THE MARS FRONTIER

Vol. 13

Outward Expansion

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Giovanni Piazzi

December 20, 2045

Its appearance could best be described as a flying saucer. The disk of kevlar and other superstrong plastics was thirty-two meters in diameter, with a sharply curved bottom and a flattish top. As the vehicle, of a type called a caravel, entered the outermost wisps of Martian atmosphere, the heat shield on the curved bottom began to glow. Plumes of ionized air began to stream past the vehicle. On its flattish top, the fuel tanks and the docking area were in the heat shield's shadow and were undisturbed by the plasma mere meters away.

The *Giovanni Piazzi* was returning to Mars after four years of exploration of the asteroid belt. On board were twenty-four crew, two children, and several tonnes of samples from four asteroids: Astrea, Ceres, Hebe, and Flora. The passage through the Martian atmosphere lasted only a few minutes, sufficient to rub off several kilometers per second of velocity and capture the *Piazzi* into an orbit around Dusty Red. Twenty-four hours later, the *Piazzi* completed a rendezvous with Embarcadero Station, Mars's interplanetary transit facility, a collection of modules in an elliptical 400 kilometer by 33,740 kilometer, 24.6-hour orbit. Waiting were two Hermes-class shuttles. The crew transferred themselves, their luggage, and their samples to the shuttles and fifteen hours later the lead shuttle, the *Nirgal*, fired its engines and lowered its periapsis into the Martian atmosphere. The *Bahram* followed fifteen minutes later.

After twelve hours of floating, the *Nirgal* flew deeply into Mars's atmosphere, losing eighty percent of its velocity. Parachutes and its rocket engines removed the rest

and the vehicle settled onto pad three at Aurorae spaceport. The *Bahram* followed. Half an hour later, two six-wheeled Conestogas, each carrying a dozen of the crew and one child, arrived in Andalus Square, where several hundred Marsians waited to greet them.

As the door of the Conestoga carrying Helmut, Clara, and Charlie Langlais opened, the crowd outside began to applaud. Six-year old Charlie was frightened by the sound. “It’s okay, Charlie; they’re greeting us,” said his mother, Clara. “Oh, Commander Vickers is waving, so be sure to wave, too, okay?”

“It sounds like everyone in Aurorae Outpost is here to greet us,” commented Helmut. He took Charlie’s hand. “Let’s go.” The boy hesitated, then stepped outside with his parents.

They instantly moved from the cocoon of a vehicle interior to exposure to a crowd of perhaps 700. Charlie had been two when they left Mars and remembered nothing of the Outpost; he was overwhelmed and his reaction was as much fear as fascination. Helmut and Clara were dazzled by what they saw as well, partly because their entire world had been either bare rock and vacuum, or a thirty-two meter in diameter caravel for four years.

Andalus Dome was the largest in the outpost, 160 meters in diameter, soaring 80 meters above the ground. Through the 20,000 square meters of advanced plastics overhead one could see the pinkish Martian sky with early morning cirrus made of ice crystals. The 1600 meter high northern escarpment of Valles Marineris rent the northern horizon with a mountain wall of tumbled rock. Closer by were the numerous buildings inside the Dome, generally five or six stories high, though the campanile attached to the Mars Authority building on the dome’s west side soared to forty meters height.

Charlie reached down to pick up a piece of dirt on the pavement. Clara scolded him and told him to drop it. Then she waved to the crowd, which Charlie did reluctantly.

They stepped up several steps and onto the platform. Just then, much to their surprise, a band began to play; it had been hidden by the platform. “Wow, music too!” said Charlie.

“Yes, this is a big welcome,” replied Clara. “Here’s grandpa, shake his hand.”

Sebastian Langlais, head of the Asteroid Belt Commission, stood at the top of the steps to greet each of the arriving crewmembers. When Helmut reached him he smiled at his older son, whom he hadn’t seen for four years, and embraced him, tears in his eyes. Clara was next.

“Welcome home, Clara,” he said, and he embraced her as well. His voice broke slightly.

“Thanks, dad,” she replied and she gave him a kiss on the cheek.

Sebastian bent down to Charlie, who was startled to be standing in front of a grandfather he didn’t remember. Never mind that he had seen him twice a week by video and had even spoken to him; a grandfather in the flesh was overwhelming. After one look he turned and grabbed his mom. Sebastian smiled and retreated.

The three of them stepped onto the platform and moved down the line of chairs, but remained standing. Once all twenty-four crew members and their two children were in place, Sebastian moved to the podium. He looked at them, gestured to them, and the crowd erupted in applause again.

