic moment."

"Okay, but don't stay up all night, history or not."

"I won't." Will kissed Ethel good night and sat to watch the routine exploration of a new world that had begun. A half hour later the coverage cut away to a commercial about mouth wash. At that point Will brought his tablet over to the couch and began to type a statement.

The Mars Commission and its employees and Mars residents congratulate the Venus-Mercury Commission and the European Union for its successful, historic landing of Hermes 1 at Concord Station, Mercury. Humanity has now stepped onto all the rocky inner planets or set up orbital outposts around them. Mercury, the innermost planet, is already known to have a unique geology, potentially important resources for the common heritage of humankind, and significant clues about the origin and development of our solar system. The importance of today's bold act will be clearest in retrospect, when

Mercury has begun to makes its contributions. Mars hails her sister world as a partner in development, a fellow traveler in the journey of exploration, a companion contributing to a peaceful human future, and a new civilization. We seek and look forward to many fruitful collaborations, an exchange of personnel, and the development of trade between our worlds.

He re-read it several times, polished the text, then sent it to Louisa for discussion. Finally, he called up Patrice Domkowski's electronic address and videomailed him: "Hey Patrice, this is Will Elliott at Aurorae Outpost. I'm attaching a rough draft of a statement I plan to release, but first I want to call you and extend my warmest, heart-felt congratulations for the accomplishment of Hermes 1. If we seek to see the end in the beginning, then we see in your first steps on the Mercurian regolith the founding of a new branch of human civilization. We want to contribute and collaborate. As you know, caravels have been designed to handle the heat and radiation typical in the Mercurian environment. This opens up many possibilities for the movement of goods and people between our sister planets.

"I wish you profound congratulations and complete success. Bye."

The next morning, Will rose early to watch an hour of live coverage of Hermes 1—the astronauts were exploring the glacier of Pax Crater—then went to breakfast. Just before he finished eating, Roger Anderson came along. "Good sol, Will," he said, then he smiled. " 'Mercurian civilization' eh?"

"I didn't exactly use that phrase, but I did refer to a civilization there. Mercury has a bright future; they'll be like Mars is now, in a few decades."

" 'Bright'? As in, five to ten times the amount of sunlight per square meter as earth?" Roger chuckled again.

"Watch out; they have enough solar power to blast us with a pretty powerful laser," quipped Will. "No, seriously, we can speak about Mercury in ways we can't speak about Mars."

"I thought it was a visionary speech," said Father Greg from the next table. "And it should be obvious that everything you said about Mercury applies to Mars as well."

"It was picked up by the *New York Times* in their Mercury editorial. Though I'm sure there will be people who make fun of it." Will shrugged.

"So, Will, do we now have the Universal Church of Jesus Christ the Creator coming?" asked Greg.

"Yes, that's now finalized. I think they'll fit in reasonably well. Their theology isn't any weirder than Roger's." Will smiled at his friend. "Actually, they are not far from standard conservative Protestantism, Roger, so you may enjoy worshipping with them. They're working very hard to develop construction and horticultural skills; they can acquire them in Nigeria. They'll be coming to Houston soon to be fitted for pressure suits."

"I think I'll prefer them to Wahhabis," said Roger.

"The minister and I have exchanged some video mails. He seems friendly and open," added Will. "I'll give him your contact information, Greg."

"Please do."

Will picked up his coffee cup and refilled it, then waved goodbye and headed for his office. There were already several videomails, though none from Patrice Domkowski;

he had hoped the commander of Hermes 1 would acknowledge his message. Louisa sent published comments about his speech; the "top ten reasons Mercury will become a civilization" on the *Tomorrow Show* were the most amusing. Other blogs and articles were appreciative and several were dismissive or farcical.

More important was Charles Kern's email. Will opened it next.

Good sol, Commissioner Elliott. I see you are as thrilled as we about the safe landing on Mercury. We anticipate that an American will go on Hermes 3. Our regret, of course, is that NASA was sufficiently distracted to let this prize slip away. We won't let that happened with Jupiter.

But that's not why I called you. Everyone is impressed that the Mars Commission is proceeding with Ceres 0, even without American funding. We would have designed a special landing vehicle based on the lunar lifter series; you just used a Phobos-based Hippogryph. We would have redesigned the basic Prospector series rover; you used your standard Phobos version and added extra solar panels. We would have redesigned lunar equipment for the outpost; you used locally manufactured inflatables and threw in used equipment! Simple and clever. Ceres is your goal this columbiad instead of two closer asteroids you would have probed instead.

Consequently, I have done a budget review and concluded we can afford to partner with you on Ceres 0. We propose to cover a quarter of the mission's costs by paying to replace the Hippogryph with a lunar lifter; there's one available on the moon and there's still time to send it to Mars this coming opposition. We are adding funding for Ceres 1, the mission involving a human crew, to next year's budget, but you know how

uncertain that is with midterm elections coming up. Please let me know whether you accept this offer. Bye.

Will stared at the screen for a moment. A spare lifter: that was an easy offer to make, with private vehicles providing more and more of the transportation to and from the moon, thanks to the revived tourist market. They could use it, but not as much as Kern might think; with flights between Embarcadero, Phobos, and Deimos and nearly twenty cargo flights to Earth every columbiad, Mars had plenty of Hippogryphs and plenty of experience handling flights similar to Ceres 0. The launch of humans to Ceres would cost far more. This was just a cheap way to buy some of the glory.

He was tempted to dismiss the offer curtly. But any collaboration with NASA was a bargaining chip. He hit reply. “Good day, Administrator Kern. We’re pleased to hear that your budgetary position has improved. We welcome partners in all our efforts, hence your offer is much appreciated. Krister Soderblom will be paying you a visit at a time convenient to both of you to work out the details. I look forward to seeing the fruit the meeting will bear.”

10

Fire and Ice

July 2054

Will walked into Mars Control and spied Ruhullah in his office. Electronic pages were spread out all over the desk in front of him and he turned from one to the next, scribbling on them with a stylus.

"Inventory?"

"I always do a spot audit myself; the staffing cuts in Houston have resulted in occasional inaccuracies."

"Maybe we need to rehire some folks or have another look at procedures. The consulting firm said the inventory department could be both smaller and more efficient."

"Well, it got smaller first. We just got three nonfunctional Prospectors back from the field and we don't have enough spare batteries to carry out a routine replacement. We're scrambling to come up with substitutes."

Will was shocked. "That's crazy!"

"We're half way through the columbiad; shortages start to show up about now. And we have other sizes of batteries, so we can substitute. But this incident highlights the problem. I'll have a report for you in a few sols. How was Caribbean Biome?"

"Excellent. Alexandra and Lisa gave me a tour; we walked very slowly because of the thin air, but that worked out also. We're all amazed we could build a B-160 and put enough air in it to make it breathable. But we have lots of spare nickel-iron and the nickel-iron cables add enough weight and strength."

"And it has 20,000 square meters of space; enough to feed 200 people!"

"The spaciousness is incredible. It's really too big for us right now; we can't afford a depressurization accident. We're crossing our fingers that the dome holds. It's divided into airtight quarters and two will be for bioarchive; Virgin Islands rainforest and southern Rio Grande prairie. The other two will be agriculture. Setting it up will be a huge challenge. It requires fifty tonnes of nitrogen, one hundred fifty tonnes of oxygen, one thousand tonnes of water, and five thousand tonnes of regolith. Lisa's going crazy because her crew has to be able to set up one of these every year. Alexandra's trying to figure out how to build one that fast."

"At least we won't have to go through names as fast," replied Ruhullah. "If we had to build eight smaller biomes and name them, this place would get really confusing."

"It has too many names already, but that's the least of our worries. We have to inflate another one of these by January 2055; ten months. Lisa thinks they can have enough soil ready by then to spread a thin layer over the floor to get agriculture started, and they'll add regolith month by month to bulk it up."

"What'll be the name of the next one?"

"Missouri, referring to the river, not the state. We'll put the Ozark and northern Rocky Mountain ecosystems in it and use two quarters for agriculture. We have to build two B-75s for housing and work space, and that'll be the challenge. Alexandra has to slow the work on caravel two to a crawl, and she's not happy."

"Thank God caravel one's going well, up on Phobos."

"They're actually ahead of schedule." Will looked around. "I better get up to the office. Anything new?"

"Rostam's checking a slight methane leak on Ceres 1's Hippogryph; he says he can fix it. The *Hadriaca* sent a request for access to the Prospectors on Gradivus and Amigo; they're doing some low-priority exploration as part of their training. We got a hello from Argo 3, also; I replied."

"Copy me; I'd like to send them greetings as well. Okay, I'm going upstairs." Will walked out of Ruhullah's office and headed up the ramp to his rooftop office. He opened his tablet and was surprised to see a videomail had arrived from Patrice Domkowski at Concord Station, Mercury. He pushed play. Patrice had been on Mars a decade earlier; he still looked pretty youthful, although he was in his mid forties.

"Hello Will, this is Patrice. I've been meaning to respond to your congratulatory message, but it has been a busy four months. Concord's finally set up. Our crater is nicely illuminated by our 'picket fence' reflection system and our two habs and matching greenhouses are functioning well. Mercurian regolith is proving fairly rich, once we add nitrogen and phosphorus. I suppose you'll get an order for them, since Mars can supply them more cheaply than Earth can! We've got a dozen Prospector-M200s functioning, mostly in the northern and southern polar regions, but we have moved two of them toward the equator. If they survive the roasting dayspan, we doubt they'll survive the freezing nightspan! It'll be some time before we have equipment that can function reliably in this environment. The next flight will bring Prospectors with RTGs sufficient to keep basic functions operating at night, and at that point we'll probably start clearing a trail between the two poles. Who knows when it'll be safe for people to venture far from the outpost. Our existing equipment can handle polar conditions fine and crews have traveled up to 300 kilometers from here. We can accommodate the heating and solar

radiation problems of polar dayspan, even for crew outside in suits. The night is much safer, but pitch dark! This place will always be much harder to explore than Mars.

"One reason I'm calling is because three of us have volunteered to stay an extra year to keep the outpost operating until Hermes 3 arrives in 2058. Eventually flights will come straight from Earth once a year, so there will usually be two crews here. Mars has been our inspiration for this new model. Hermes 2 will fly six here thanks to expanded use of the Sunfire, which has really proved itself. We hope finances will allow an increase to eight by Hermes 4. Hermes 3 will see the first use of a solar sailing cargo vessel. It appears the United States, China, Russia, Japan, Brazil, India, Pakistan, Korea, Mexico, Canada, Ukraine, and possibly Israel are interested in sending at least one crewmember eventually. If it proves possible to start families here—which should be as easy as on Mars—we may see this place develop into a small colony. We're shielded from solar radiation, after all, and the sun's magnetic field deflects most cosmic radiation, so we have less radiation here than you do. Right now we don't even have married couples here, though; they're all heading to Mars.

"I hope to hear from you some time. Since I'll be staying here for another year and a quarter and will be Commander, I hope we can swap stories and ideas. I could use the advice and encouragement occasionally. Bye."

Will hit reply. "Patrice, good day to you, and congratulations on the decision of three of you to stay. I'm delighted; it's not only technologically difficult to abandon a facility after finishing it, it's psychologically difficult as well! I have no regrets about my decision to stay here with Ethel. Neither of us had any idea we would still be here eighteen years later, with a fourteen year old son and an eleven year old daughter. I hope

someone does start a family on Mercury eventually; it changes the social environment radically and converts visiting residents into passionate advocates and, eventually, some start to feel like citizens. A world deserves nothing less from its human population.

"Remember that Mars can launch to Mercury every 110 days; Earth, every 116 days! Our first cargo flight to Mercury is scheduled to depart in a year and we'll be very interested to see how it goes. Once you have your Portal Station set up at the Mercury-Sun Lagrange 2 point and able to provide emergency service, Mercury may even see some cargo and passenger flybys destined for Mars.

"As you probably know, all is going very well here. Our population of 368—if you include the sixteen flying the caravel *Intrepid* to Earth right now—is scheduled to grow to about 570 next year, so we are scrambling to be ready. A few years ago we could not have imagined that such a rapid population increase would be possible, nor could we have imagined we would be able to be ready for it. We have an asteroid mission about to reach its target and Ceres 0 is doing well in spite of a string of technical glitches; it arrives there next year. In short, we are incredibly hopeful about the future. I hope some of our optimism rubs off on Mercury as well. Bye."

Nandan Rao, Commander of the *Intrepid,* and his partner, Evo Sanchez, were back at work on the caravel after a filling supper. The *Intrepid* had almost 200 rooms, so there were always more walls to set up. The second level up from the outer edge, where the spin made gravity of about a third of a terrestrial gee, had a corridor running all the way around the circle and rooms opening onto it. With the six pressure doors open one could jog all the way around, a run of 95 meters, an impressively long way to run inside a ship.

They were finishing up a bedroom, making sure the walls were smooth and clean, checking out the electrical plugs. Just before they were ready to wrap up the work for the day—they were both exhausted—Nandan walked into the next room, which was still unfinished, and plugged a plastic cutting saw into the wall socket, so they could use it the next day. Putting the saw down he accidentally bumped the trigger and activated the blade, which then hit the power cord lying on the floor.

A burst of sparks flew everywhere from the short circuit. “Whoa!” exclaimed Nandan, surprised, and he jumped away from the saw.

There was a whoosh behind him and he turned to see a fire spreading in the hallway right outside the room’s doorway. A spark had fallen on an area covered with glue, which was curing a bit before Evo could place the inflammable floor tiles. In a flash, Nandan saw the danger.

“Fire!” shouted Evo.

“Evo, I’m trapped!”

Evo dashed into the hall and saw Nandan’s predicament. “Jump through the flames! It’s the only way!”

“They may burn out!”

“No, they’re spreading, the plastic’s beginning to melt!”

Suddenly the alarm sounded throughout the ship. Startled, Nandan bolted for the door and dashed through the curtain of flames, which singed him pretty badly, though his fire-resistant clothing protected him.

“We’ve got to get out!” Nandan exclaimed. “Let’s go!”