“You deserve every clap,” he began. “Just four years ago, twenty-six people left for a mission to Astrea, Ceres, Hebe, and Flora. They were flying the latest space vehicle,

but one that had never been operated in deep space four years straight. They visited all four asteroids, toured the heart of the Asteroid Belt, explored the queen of the belt—the asteroid Ceres—for over a year, made unnumbered discoveries of immense significance, vastly expanded our knowledge of the formation of this solar system, then returned safely home. Never before have human beings cast off from the shore of civilization, gone so far, and stayed away so long. They returned with or sent back literally tonnes of samples, some of which are already on their way to Earth. Others are destined to be on a ship to Earth in a matter of months. Furthermore, this was a community—a village—which included two children. Never before have children gone into space on a mission of exploration before. Their successful, healthy return sets a precedent for the expansion of humanity across this solar system and beyond to the stars. Finally, this community operated with impressive unity of purpose and social cohesion. Their courage will be an example to us, their creativity a model for us, their friendship a beacon to us for a very long time. We are happy, relieved, and proud they have returned home safely."

Sebastian sat to another flood of applause. Dr. Enlai Tang, Chair of the Mars Council, legislative body of the Mars Authority, rose next.

"My friends, welcome home." He said it slowly, deliberately, and with great emotional force in his voice, which generated additional applause. "The Mars that greets you looks different from the one that saw you off four years ago. In 2041 you trained in a newly pressurized dome called Andalus. It was barren, unimproved polder. Look at it now! It is the heart of a community of nearly 2,000 people, with shops, homes, schools, and offices. The transformation you see has been confirmed by your odyssey of exploration. Humanity can expand into space, not just as small teams of scientists and

engineers, but as families as well. Mars demonstrated this first; it is now the home to nearly a thousand children, the oldest of whom are in university. You have now demonstrated that families can be successful off-planet.

"In the next few years, human beings will reach Jupiter. You have proved that the equipment and social conditions for such a trip are possible, and that we have been able to invent the first and pioneer the last. When people visit the Galileans for the first time, they will owe you a debt of gratitude.

"Finally, you have helped make Mars the center of future space exploration. We have the skilled personnel, the experience, the equipment, the will, and the courage to push humanity's frontier outward. Increasingly, humanity is turning to us for participation in great national adventures of exploration. Next year the Chinese will launch their first mission to the asteroid belt from Mars orbit. Your return to Mars brings us the skilled personnel to attract other national projects. We look forward to your participation in many future missions to expand human knowledge."

Enlai nodded and sat to applause. Helmut raised his eyebrows; he was surprised and hadn't realized that what they had accomplished would set the stage for a wide range of projects. He watched Commander Charles Vickers rise and walk to the podium.

"There are so many people here who are our friends," he began. "And so many people here we do not yet know, who will soon be our friends. On behalf of my crew, thank you all for a welcome that none of us could have imagined. We are not used to being told that we are courageous, or even to hear that Mars has now proved its ability to conduct deep-space missions. We did what we were trained to do. Mission Control here and in Houston did what it was trained to do. We left confident that everyone had the

training to complete the mission. We completed it and many additional tasks. We hit unexpected obstacles; it is true that our equipment functioned for four years, but during the last year the necessary maintenance work doubled. We have returned as a very close-knit community, and we now have extensive medical work to complete!

"Yes, deep-space exploration is possible. Yes, much training is needed. It is not easy. But it is community that makes a lengthy mission more than just a tolerable experience. How did we create a community? There is some science, some training, some counseling and leadership necessary, but much of it is human instinct. As humans, we want to care for each other, help each other, cooperate together. I hope our mission has reaffirmed that truism. That which is most ancient in us, that which goes back to our hunting and gathering societies in Africa, is what makes a mission like this possible. The skills that allowed us to explore Earth continent by continent, island by island, allow us to explore space as well.

"We are delighted to be home. We are excited to explore this newer, more sophisticated, Mars. We look forward to contribute to the ever-advancing enterprise that is Mars. And all of us look forward to our return to space, to future missions. Thank you."

The crowd rose to give the explorers a standing ovation. Charles waved to his crew to rise as well and they began to applaud the crowd, for their accomplishment would not have been possible without the support Mars provided.

The band struck up another tune as everyone began to disperse. Sebastian hurried over to Helmut. "As you know, there's a debriefing tomorrow afternoon and individual

medical appointments at the hospital, but otherwise you're free. Kristoff and Irma are expecting us; can we go over now?"

"We need to get our luggage from the Conestoga," said Clara.

Sebastian shook his head. "Someone's loading it onto robotic carts. They'll deliver it straight to your apartment; they'll take it inside the door, in fact. I authorized the access."

"Oh; thanks," said Clara.

"Then let's go," agreed Helmut.

Sebastian led them off the platform and into the dispersing crowd. Many people stopped to congratulate Sebastian, Helmut, and Clara; Clara picked up Charlie and carried him because he clung to her tightly. The noisy crowd was a strange, frightening experience for him.

It took ten minutes and shaking hands with thirty people to get through the crowd. Sebastian led them southwest to the pedestrian tunnel going to Cathay Dome. He pointed out two side tunnels with closed airlock hatches. "These lead to new underground subdivisions constructed by two private firms. They're fairly spacious and inexpensive, but have little or no natural light."

"They're completely underground?" asked Helmut.

"Except for skylights. Afigbo Construction's using inflatable, transparent 'Quonset Hut' tubes twenty meters long and ten in diameter; they build two levels of housing in them after they're installed and cover them with three meters of reg, except for several skylights, some of which are pretty big. Cowdrey Construction's using cheap nickel-steel tubes of the same dimensions. They complete each unit in a factory, then haul

them to the excavation, dock them to a preexisting airlock, and bury them. Cowdrey's units have no skylights at all, but they're cheap. A lot of units were made here complete, then hauled two thousand kilometers to the new outpost at Uzboi for housing and work space."

"The factory must be perfect for that situation," noted Helmut.

Sebastian nodded. They stopped in front of an airlock door to wait for it to open. There was a brief delay; someone else had entered the tunnel at Andalus and the door there hadn't completely closed yet. But once it had, the door in front of them began to open. They entered the last half of the tunnel, hurried forward, and the door separating it from Cathay opened immediately in front of them.

They were back in sunlight. Cathay was a long semicylindrical dome, seventy meters wide, thirty-five high, and two hundred long. They had entered near the southernmost end. An alley ran north-south along the eastern dome perimeter. A line of planters five meters above the pavement jutted out from the concrete base of the dome and provided sustenance for a long thicket of hazelnut and cherry trees. The western side of the alley was defined by a five-story rowhouse covered by vinyl siding that looked like sandstone; some parts of the building were yellow sandstone with brownstone trim, other sections were red sandstone with yellow sandstone trim or gray with red sandstone trim. Large airtight windows interrupted the siding periodically. A wide overhang provided radiation protection; its façade of fake roofing tiles gave the building a Chinese look.

Helmut was impressed by the building's beauty. Sebastian led them across the north-south alley and to a grand entrance in the rowhouse's southern end. They entered and went up a long ramp to the fourth floor. Kristoff and Irma lived in unit 407.

The door was ajar and Kristoff stood waiting. When he saw Helmut he dashed forward to greet his brother. “There you are!” he said. The men embraced.

“Wow, I haven’t seen you in so long!” said Helmut.

“Twelve and a half years!” said Kristoff. “You left Earth for Mars in early 2033, and by the time I got here you had headed for Ceres!”

“That’s a long time ago, brother. I was 26 and you were 23.”

“Now look at us, practically middle aged!”

They both laughed. Then Kristoff turned to Clara and embraced her as well—they had never met face to face before—and gave a kiss to reluctant Charlie. They all entered.

The apartment had a parlor six meters by five with big windows overlooking the center of the dome. Irma stood inside and hugged Helmut, then Clara and Charlie, warmly. Helmut made a beeline to the two bassinettes holding their twin babies, Mark and Nicola. “They’re what; four months old, now?”

“Not quite,” replied Irma. She reached down and picked up Nicola, handing her to Helmut. “She’s the cuddy one.”

Helmut took his niece with a smile, cooed at her, and held her. Clara picked up Mark, then eventually handed him to Charlie, who had become curious about his little cousin.

“So, instant complete family!” exclaimed Helmut.

“Yes; Geminale is a remarkable fertility drug,” said Irma. The pill made each ovary independent of the other, so each released a fertilized egg every month.

“And carrying two babies is easier in this gravity,” added Clara.

Helmut wandered over to the window. “Wow, what a view! The other rowhouse is nice, but you’ve got the escarpment as well, and the river between the two rowhouses. . . that’s a nice touch.”

“We’ll have to go for a walk later,” suggested Kristoff. “This is a nicely designed dome. The Riverwalk is really pretty, and because the dome slopes downhill by thirty meters to the north, we have a very nice view in that direction.”

“Sit down and make yourselves at home, please,” said Irma. “And we have all this food! You must be hungry after the long flight.”

They grabbed sandwiches and sat. Clara’s eyes continued to be turned toward the window. “So, after Andalus is Cathay, then Punjab, then Zanzibar,” she said. “When we left, Andalus was the western end of the outpost.”

“Don’t forget Andalus Northeast and Northwest,” added Kristoff. “They’re seventy by two hundred meters. They’re agricultural and were finished in the last two years.”