Evo nodded and the two men dashed along the corridor to the nearest pressure door, which was just 15 meters away. They leaped through it and shut it.

“Bridge, this is Nandan! We have a fire in sector 3! Close all pressure doors and activate the CO2 flood!”

“Where’s Evo!” exclaimed Susanne Lambert, who was on the bridge at the time.

“Right here with me!”

“Acknowledged. I’m shutting all pressure doors!”

Nandan popped his ears. “Hurry, the pressure’s building fast! You’ll have to depressurize the sector as well!”

“Acknowledged. All staff, evacuate the caravel immediately.” Susanne tried to remain calm and professional, but her voice boomed through the space. They could hear pressure doors closing all around them.

“Let’s go,” said Nandan, and Evo nodded. They headed for an access shaft that had both an elevator platform and an emergency ladder in it. They opened the pressure door by hand and entered the shaft. The walls between it and sector three were hard and stretched because of the increasing air pressure on the other side. They began to climb up toward the axis as fast as they could. Then through the wall they could hear a whooshing sound.

“Is that depressurization?” asked Evo.

“I think so. It’s the fastest way to put out the fire.”

“True.” They climbed up the ladder in the shaft as fast as their arms and legs could safely carry them. At the top, John Hu opened the pressure door to let them into the axis, which was not open to any of the caravel’s six separate sectors.

“What happened? asked John.

“A freak accident. The plastic saw accidentally cut through its electrical cord, showering an area of glue on the floor with sparks.”

“That stuff isn’t flammable!”

“Yes it is!”

Just then Nandan’s communicator beeped with a call from Susanne. “Sector three is depressurizing rapidly, and all staff are accounted for. We’re transmitting everything back to Mars Control. Is anyone injured?”

“Negative.”

“Nandan, your hair is all singed and your arm is burned!” said John.

Nandan looked down and was surprised to see that his arm was badly burned; he hadn’t noticed before.

“Head for the sick bay; Sophie’s already standing by,” said Susanne.

“Negative; I’m on my way to the bridge.”

“We need you. We’re having all sorts of problems. Sector 2’s leaking air into sector 3, so pressure is not dropping as fast as expected. Heating is already distorting the structure so we have to stop the rotation right away.”

“Is there a door open?”

“Yes. . . sector 2/3, level 3.”

“Depressurize both sectors, then.”

“Sector 2 has open water; the toilets are full,” noted Evo.

“Probably better the water boils than spills everywhere when rotation stops,” replied Nandan. “Let’s get up to the bridge.”

The three of them headed across the hub to an airlock leading to the transit hab attached to the caravel. They could hear the depressurization alarms in sectors 2 and 3 through the walls, and as they reached the airlock to the hab, the derotation alarm went off as well. They pulled the door open and floated into the airlock, then crossed into the hab, which was in zero gravity anyway. They headed down the central shaft to the bridge, which was crowded.

"Everyone's out?" he asked.

"You guys were last," replied Susanne. "I think the worst is over. The heat sensors show a decrease in temperature."

"Assuming the bulkhead with sector 1 holds," added Sonya Volkov, sitting at one of the monitors.

"They shouldn't burn through that fast," said Nandan. "Is Houston and Aurorae listening?"

"We're broadcasting everything to them, but they can't help."

"No one can," noted Nandan.

When alarms went off in Mars Control, it was 11:20 p.m. and the shift had just changed. Kent Bytown, now in charge, immediately called Will, who was at home.

"Hello."

"Will, there's a fire on the *Intrepid*."

"How bad?"

"Uncertain; we're getting the live feed of the telemetry. Fire alarms are going off in sector 3."

“I’ll be right up.” Will closed the circuit and headed for the door, even if he was wearing pajamas. He dashed up the spiral ramp to the third floor and entered Mars Control ten seconds after the call ended.

They watched the data stream helplessly; round trip time for communication was seventy-four minutes. Meanwhile, technicians poured into Mars Control as the recall order reached them. The second shift had not yet gone to bed and were able to arrive quickly.

“It appears to be confined pretty well,” said Rostam Khan in a few minutes. “By evacuating air and flooding the sections with carbon dioxide, they stopped the flames pretty fast.”

“How much damage?” asked Will.

“They’ll need a few hours to assess it,” replied Kent. “But we’re getting one frame per ten seconds from every camera on the caravel, and four people are checking the images.”

“The flames were confined to section 3, level 2,” said Zach Hersey. “The smoke spread to levels 3 and 4 and a little to section 2, level 3. Air pressure has dropped to Martian levels, suffocating the fire.”

“How did it start?”

“Nandan says a plastic cutting saw cut an electrical cord, which showered some glue with sparks.”

“That glue is supposed to be flame resistant,” said Will.

“Sounds like a screw-up; maybe by the terrestrial manufacturer of part of the glue,” suggested Kent.

"It's against regulations to be operating electrical equipment in the same room where flammable glues are being used."

"Well, look at this," said Zach. Will walked over and looked over his shoulder at the console. "Here's the saw," noted Zach, pointing. "And here's the burned area. The saw is in the room but the fire was in the hall."

"Why were they working at 11 p.m.?" asked Kent.

"Those guys work about thirteen hours a sol," replied Will. "That's why they're ahead of schedule."

"I think they'll be working less now," commented Zach.

"That's for sure." Will looked at Ruhullah. "Call a head of staff meeting, Earth and Mars. I don't know when we'll start, but I want us all linked together as soon as possible."

"This will have implications."

"Exactly."

It was an exhausting and exasperating night. The time delay to the caravel and to Earth produced tediously slow, repetitious, disjointed discussions. Louisa Turner released news to the media as often as she could to keep them informed, because millions were fascinated and worried. Will finally held a press conference at 11 a.m. Aurorae time to straighten out misconceptions and encourage the discouraged. Then, before going to bed, he turned to the accumulation of messages. One was from Patrice Dumkowski.

"Will, all of us here at Concord have been following the situation on the *Intrepid* closely. I still think back on our last conversation a few days ago and how it was brim-full

with optimism for the future. This is a good time to remember that optimism. One accident won't change the situation radically, except for cynics and nay-sayers. I say, keep on course. That's what we plan to do here. We're about to launch a manned expedition to a volcanic complex 500 kilometers from here; the farthest we've traveled yet. I'm sure Mars will continue its plans as well. Bye."

Will was touched by the comments and immediately hit reply. "Thanks, Patrice. You're quite right, and you've made my sol by saying so. We don't see any reason to change our plans. The *Intrepid* is intact, except for a month of repairs to sector 3. This was a freak accident. At first we thought there was a violation of safety procedures, but there wasn't. But the glue is definitely defective; it appears the batch of ingredients from Earth did not include one flame-retardant chemical. Sounds like we'll be suing. The crew on board gets several sols off to rest and get a good night's sleep several nights in a row. One problem was fatigue; they were driving themselves too hard. The worst case scenario is that we'll fly the *Intrepid* back to Mars without anyone living in sector 3. That'll reduce its capacity from 100 to about 88 people, which we could live with. I doubt that'll prove necessary because the fire was stopped before the damage was serious. We need to rethink our safety procedures and our procedures for completing major construction work during interplanetary transit when medical care is limited. But in principle, the problems can be solved. Bye."