“They broke ground on two more domes a few months ago, too,” added Irma. “After Zanzibar will come Liberty, which will have the United States of America as its architectural and cultural theme. It’ll have a small version of the Statue of Liberty at the southern end and a Mormon Temple in the middle. That was a controversial decision. West of Liberty will be El Dorado, which will have Latin America as its cultural theme. Both domes will be seventy wide, but three hundred meters long; they’ll be our largest enclosures yet.”

“And together they won’t be big enough to accommodate the fourteenth columbiad!” added Sebastian. “If we get 750 arrivals plus 700 births, Mars will have to

accommodate over 1,400 new people by 2048. That requires 175,000 square meters of new enclosures!"

"Where will the rest be?" asked Clara.

"They're constructing northern extensions two hundred fifty meters long to Cathay, Punjab, Zanzibar, Andalus Northeast, Andalus Northwest, Liberty, and El Dorado," replied Kristoff. "They'll be called Cathay Alpha, etc. They'll be agricultural or for bioarchive. Liberty and El Dorado will have Alphas as well. At that point, Aurorae Outpost will extend almost 600 meters north-south and 800 meters east-west; it'll be an incredibly big place."

"You're talking about nine major domes in two years," said Clara. "That's amazing! That's a lot of construction."

"And it'll be enough to accommodate a thousand people, not 1,400. The rest will go elsewhere on Mars. New Tokyo, up on the escarpment, and all the outposts are getting additional domes," added Sebastian. "Even with two rapidly expanding private construction outfits and a huge construction department for the Commission, there's an awful lot to do. But this place now has the resources for so much expansion."

"But we were straining ourselves badly to keep up with fifty percent expansions," said Helmut. "It sounds like the expansion rate hasn't slowed much."

"No, it hasn't," agreed Sebastian. "But at least we have a lot more robots and machines now. The cylinder domes require a lot of ground preparation, but we have some pretty big bulldozers and regolith sifters, and the pile drivers that install the foundations are automated. The plastics factory is enormous; you should tour it when you get the chance."

“We’ll have a lot of time on our hands in the next few months,” agreed Helmut.

“What are you going to do now?” asked Kristoff.

“After a two-month vacation? I don’t know.”

“Ceres,” replied Sebastian. “That’s your passion; it’s plain for anyone to see. The Commission will need four teams to continue automated exploration of Astrea, Ceres, Hebe, and Flora. The teams will no doubt continue research on samples and the accumulated data as well. That’s the obvious place for your energy.”

“Maybe,” said Helmut. “Frankly, I’d like to see a team return to Ceres. I’d rather work on that.”

“Well, the lobbying base for a return mission will be the follow-up team,” replied Sebastian.

Helmut looked at Kristoff. “Are you planning to return to Phobos?”

Kristoff shook his head. “I was offered the position of head of Phobos agriculture, but I turned it down. Mark and Nicola can’t go there for several years and I don’t want to be away that much. No, I’m thinking of starting my own horticultural operation. I’d have to buy one of the new domes and plant it in a single-climate set of crops.”

“How much will that cost?” asked Helmut.

“A lot. Polder—enclosed, pressurized, but otherwise unimproved land—costs a thousand redbacks per square meter. One of these alpha domes will have 17,500 square meters. Fertilizing the land so that it’s agricultural in quality—it’s then called grange land—costs 100 to 300 redbacks per square meter, depending on how long you want to take and how much compost, organics, and fertilizer you buy. Then there are robots and machines to purchase. Each dome is about a thirty million redback operation.”

“Wow. How much of that can you borrow?” asked Helmut.

“Most of it. I’ll probably need fifteen percent to get started. If you’re interested in a business proposition, Helmut, we can talk about it.”

Helmut looked at Clara. “Maybe we can; Clara and I should talk first, though. We have four years of flight pay—half a million redbacks per year each—and on the flight our only major expense was paying the mortgage on our flat, which had a rental in it.”

“I hope you were investing it in platinum group metals,” said Irma.

“Oh, yes!” replied Helmut, with a smile. “Not all of it, the investments were diversified. But the PGM investment has been incredible, doubling in value almost every year.”

“We have some stock, too,” agreed Irma. “But dad’s skeptical.”

“I am,” agreed Sebastian. He had been concentrating on his grandson and now had Charlie on his lap. “The most recent round of investments are two years old and haven’t made any profit yet. The sharp rise in stock valuation’s due to speculation. It’s a bubble and it could burst.”

“But the investment’s basically sound, don’t you think?” asked Helmut, alarmed. “After all, Earth needs platinum and palladium.”

Sebastian nodded. “Yes, right now demand outstrips supply, so price is sky-high. But new fuel cells with no platinum will soon hit the market. Once development costs are covered, their price will drop. And the new organic solar cells are revolutionizing power production because they’re so cheap. Everyone’s so frightened about the availability of power, they want some ability to produce their own power; so you can predict that solar production will be overbuilt in five years or so. The price of petroleum’s already coming

down, and it's not just because Khalistan's production is back on line; demand for petroleum has actually dropped, and the experts say one percent of that is because of use of solar."

"So, what are you saying? The price of platinum will drop?"

"Eventually, because when the fuel cells with platinum are replaced their platinum will be recycled. Demand will drop and supply will actually grow. The price will drop until other processes that use platinum take up the slack."

"At what price?" asked Helmut.

Sebastian smiled. "Do you think I'm an expert? No one knows. One guess I read was US$100 per ounce; that's three million dollars or five million redbacks per tonne."

"That's a tenth of what the price is now!" exclaimed Clara. "Surely demand for jewelry will hold the price up!"

"Maybe; maybe not."

"So, what will happen to Mars?" asked Helmut.

"The same thing that happens to any economy dependent on sale of raw materials; severe economic shrinkage. We could even have unemployment. I suspect Uzboi will remain in business and become our main platinum export source. The gold processing outposts will do fine because gold prices are unlikely to drop below $300 or $400 per ounce. Platinum production on earth will stop because it can't be produced profitably at $100 per ounce. The moon will probably stay in business as well if it's processing ataxites and other platinum-rich meteorites. Aurorae will no longer produce platinum, I suspect."

"Will Mars ever be economically viable?" asked Kristoff.

"Your guess is as good as mine. It won't be easy. Production here and export to Earth normally costs five times as much as producing something on Earth, and that will *always* be true. Earth has used up its rich gold deposits and we still have rich deposits to exploit, but when our rich deposits are gone our costs will rise above Earth's. Earth doesn't have ataxites, so we'll always have an edge with platinum production."

"Until asteroid mining kicks in," said Helmut.

"Mars may be able to compete with asteroid mining, but it's too soon to predict. Consider the ataxite you found on Ceres, Helmut. It has the potential to reduce the cost of an outpost on Ceres, but it may never cover such an outpost's costs completely. Solar sailers can move the stuff from Ceres to Earth cheaply, but it'll take *five years* one way. That's a big disincentive. So you'll have to use chemical engines and that raises export costs to a level similar to Mars's. We haven't found a near-earth object with ataxite, but even if we do there will be the costs of importing the carbon dioxide and water to run the carbonyl process and support the crew. No one has yet figured out how to build a robotic factory that repairs itself. Putting a crew on an asteroid is a huge cost and complication; you have to be able to handle medical contingencies and supply them with terrestrial luxuries periodically. Personnel costs on Mars are much less. The moon has the advantage over everyone of cheaper, faster transport to Earth, but they have a shortage of carbon, which is essential for extraction of platinum; they're buying half their carbon from Phobos! We'll be Earth's supplier of platinum for some time, I think, but it won't solve our financial problems."

"And what's the Commission doing about it?" asked Helmut.

“The Mars Commission? They’re building up Mars manufacturing as much as they can to bolster other exports. We can get things to low Earth orbit as cheaply as they can be moved from the Earth’s surface; we’re cheaper to the moon, Venus, Mercury, and of course the outer solar system.”

“So, it sounds like your desire to return to Ceres isn’t very practical,” Kristoff said to Helmut.

“It may not be practical for other reasons anyway,” added Clara casting her eyes on Charlie.

“I thought interplanetary spaceflight has proved safe for families,” exclaimed Irma.

“Well. . . it depends on how you define ‘safe,’” said Clara. “Charlie’s already been exposed to half the maximum radiation NASA wants adult astronauts exposed to, and he’s much more sensitive because of his age. He’s already developing cataracts in both eyes, and we’re watching closely for cancer.”

“Fortunately, the new lens replacement operation is extremely effective,” said Kristoff. “I just had it last year and my eyesight is better than it was when I was a teenager. The new semi-liquid plastic has better flexibility than the natural lens of a middle aged person. I’ll never need bifocals.”

“But Charlie doesn’t need bifocals,” replied Clara. “And six year olds shouldn’t be having cataract operations. It’s a bit hard to explain to them.”

“Fortunately, he can wait five or six years,” said Helmut.

“It sounds like your approach to families in space has evolved a bit,” Irma said to Clara gently. Five years earlier, Clara had been the big advocate on Mars for more family-oriented conditions for surface exploration.

“Yes, I guess so. I was gung-ho about including kids in as many things as possible, including space exploration, and Charlie has enjoyed it. . . .” She looked at her son. “But it wasn’t so good for his health, in spite of our advanced medical technology.”

“Your views, though, have really changed the situation for surface exploration,” said Irma. “We now have thirty fixed habitats scattered across the Martian surface, radiation hardened under three meters of reg and equipped for children. Only a few expeditions have children with them, but the adults much prefer the habs anyway; they’re more comfortable. And the new modules Cowdrey Construction is making are even better for setting up habitations across the surface.”