11

Dilemmas

Sept. 2054

Nandan Rao paused in his videomail and held up his right arm. “Mr. Commissioner, I think I’m in better shape than you are right now. As you can see, the burns are pretty much healed, and the doctors here in Houston are pleased. It’s not clear to me that I had to miss a month of construction work. But the fire damage is repaired. The fire suppression system worked, though it would not have been quick enough if the fire had happened at 3 a.m. in a section filled with sleeping passengers. If we don’t fight a fire like that fast, it could do serious structural damage to the ship. So the safety committee needs to look into that problem carefully.

“The *Intrepid* should be able to depart for Mars on time. A reduction in passengers may be wise; we need to consider seriously scenarios where we have to accommodate damage to two of the caravel’s six sections rather than just one. But the safety committee must make that recommendation. Bye.”

Will hit reply. “Thanks for the report, Nandan. Perhaps, when I videomailed you a half hour ago asking for a report, I should have offered an explanation: I just had a cataract operation yestersol, so I’ll be wearing this eye patch another sol. I’m fine and have no intention of looking like a Halloween character forever.

“I’m glad to see your arm has healed. Congratulations to you and your team for such a steady recovery from the accident. Accidents will happen. Our decision to send a fully certified flight surgeon with a well-equipped sick bay on the mission has been fully

justified. Frankly, this accident is the strongest argument yet that missions to the asteroid belt and beyond have to be large enough to provide complex medical care. The Venus-Mercury Commission has been reviewing their staffing levels at both planets as a result.

"We can afford to reduce the caravel's passenger manifest ten or twenty percent if necessary; both United Spacelines and Lufthansa Space Express are flying passengers and cargo here, and their plans are remarkably sophisticated. So you and your team should not feel discouraged or guilty in any way. The work has been of excellent quality and the freak accident has given all of us an opportunity to learn. We're looking forward to seeing many of you back here in less than a year. Bye."

Will pushed a button and sent the message. He noticed that meanwhile, a message had arrived from Pete Theodoulos, a Mars resident during Columbus 5 who was now the Commission's director of Project Columbus. He had promised a report as well. Will played it.

"Good sol, Will. I'm rather ticked off today, so excuse me if I am 'too' frank. Gateway Station, here on the gravitational watershed between the Earth and the moon, has become chaotic and may be an accident waiting to happen. There are too many terminals there, even if they are a minimum of ten kilometers apart. I had to call Roy Davison of United Spacelines earlier today because our terminal and the Sunfires docked to it are being shaded by the huge mirrors of their Sunfires. Roy apologized and said he'd get the Sunfires moved, but he was mad because he had informed the Lunar Commission of the problem and they hadn't said anything about it. Someone has to be in charge; either

the Mars Commission or the Lunar Commission, or maybe a jointly organized ‘Gateway Commission.’

“Roy also told me that they were flying another twenty tonnes of cargo to Mars for the Green Earth Community; that’s the fifth cargo vehicle they’re sending. It’ll be a lunar lifter, too, so he asked for a quotation for landing the cargo, since the lifter can’t do that. I reminded him that he needed to email Érico Lopes about that, and he wasn’t happy; he prefers to be able to conduct a face-to-face negotiation. I gather Érico feels we should use the maximal accounting figure for landing costs. I disagree. It’d be better to keep it low, like the costs we’re aiming for if we fly Martian goods to low Earth orbit and compete with the Swift Shuttle. Remember, United Spacelines is considering competing with us in the Mars-to-low-Mars-orbit market. They can’t right now, but eventually they could go to court to force the market open under reasonable rules of competition. Érico has to anticipate that.

“But here’s what really has me ticked off. I got a call from Klaus Herron at Lufthansa this morning expressing to me his concerns about the upcoming shadowing of his terminal—as if there were something I could do!—and he then mentioned that they plan to fly three inflatables to Mars, one to serve as an axis and zero-gravity gym—and as backup accommodation—and two as rotated modules with gravity. I asked him about their pricing and he said they figure they can sell tickets for six million, and apparently that includes two million for margin and profit. I ran some quick calculations and figured that no matter what cost-cutting measures we implement, the cheapest we could fly passengers to Mars is 5.5 million redbacks each. So Lufthansa’s really squeezing costs somehow. I think we have to request a full safety audit. It strikes me as grossly unfair

competition. I admit, if we ask for a safety review, we'll generate terrible anger and resentment at Lufthansa; they'll think we're playing hardball and may retaliate in some other way.

"That's it. Bye."

Will stared at the screen, uncertain who to be angry with. Certainly not Pete; he was in the dark about a lot of things. He hit reply. "Thanks, Pete, and good sol. We received a full report from Lufthansa last month about their flight plans; didn't someone copy you? I bet they didn't. Pierre Messier got it and he copied it to me, Érico, and a few others. Call him and get it. Lufthansa's planning to fly two Lyra-class shuttles accommodating twenty-four passengers each. They figure they can squeeze in twice as many as on a three day flight to the moon because the lunar flights are geared to millionaire tourists. The inflatable transit habs will be tight, too; forty cubic meters of volume per passenger, less than half of standard! It'll be very crowded. When Pierre expressed surprise he was told the accommodation would be better than on nineteenth century transoceanic passenger sailing vessels! Lufthansa also sent a cost breakdown that showed how they planned to achieve four million redbacks of costs per passenger. We're skeptical. They'll do better than us mostly because they're doubling the passenger density and because the Lyra vehicles fly so many more times on the low earth orbit to lunar surface runs, they're already paid for. We do not plan to raise our density; if anything, the fire on the caravel will necessitate lowering it. Besides, with United flying twenty-four here and Lufthansa forty-eight, Mars appears set to receive over 250 people! Even with all the cargo coming, and three more gryphons, we have our doubts we can comfortably accommodate all these folks. We're beginning to tear our hair out; construction of the

caravel *Courageous* has been stretched out even more so we can get at least one more agricultural biome going in time. We may have people camping in tents!

"But you have raised another issue that must be dealt with: this rapid expansion in transportation necessitates that we appoint a Director for Transportation. It used to be the Director of Columbus was in charge of what came here on the Gryphons and hippogryph cargo vehicles. Moon transportation slowed down to accommodate us during that time. But that arrangement doesn't work with this greater scale of operation and with the continuous tourist flights to the moon. Too many different tasks are being done and too little information is flowing. You and Érico can't coordinate the orbital refueling and landing anymore, either; there are three entities shipping things to Mars, often just to Mars orbit because they're adapting lunar vehicles for the task, and potentially three that will want us to launch exports to their orbiting cargo vehicles during a short launch window back to Earth. It's crazy. We'll have to meet tomorrow and straighten that out; I'll ask my secretary to schedule the meeting.

"Call me back with any comments. Bye."

Will sent the message, then copied it to Érico with comments about the problem of coordination; copied it to Pierre with an admonition to get the Lufthansa report to Pete; and copied it to his secretary in Houston with a request to plan the meeting and invite the attendees, which he listed. He had to figure out how to resolve some difficult issues of territoriality and to overcome Pierre's distrust for Pete, who was at least as ambitious, younger, and a dual citizen of Canada and Europe. Then he turned to message number three, from the Director of Personnel, Jane Cairncross.