“Personally, I hope you’ll settle on Mars, now,” said Sebastian. “I’d like to have both of my sons with me in my retirement. I turn seventy in a year and a half, and I’ll probably retire at that point.”

“Really?” said Helmut. “What will you do?”

Sebastian laughed. “I can always be a curmudgeon! I’ll have run the Asteroid Belt Commission six years, launched two missions, planned the third, and saw the first mission home safely. That’s on top of running the Lunar Commission for a decade. That’s plenty. I already have three grandchildren and who knows, I may have more. I have memoirs to write. Mars will need wizened experts to serve on blue-ribbon panels and commissions of investigation. I could even write a column for *Mars This Sol.* There are plenty of options.”

"Well, grandpa, we want you around for the kids for quite a while," said Irma affectionately. She looked at the food. "Goodness, we've been so busy talking, we haven't eaten very much. Let me ladle out soup for everyone." She rose and prepared bowls for everyone, including Charlie. The conversation turned to the university—Martech or Mariner Institute of Technology—then to all the new businesses opening in Andalus Square, the new buildings that had been finished, the new hospital complex, the growing facility at Uzboi Outpost, the latest developments with the Green World Community, and the expansion on Phobos. Helmut and Clara had kept up with many developments via *Mars This Sol*—it was a "multi," a news site with audio stories, video stories, and print stories, plus advertisements—but it was different hearing everything in person from people who witnessed the events. They had a lot of catching up to do.

By late afternoon Helmut found himself looking at his watch. "We should get to our flat," he said. "Charlie probably needs a nap, I want to unpack some clothes and take a shower, and I want to see how the place looks after four years."

"Yes, I feel a need to roost in my old nest for a while," added Clara.

"You had better go soon, then," added Sebastian. "Because the big welcoming dinner in the Gallerie starts at 6:30 p.m. The Mars Commission is paying for it, not the Asteroid Belt Commission; Will Elliott insisted. The food and drink are free."

"I was surprised he didn't speak at the ceremony this morning," added Helmut.

"That was Will's idea, too. He felt that the Mars Authority had to welcome you back, not the Mars Commission. Érico left for Earth last month, so the task fell on the shoulders of Enlai, as Chair of the Mars Assembly." Sebastian stood up with Charlie in his arms; he had had the little boy in his lap the entire time. "I'll walk you home."

They said goodbye to Kristoff and Irma for a few hours and headed out. Clara was curious about the Gallerie, so they detoured to go through it. A Santa Claus sitting just inside the front door of Deseret Department Store, talking to children, startled her. “Oh, yes, you haven’t heard,” said Sebastian. “Santa Claus authorized some elves to fly here on a rocket sleigh and set up operations at the Martian North Pole. One was Santa’s chief helper on Earth; Kris. He’s the Santa of Mars, now. This is his first Christmas. But he has also agreed to deliver presents to children on New Year’s, Hannukah, etc.”

“Oh, how pluralistic of him,” said Clara. She glanced at the clothing on display and leaned toward the store. Helmut put his hand on her shoulder.

“Not now; we can shop tomorrow morning. We have to buy a whole new wardrobe and may want new furniture.”

“Okay,” she said, reluctantly. They turned and headed out of the Gallerie.

The walk to Columbia Dome took five minutes, and even though they had walked across the Outpost many times, after four years of confinement in a caravel the place felt huge. Columbia was in midsummer, and like the Columbia Plateau of Washington state and British Columbia, it was hot and dry. The construction was of the cheapest type; plastic cylinders ten meters in diameter and ten high, standing on their end to produce four stories of housing, were clustered together under gardens on stilts. They entered their cylinder—which, in its white vinyl siding, looked cheap and old compared to the new false-sandstone siding of the buildings in Cathay—and hurried up the ramp to the fourth floor. Helmut stood outside his door and spoke to it, asking it to open, and he heard the latch open, so he pushed on the door.

They walked in. They owned the entire floor except for the ramp well; 70 square meters, which had been fairly spacious when they purchased it seven years earlier. The eastern half of the cylinder was a “parlor,” a living room/kitchenette combination. It had a counter, some cabinets, a microwave, and an ice chest to keep milk and other items cold overnight. Near the counter was a table for eating; the rest of the space had a couch, some comfortable chairs, and a rug. Two large framed pictures hanged on the wall. The western half of the cylinder had a bathroom, a master bedroom, and a small bedroom for Charlie.

Their luggage was just inside the door. Helmut and Sebastian carried it to the double bed, then Sebastian said goodbye and left. While Helmut unpacked, Clara took Charlie to his room and helped him go to sleep. Neither task took very long; Charlie was exhausted from the twelve-hour flight and the immense excitement after the landing, and four years of possessions for a spaceflight didn’t amount to very much. They had brought only a dozen changes of clothes and two pairs of shoes for Helmut and Clara, and only eight or nine changes of clothes, much repaired, remained. Charlie had had six sets of clothes and one pair of shoes per year, as he grew, and the items he had outgrown had been recycled on board for rags. When Clara came out of Charlie’s room, only the little boy’s toys were left to put away.

“He’ll probably sleep several hours,” she said. “He’s really exhausted.”

“We’ll wake him for the dinner, then.”

“Yes. I wish they had scheduled the dinner for tomorrow night. I don’t have the energy to go.”

“We need to rest, too.” He sat on the bed; Clara sat next to him. Helmut looked around. “Sebastian’s place is the same size as this, but it looks so much nicer. The furniture is more comfortable and stylish, the wall decorations better quality. . . everything’s different.”

“They even have a real refrigerator and a two-burner electric stove. I gather they’re now standard equipment. When we got this place they were incredibly expensive luxury items.”

“I remember. Well, my dear, we’re worth about five million redbacks, so I think we can afford some furniture. For that matter, we can afford a new place.”

“Yes, let’s get a new place. I suspect this place hasn’t gone up in value very much.”

“Who knows. I bet most of our neighbors have changed. As salaries go up every year, people move.” Helmut shook his head.

“So many changes all at once. We’re out of a ship and back on Mars. Our jobs change; in fact, we won’t have practically any work for the next two or three months. Charlie starts in school after Christmas and New Years. We get all new clothes, a bunch of new furniture, and we’re temporarily in a ‘new’ old place. Then we get a really new place.”

“And we’ll probably have another baby.”

“Yes, that too.” Clara looked at him. “In vitro; I’d rather use the stored eggs and sperm. Our gonads were fried by the voyage.”

“Okay. That’s why we stored them, after all.”

“I don’t want to take a chance with fertility drugs or even Geminale. One more is plenty. And we’re not leaving Mars for quite a while, either, Helmut. At least five years.”

“I doubt anyone will plan a return to Ceres before then, anyway, and I’m not thinking about Jupiter. Maybe Saturn, but that’ll be fifteen or twenty years.”

“We’ll be too old for that! You’re almost forty.”

“Even twenty years will work. Besides, the older you are, the more radiation you can tolerate.”

“Maybe I’ll be up for another adventure by then. But not for five or six years. I want to enjoy a middle class life for a while.”

Helmut chuckled. “Marsian middle class, complete with real kitchens, Coca-Cola, MacDonalds, and Santa Claus. Okay.”

2

Conspiracy

1 April 2046

The flight from Uzboi had been quick. The jetwing had lifted off under rocket power from the outpost at 8 a.m., about an hour after dawn had streaked the sky. Ethel MacGregor caught a brief glimpse at Uzboi's dome, seventy meters wide and two hundred long, with several hastily erected buildings around a paved square and a big excavation on the dome's east side where prefabricated metal cylinders hauled two thousand kilometers from Aurorae were being installed two at a time. Several kilometers farther east, a small excavation marked the spot where millions of tonnes of high-nickel, high-platinum meteorite had fallen 4.3 billion years earlier. The body, once hundreds of meters underground until exposed by a catastrophic flood, was 35 parts per million—or grams per tonne—Germanium, 87 ppm Gallium, 84 ppm Platinum, 56 ppm Ruthenium, 9 ppm Rhodium, 1 ppm Palladium, 31 ppm Osmium, 31 ppm Iridium, and 1 ppm gold, for a total of 335 parts per million or 335 grams per tonne of rare, precious elements. They had to process 3,000 tonnes to obtain one tonne of useful rare materials, worth about fifty million redbacks; but as bad as that sounded, the "average" nickel-iron they processed at Aurorae produced only a tenth as much. Hence the reason for Ethel's trip, to make sure the equipment moved from Aurorae was working at optimum efficiency.

The jetwing's turbojet engines roared for two minutes as they burned silane fuel using stored liquid carbon dioxide. They were supplemented by small rockets located in the vehicle's belly and the bottoms of the wings, which compensated for the meager lift produced by the thin air. Once the vehicle broke the sound barrier, the rockets fell

silent—the wings could now generate enough lift. The turbojets throttled back and switched over to burning silane in atmospheric carbon dioxide. In fifteen more minutes the vehicle was moving twice the speed of sound, which was its cruising speed. It flew to Aurorae in about an hour.