"Will, I can't communicate adequately with Tariq Omar, coordinator of the Wahhabi group. They are insisting that only the men can work outside the home and that the women, if they work at all, will have to be either at home or in an all-women's environment. As you can imagine, it is rather difficult for a woman to argue against this; he keeps insisting to talk to my boss, and when I say that's you, he gets upset and stubborn. I'd favor giving them an ultimatum and dropping them from Columbus 10 entirely. Their position, in my opinion, is utterly unreasonable, besides being medieval, barbarous, misogynist . . . oh, and did I say I don't agree with them? Advise, please. Bye."

Will collected his thoughts, then replied, copying Hosni Hijazi, their local Saudi geologist and Arab hero as well. "Good sol, Jane. Our position is clear: everyone here works unless they have medical or maternity leave. Of course, if they want to go off and found their own community in the wilderness, they can do anything they want, but even then they'll have to figure out how to cover their costs and fill their needs, and everything here is ridiculously expensive. We have the same issue with the Mormons.

"Call him back and lay down the law. Tell them they don't have to come to Mars if they don't feel it's religiously appropriate. Tell him there is no one to appeal to. I'll leave the communication to you. But I will ask Husni to give Dr. Omar a courtesy call in a few sols, since they know each other. Husni will reinforce your message. Bye."

He sighed at that problem. He would prefer that the Wahhabis not come. They didn't want to speak to him at all as a Bahá'í "apostate" even though he had never been a Muslim; they wanted to keep their women completely separate and cloistered; and they tended to push their religion too much. Their presence would generate ill feelings.

Then the videophone icon beeped; it was Érico. “Will, Pierre was supposed to copy that Lufthansa memo to Pete. And this is the first time I’ve heard of United’s fifth Hippogryph. Maybe Pete should start copying memos and messages as well!”

“Really?” Will shook his head.

“This makes a very bad situation worse. We’ll be refueling vehicles, overseeing their landing, unloading cargo, and refueling vehicles for launch back to Earth for six months. A lot of folks will have to wait a long time for their stuff. And that’s assuming we have no disasters.”

“The situation has gone beyond ridiculous; it’s become dangerous. I’m calling a meeting for tomorrow so we can coordinate the upcoming opposition better. I thought we had worked out the lines of authority and communication very clearly, but I guess not.”

“No, things are broken.”

“We need a Director of Space Transportation.”

Érico raised an eyebrow. “The trick will be avoiding a revolt, or making personality clashes worse!”

“I know, but the alternative could be loss of a vehicle.”

“That’s true.” Érico pondered the situation. “We’re running into difficult import problems. Alexandra was telling me yestersol that production of nomex and kevlar is inadequate to make enough B-160s to feed everyone, and if they switch to B-75s they can produce enough plastics to fabricate the domes but they won’t have enough manpower to set them up! So it sounds like Bioarchive will get squeezed yet again. The hospital has increased its orders of basic supplies to maintain minimum per capita quantities.

Everyone around the planet is increasing their orders about twenty-five percent to accommodate the larger population."

"I know. Like you said, we'll be deorbiting cargo for six or seven months. We'll have to plan the landing schedule carefully; surplus supplies for the second half of the columbiad can be landed last."

"But a lot of supplies were lifted to orbit months ago and weren't packaged that way. We may have to maintain a crew at Embarcadero full time for a year to repackage supplies. The new communities keep raising their imports, too. The Green Earth Community just scheduled an entire second Hippogryph for their supplies, though they've resold some of the space to the Zen Monastery, with whom they're working closely. Part of the problem is that United Spaceways lowered their per-kilogram price for cargo, and that generated more demand. But that increases our work here!"

"I know. Silvio told me when he saw United's prices, he ordered two more tonnes of stuff for the store. I was disappointed; he had always been flying cargo with us."

"I can't blame him. United's got a lot of spare cargo capacity with all its tourist flights to the moon, and they decided to launch four to six months earlier than everyone else and fly everything on a long trajectory that comes back past the moon and earth for a double gravity assist. That slashes propulsion costs. We've got to adopt that trick next columbiad."

"Write up a report for the meeting tomorrow. I want figures, details, and recommendations."

"Alright, I can do that."

"Good, thanks. Bye."

"Bye."

Everyone's schedule accommodated a meeting best in the early afternoon, Aurorae time. After lunch, Will walked the kids back to school and then headed for his office. He was about to walk to the conference room when the videophone rang. It was Arieh Feldman, the hospital's oncologist and chief surgeon. His heart sank; Ethel had just headed to the hospital for a mammogram.

"Good sol, Will," he said. "Can you come over? Ethel has some decisions to make."

"Oh? I have a meeting, but I suppose I can cancel it."

"I'd advise it. They're doing a scan now to collect additional data, and I suspect we'll want to run a biopsy later this afternoon."

"I'll be right there." Will closed the circuit and jumped out of his chair. The c-word: cancer. No one wanted to hear that. He grabbed his tablet so that he could call Ruhullah while hurrying over. The meeting would have to wait a sol.

He reached Mariner Hospital, located in Catalina's North Building, in a minute, and headed downstairs to the testing area. Ethel was just coming out of the scanning room. Arieh Feldman and Eve Gilmartin were in the next room looking at the detailed microscopic images the new technology created.

"That doesn't look good," Arieh said to Eve, who nodded.

"At least it's extremely small."

"True." Arieh looked at Ethel. "You should have a biopsy, and there's no medical reason to wait. We can extract cells by aspiration; you know, with a needle."

"Is it cancer?" she hesitated to say it.

"We don't know yet. But it looks like ductal carcinoma *in situ*. The most common type of breast cancer starts in breast ducts; if it's 'in situ' that means it hasn't spread yet, which is good. We can pull out some cells and take a look at them tonight. We'll send the images to the medical support facility in New Delhi and they'll check our diagnosis. If it's DCIS, we'll biopsy the whole thing and remove the sentinel lymph nodes to make sure it hasn't spread; in popular language, a lumpectomy."

"When?" asked Ethel.

"Two sols."

"That's what Lisa had last year, right?" asked Will.

"And what I had three years ago," added Eve. "Statistically, it appears that one fifth of the women here will get breast cancer."

"And on Earth?" asked Will.

"One seventh," replied Arieh. "The incidence here is forty percent higher but so far there have been no fatalities because we catch it earlier. Even our use of chemotherapy is less."

"How much more cancer are we getting?" asked Ethel.

Arieh hesitated. "It's hard to say; not everyone has been here the same length of time, and our population is too small for drawing statistically significant conclusions for many medical conditions. Breast and lung cancers are definitely more common and colon cancer appears to be more common. I'd guess we're getting twenty or thirty percent more cancer for a population aged 25 to 50. We don't have enough people older than 50 to draw statistically significant conclusions, but the computer models based on the younger

population are not encouraging. At least it appears we have lower cardiovascular disease; everyone exercises and watches their weight pretty well."

"This isn't the time for a cancer analysis, though," exclaimed Eve. "Shall we do the biopsy?"

Ethel looked at Will, then nodded. "Yes, let's pin this down."

"Alright," said Eve.

The physicians left in order to prepare. Will put his hand on her shoulder. "How are you doing?"

She shrugged. "A little angry and a little scared."

"This sounds like something they can handle."

She took in a breath. "Yes, it does. We're quite a pair, aren't we, me with a bad boob and you with your eye patch!"

He laughed. "Yes, I guess we are. I suppose I can't complain any more about my body falling apart."

"No, that's my line, now. We did this to ourselves. Both conditions were probably caused by radiation."

"Yes. I guess I had better buy you one of those big, ridiculous-looking women's hats with feathers and fake flowers covering ten kilograms of hydrogen-rich polyethylene. And a big, oversized radiation vest with huge shoulder and chest pads that'll make you look like one of those huge Wagnerian valkyries."

"Or a football player. Make sure the hat has one of those wide brims that turns up and hides four centimeters of polyethylene over the eyes. I don't want cataract surgery."

"You should have bought me one of those radiation-protecting fedoras. They actually look pretty good."

"Well, let's hope we influence fashion on Earth, so people here won't feel silly wearing these things," exclaimed Ethel.

The biopsy was complete before suppertime. Ethel went straight home; she had no appetite. The next sol the results were complete: it was DCIS. The surgical team prepared, Ethel went to work to plan the carbonyl separation team for a week without her, and Will held the major meeting of selected staff to review the Columbus 10 plans.

The next sol Ethel was at the hospital from 7 a.m. to 6 p.m. for the ninety-minute operation, then home and sleeping. The sol after Will went back to the office to finish the major meeting. He brought them both lunch.

"Where are the kids?" asked Ethel, surprised he hadn't brought them as well.

"Marshall's eating with Rahula and his friends, much to his delight, and Lizzie's with Carmen and Corazon. How are you?"

"Feeling kind of hungry! Did you get the soup?"

"Yes, and it's delicious, so I got some for me as well." He sat on the couch next to her, spread out their meals, then gave her a kiss. "Pain?"

"No, not bad; I took the pills." She sipped some. "Yes, this is perfect."

"Did you get some rest, or watch t.v.?"

"Not much of either. Eve stopped by to check in on me, change the bandage—it was fine—and give me the results of the pathology tests so far. They need another sol or

two for some of them. They think they did get it all and the lymph nodes are indeed negative. With radiation treatments, the recurrence rate is pretty low."

"How low?"

"On Earth, three percent. Here it might be five. I commented that radiation 'treatment' had gotten me this far and wondered whether radiation was what I need, and she replied that everyone on Mars says that. Then she left and Martha stopped by to make sure I was doing okay. She invited me to the cancer survivors group; I was only vaguely aware we had one until this sol! Then Father Greg stopped by to make sure I was doing okay and assured me his pastoral care was universal, not catholic in the narrow sense. We had a good laugh and he made his own cup of tea. Then there were the calls, most of which I didn't answer. I listened to the messages later."

"Everyone's concerned."

"How was your meeting?"

Will shrugged. "I think we worked through the issues, personal and otherwise. Pete Theodoulos will be in charge of 'Cisterrestrial Operations' and Érico Lopes of 'Cismartian Operations,' with Pete as overall Director of Transportation. If something flies from here to Earth, Érico has to get it to Embarcadero and Pete has to get it from there to Earth. If something flies from here to Venus, Érico's in charge and Pete has to know what's happening. If Yevgeny wants to export something to Earth, he has to talk to both of them in order to get it from here to there."

"What does Érico feel about that?"

"He's hurt; he has the seniority. But people on Earth can't talk to him live, and that's the big problem. They can talk to Pete, so Pete's overall coordinator."

“Érico will get over it.”

“Let’s hope so. There’s another interesting bit of news this sol. Brian Stark called just before I came over here to tell me that at New Hanford they just created their first reactor-grade uranium this sol.”

“Oh? Good news, I guess.”

“Exactly. It will be greeted ambiguously. Overall, I think we’ll see that it was good.”

“I hope we can say the same about the entire last week!” added Ethel.

12.

One World

Nov. 2054

Ruhullah Islami hurried up the stairs to Will's rooftop office. He walked down the path between overhanging walls of tomato plants and knocked on Will's door.

"Ruhullah, good sol. Come in."

"Thanks. Good sol to you as well." He stopped to smell his hands. "My hands brushed against tomato plants all the way here from the stairwell, and now they smell of tomatoes!"

"I know; mine do, also."

"Will, we need to move you downstairs. It's becoming inconvenient for everyone to go up the stairs. Besides, Columbus 10's bringing a real secretary-receptionist."

"I know, but I love my view of the escarpment." He pointed out the door at the northern escarpment visible in front of him.

"Look, we're buying the apartment next to Mars Control in order to expand it. It's on the third floor and has an eastward-facing window. You should be able to see the escarpment from there. If necessary, we can lower the concrete wall outside the dome a few meters."

"That might work. But you didn't come up here to urge me to move the office downstairs."

"No. I have a replacement group for the Wahhabis, if they're not coming. Do we know, yet?"

“Hutan talked to them yestersol and they said they want to wait another columbiad and come here in 2057. They’ll save face by postponing instead of canceling and we’ll avoid criticism for being un-Islamic.”

“Good. Because I got a call from Hamid Khuyi yestersol. He’s the owner of a big Iranian software firm; a billionaire. He was concerned the Wahhabis would become the representative Muslim group on Mars and wants to sponsor the immigration of a dozen Iranian Shi’ites instead.”

“Interesting. Of course, if he hears the Wahhabis aren’t coming, maybe he won’t be so worried about their plans.”

“Oh, on the contrary! He’ll be delighted to know his group was first and they were second! In fact, the Wahhabis might change their mind when they hear!”

“I see. Then I’ll check with Hutan right now. If they aren’t coming, call Khuyi and offer the slots to him. At this late date, that may be our last chance to fill the seats.”

“No one else plans to come?”

“We’ve got 196 slots rather than 96! We’re beating the bushes to fill them.”

“And struggling to supply their needs, too; I know about that.” Ruhullah nodded.

Will called Hutan and confirmed that the Wahhabis had postponed. So he nodded to Ruhullah. “Call Khuyi. That’s only ten slots, though, not a dozen.”

“I’ll tell him. Thanks. I think you’ll prefer the Shi’ites; the women are well educated, work hard, and they can do almost anything, so long as they cover their hair.”

“And don’t shake hands with strange men.”

“No, a lot of them will shake hands with you; wait and see.”

“Good. Fewer problems with social cohesion.”

Ruhullah chuckled. “I didn’t say that!” He turned and left.

Will wrote a few more emails and read several brief reports sent to him. Then his tablet beeped and spoke. “You have an appointment with Silvio at 10:45 a.m.”

“Thanks, Anisa. Is Silvio coming here?”

“No, you’re meeting him at the store.”

“Thanks.” Will folded up the tablet and clicked it onto his belt, then headed through the jungle of tomato plants, down the stairs, and through an airlock into Yalta Biome. Will didn’t see Silvio at first, so he hunted around until he walked through an open door in the basement and into a large empty space.

“Your new store space?”

“Yes; I finally have the entire basement of the building and half of the first floor. I’m trying to buy out the other condo. Once Columbus 10 arrives, I’ll probably need it all. Pretty soon I’ll have to buy the top floor, too, and it’ll still be too small.”

“Yalta’s not big enough to serve as our commercial center much longer.”

“It can handle the commercial needs of maybe a thousand people, but not the cafeteria needs as well,” said Silvio. “We’ll have to plan a move pretty soon. How can I help you this sol, Will?”

“We have a 10:45 appointment.”

“We do? Oh, God, that’s right! Come back to my office.” Silvio turned and led Will out of the basement and to his tiny office behind the current store. His judge’s robe hung in a corner; a book case of imported legal books covered a wall; his desk was draped with electronic paper, each of which displayed vital or once-vital information. Silvio sat behind his desk and cleared some sheets off a seat for Will.

"Now I know where all our electronic paper has gone."

"Yeah, I loved to have information stored on paper in front of me. It's the best way for me to think about things." He grabbed two sheets and spread them out before Will. He pushed on an icon in the upper right corner with a magnetic stylus and called up a page on each. "Here are the new designs for redback bills; the one, five, ten, twenty, fifty, one hundred, one thousand, and ten thousand."

"Wow, these look professional."

"They are; as good as any national currency. They don't look amateurish, like our current bills. Click on each one to make it larger, on this icon to turn them all over, and on this one to 'shine a light through them' and see the water marks."

Will nodded and examined each one closely, obverse and reverse. "These are great; I certainly approve! This view of Face Rock is well done. I hope the Spirit of Mars statue looks as good as it does on the $100!"

"I'm sure it will. The special inks are already on their way; some are iridescent. We're importing enough special paper to print ten million redbacks. But I want to approach the Mars Council about printing ten million redbacks *on Earth,* to circulate there."

"Why? The redback is a purely local currency, not a national currency. It's only convertible through your bank here. You've already proposed various speculative schemes, Silvio, and they've been voted down."

"I know. But you've heard the anecdotes about would-be settlers returning to Earth with a few hundred redbacks as souvenirs and selling them for several times their face value. Redbacks are a potential income source. It costs a few hundred thousand to

print them and we'd have to 'back' them with only a few hundred thousand because almost no one will try to redeem them."

"Assuming you can really sell that many. A redback's worth twenty new dollars and ten euros. A lot of people won't want to trade a piece of paper with a '20' on it for a piece of paper with a '1' on it."

"A redback's worth about the same as dollar in 2000, though, and people know their 2054 dollars aren't worth as much. They can adjust to that."

"Perhaps. Silvio, everyone's going to ask whether this is a slippery slope. I know you've been pressured to try all sorts of investment schemes—"

"Will, most aren't 'schemes.' Manhattan International Bank—the terrestrial bank we're affiliated with—has advocated several of them, like redback accounts. Whether the redback is an official currency or not, it has a predictable value based on a basket of currencies and the value of gold. Investing in redbacks is like investing in gold, diamonds, land, pork belly futures, or whatever; it's an existing commodity. We'll make money on a legitimate investment, and that'll help Mars grow."

Will shook his head. "Perhaps, but any investment carries risk. I wouldn't want billions of redbacks to be created on Earth, have their value crash, and we'd have to divert an entire columbiad of gold production to covering debt instead of importing settlers and supplies. That can happen."

"I concede all investments are risky, but with proper management, some investments are worthwhile."

Will looked at Silvio. "I'm not a financial analyst, but I am open to professional advice. Get a plan together that is articulately and thoroughly explained, and is a very low

risk—because we are in the business of Mars, not in the business of making money for its own sake—and I'll support it."

"Okay, a conservative strategy; fair enough."

They chatted a few more minutes about the outpost, then Will said goodbye and headed to the patio for lunch. Ethel was already there; the kids were eating together as a class, so they had some peace and quiet.

"Redbacks on Earth," said Ethel, after Will explained the idea to her. "Watch out; you're creating patriotism."

"True, but it's been emerging for years. How did the doctor's visit go?"

"It was routine. No evidence of a return of the carcinoma."

"That's a relief." Will downed his tea. "I hate to eat and run, but I've got a string of meetings this afternoon."

"Tiring ones?"

"The usual on-again, off-again videoconferences with people on Earth, with things to read in between."

"Good luck. I've got to get the carbonyl fractionator running again. The separator is working again. I think it'll go two weeks before breaking this time."

"That's progress. So, you'll be recovering platinum and iridium by 2 p.m. and throwing away even more nickel-steel. See you tonight." Will kissed her, then headed to his office in Riviera. When he arrived there, he saw that Charles Kern, the NASA Administrator, had called. He activated the video message.

"Good sol, Will. I've heard that the Chinese have approached the Commission to purchase a caravel for deep space exploration. Frankly, the news startled me. I admit that

no one has an exclusive agreement to purchase caravel technology, but I'd worry whether some of the technology incorporated into the caravel might be classified.

"Also, our lawyers were reading over the new law for incorporating boroughs and were surprised such an arrangement was never offered to us when we requested an American station at the Martian South Pole. The new procedure would allow us to set up a base and apply for borough status. We've got a team on Mars already and another eight folks scheduled to leave in a few months on Columbus 10. Why can't they simply apply for borough status? Bye."

Will stared at the screen, irritated by two provocative questions and the assumptions behind them. Kern constantly pushed for everything he could get. He tended to regard the Mars Commission as a largely American operation because NASA had founded it and because Will was an American citizen. But NASA dominance of the Commission had ended years earlier.

Will listened to the message again, taking a few notes. Then he said "Anisa, take a response" and paused for the green light on the tablet to come on. "Good evening, Dr. Kern. Thanks for the message. There's really not much to say about the Chinese. Obviously, I would not be in the position to divulge the contents of any negotiations if there were any. As you noted, caravels can be sold to anyone. We've documented the origin of all the technology we're using; none is classified. That's why we were able to build our first caravel in three years. If the U.S. wants us to incorporate their own proprietary technology into one, it may add it after purchase, or license us to do so. It would be the same for any other nation. Everyone knows the Chinese are aiming to send a spacecraft to Jupiter by 2063 or 2065. Caravels are one option to get there.

"As for a U.S. polar station, two years ago we didn't have the legal framework for boroughs we just created. We'll soon have many private groups here; they can start their own boroughs. The U.S. can as well. A borough, however, is not the same thing as a national station. It elects representatives to the Mars Council; it has local authority over its land only; it is still subject to the Commission. Read the framework carefully and you'll see that. But with those limitations in mind, a NASA-run polar station could apply for borough status, if that's what NASA wants. Note the Council approves such petitions, not the Commission.

"It's good to talk to you. Bye."

He sent the message with some regret. The Chinese would hear about the arrangement and want a borough as well; maybe other nations also. They would still be subject to Commission oversight, but that could get eroded. It made him worry about the unity of Mars as a society and polity.

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)

Feb. 1, 2052: Marshall's twelfth birthday

Feb. 25, 2052: Earth to Venus; June 2, 2052: Venus to Mercury; 18 Aug. 2052: arrive Mercury

Mar. 29, 2052: Autumnal Equinox

May 15, 2052: Dust storm season begins

Columbus 8 heads home: 28 May 2052

Columbus 9 heads to Mars: 4 October 2052

Oct. 2, 2052: Dust storm season ends

Opposition: 28 Oct. 2052 (cargo: Earth 23 Aug. 52 to Mars 23 Apr. 53; Solis: Earth 24 Sept. 52 Mars 21 Feb. 53 [150 days]; Hellas: Earth 23 Aug. 52 to Mars 4 Apr 53 [with an asteroid visit])

Mars 1-2-2053 223d Venus 8-13-53 166 Earth 1-26-54 6.24 389d

Feb. 1, 2053: Marshall's 13th birthday

February 1, 2053: Vernal Equinox

Apr. 5, 2053: Mars to Mercury, arr. Sept. 25; depart Mercury Sept. 13, arr. Earth Dec. 27 2053

July 16, 2053: Mars to Mercury, arr. Jan. 4, 2054; depart Mercury Jan. 7, arr. Earth Apr. 22, 2054

Oct. 26, 2053: Mars to Mercury, arr. Apr. 14, 2054; depart Mercury, May 2, arr. Earth Aug. 16, 2054

Nov. 1, 2053 Earth to Venus 4.5 km/s 76d Venus Jan. 16, 2054 Mercury 14 Mar. 2054 57d 7.6 km/s 133d total [Oct. 1, 2053: Earth to Venus; Jan. 1, 2054: Venus to Mercury; 16 Mar. 2054: arrive Mercury] [15 July 2039: Venus/Mercury launch; 23 Dec. 2039: Venus arrival/flyby; 8 Mar. 2040: Mercury arrival]

Oct. 16, 2053: Conjunction

Earth 2053-11-9 138d Venus 2054-3-27 135d Mars 2054-8-9 7.91 273d

Feb. 16, 2054: Autumnal equinox

Apr. 3, 2054: Dust Storm Season begins

June 29, 2054: Hohmann cargo launch to Ceres / Sept. 15 2038: Ceres cargo launch (nominal)

Aug. 21, 2054: Dust storm season ends

Mars 11-4-2054 248d Venus 7-10-55 95d Earth 10-13-55 5.78 343d

17 Dec. 2054: opposition

19 Dec. 2054: Vernal Equinox

Jan. 1, 2055: Mercury to Earth 8.8 km/s 125d arr. 6 May 2055

January 29, 2055: Ceres/Mars opposition (cargo arrives Jan. 2056) [1 Mar. 2041: Ceres cargo arrival]

Earth 2055-9-10 158d Venus 2056-2-15 106d Mars 2056-5-31 10.3 (5.04 Mars) 264d (leave Earth 2055-9-15, swingby Venus 2056-2-20, arr. Mars 2056-7-5, arr. Delta-v 3.4, total delta-v 8.84)

Earth Dec 25 2056 Venus 92d 4.29 km/s Mar 27 2057; 50d Mercury May 16 2056 5.1 km/s

July 14, 2058: Earth to Venus, 4.95 km/s, 96d; Oct. 18, 2058: arrive Venus; 19 Dec. 2058: arrive Mercury, 62d, 5.6 km/s

1. Pax 2
Hermes 0, the unmanned precursor to human exploration of Mercury, lands at the Mercurian north polar region and begins to set up a base. Will, Ethel, Alexandra, and Yevgeny and children watch, marvel at the technology, and speculate about the future. Will receives a call from Brian Stark.

2. Balancing Act 10
Will visits Liz's ballet class, talks to Ethel about the plans for PGM production, and discusses the recent American presidential and congressional elections, which have swept the Republicans from power.

3. The Solis 16
The *Solis* complex and the *Ma'adim* Hermes-class shuttle arrive, including the Peres family. Marshall and Rahula talk; Marshall looks up to the older teenager. At the welcoming dinner, Rosa and Neal Stroger talks to Brian Stark about nuclear plans. Will makes his vision speech.
DATE: 17 Feb. 2053

4. Beginnings 38
Will learns he needs a cataract operation. They discuss health, cancer, kids in conestogas. Then he meets Nigel Stanfield, head of polar operations. They discuss ice on Mercury and Callisto. Brian and Lisa stop by; Brian wants a B-160 low pressure biome for the nuclear facility. Site selection is almost complete. Clara announces she is pregnant but is going to Cassini and the North Pole anyway.
DATE: 8 April 2053

5. Settlers 51
The Hippogryphs begin to arrive. Sebastian Langlais tells Will he plans to come back to Mars. Will forwards the message to Dave Wright, who told him about a message from the Green Earth Community. A week later, with more information, they debate whether to let the community come to Mars, and the effect it might have on the place.
DATE: 25 April 2053

6. Keeping up with the Joneses 63
The Patio buzzes with debate about the Green Earth community. Mormons, Wahhabis, and Zen monks decide to come as well, then a small African sect. Companies call and offer to privatize spaceflight and construction. The legal experts agree Mars can't be closed arbitrarily from immigration. Marshall and Rahula discuss the paucity of children on Mars and the possibility of more arriving. Will tours the first caravel; he and Alexandra hit on a plan to send it to Earth in time for Columbus 10, doubling the size of the immigration wave.
DATE: 10 May 2053

7. Elections 74

Town meeting is held where the Commission's plans are attacked, but ultimately are supported by the Martian public. At the north pole Jen Tan and Nigel Stanfield argue; Clara decides to ask for help.
DATE: early June 2053

8. New Directions 90
Brian and Nigel commiserate about politics. At the welcoming dinner, Will learns Project Odyssey is redirected away from the asteroid belt. He greets Johnny and Emily and their crews. Clara has her baby. Will suspends Nigel Stanfield until he improves his management style.
DATE: Early November 2053

9. Hermes 1 105
Hermes 1 lands people on Mercury; Will congratulates them and refers to the future Mercurian "civilization"; NASA agrees to pay for a quarter of Ceres 0.
DATE: June 2054

10. Fire and Ice 115
Fire on the caravel en route to Earth. Ceres 0 is on its way.
DATE: July 2054

11. Dilemmas 128
Will has a cataract operation. Ethel has breast cancer operation. Nandan's recovering. Wahhabis want to support their families on one income and Will says no. He has to get Hijazi involved in negotiations. Two commercial companies have agreed to offer flights to Mars; the Director of Project Columbus wants them banned as competition.
DATE: Sept. 2054

12. One World 141-48
Wahhabis withdraw for now; Shiites come instead; US wants to set up its own polar station; Chinese will want the same as well; Silvio recommends selling Martian currency on Earth; the impact is debated.
DATE: Nov. 2054

Finished Mar. 28, 2004, 1:12 a.m.; chapter 9 added April 8-9, 2004. Rewrite began Jan. 2, 2009 and finished Jan. 12, 2009. Add three new chapters to flesh out a still skimpy volume. Reread and edited lightly, May 6-8, 2012.