On approach to Aurorae some 2,000 kilometers to the north, the jetwing began to throttle back its engines and extend its flaps, trading velocity for altitude. The aircraft banked in order to make its final approach, giving Ethel a great view of the area. The first thing she saw was the northern escarpment of Aurorae Chaos, which descended from a scalloped cliff down two thousand meters of debris chutes and talis piles to the rolling, cratered floor of the Mariner Valley system. Breaking the ragged edge of the cliff was a gash that they called Little Colorado Canyon, a narrow, steep ravine that had provided a route to the plateau on top. Looking closely, she could see the bubbles of Little Tokyo and of the Zen Monastery on top of the escarpment, but not of the Dacha, their secluded little vacation spot, probably because it was so small.

Then the jet banked and she saw Layercake Mesa, 4,000 meters long, 1,000 meters wide, and 100 meters high, aligned east-west parallel to the escarpment but twenty kilometers to the south, on the valley floor. Immediately to its east and separated from it by “the Notch” was Boat Rock, 300 meters long, 200 wide, and 100 high, a smaller plateau with a more rounded top, like the keel of an upside-down canoe. Finally, looking very closely, Ethel could see Face Rock, a mere fifty meters square and a hundred meters high, dangling off the eastern end of Boat Rock; from a certain position on the south side, the eastern profile of the butte looked like a man’s face, complete with goatee. She could

just make out Face Rock; Boat Rock and Layercake Mesa were unmistakable because their tops were decorated by slowly spinning wind turbines every two hundred meters.

From Face Rock she took a quick, silent survey of the Outpost she had helped to found in 2021, some twenty-four years earlier. First was a square of four inflatable "habs," each twelve meters in diameter, still visible as a quartet of mounds of dirt, with an associated farm of greenhouses. To the south and west of the greenhouses were two rectangular buildings of duricrete, their first efforts to build pressurized structures on Mars. Next to them was a round, transparent dome thirty meters across, their first "large" pressurized space. It was followed by a cluster of four "biomes," transparent domes forty meters in diameter with buildings and farm land inside; from an altitude of over a thousand meters all Ethel could see was four circles of greenery, because the buildings had intensive agriculture on their roofs. Farther west was a pair of fifty-meter domes, then a fifty-meter and a sixty meter, then two sixty-meter domes, then a pair of seventy-five meter domes; they marked the progressive enlargement of the technology that had started with a thirty-meter dome imported from earth in 2027. They were followed by Andalus, 160 meters across and by far their largest single enclosure. After it were domes seventy meters wide and of varying length, with two excavations marking the westernmost extension of Aurorae. The outpost was steadily marching westward and growing wider by expanding northward, giving the pressurized area a triangular shape overall. Filling the northeastern quadrant was an expanding industrial area, mostly of buried factories. To the north and east of the industrial area was an extensive solar farm, where cylindrical bubbles rotated to track the sun and concentrate sunlight on lines of arrays; the units also produced heat that was pumped into wells up to 800 meters under

the solar farm, releasing water vapor to slake the outpost's immense thirst. On the south side of the three mesas was Aurorae's Spaceport, circular landing pads a hundred meters in diameter scattered amidst the stonescape, with a buried series of methane and oxygen tanks feeding hidden pipelines that ran to the pads and to the Outpost.

The jetwing was descending fast now, falling at a forty-five degree angle toward a short but very wide landing area that was half pad, half runway. The turbojets reversed themselves and the stored liquid carbon dioxide was poured into the afterburners while the ventral rocket engines began to fire. The vehicle slowed rapidly and transitioned from aircraft to rocket. It landed with barely a bump and no forward rolling on the landing pad.

"Welcome to Aurorae Outpost," announced a computerized voice. "Please wait in your seat for another few minutes while the crew completes its landing checklist and while a vehicle docks to our airlock. Thank you for flying Mariner Airlines."

She chuckled at the last comment. Mars had only one airline, after all, and it was heavily subsidized. The jetwings had revolutionized transportation, but had cost billions to develop and demand was still far too light to recover even operating costs. She was the only passenger on the weekly flight. Many people still hitched free rides on the cargo caravans that rode between outposts.

A few minutes later, she heard a clanking sound as a vehicle docked to the jetwing's airlock. A minute later the door opened and she unhitched her seatbelt. Grabbing her garment bag and her purse—she had started carrying a purse again after two decades without one—she headed for the exit.

Ten minutes later she was inside Aurorae Outpost. It was 9:30 a.m. Satursol morning. Will was probably at home; Lizzie would be at her day care job. Ethel

wandered slowly across Andalus Square, stopping to admire several tables of merchandise that had been set out. Quite a few people did handicrafts in their spare time and sold the results on Satursols; it was one of their principal sources of consumer goods. That sol she saw nothing she wanted, so she headed home.

Will was in their living room watching an event on television. When she poked her head into the room, he stood up. “Ah, you’re home! That was quick!”

“The flight isn’t very long.” She walked over to him and they kissed. She sat on the couch next to him. “What’s this?”

“Érico’s arrival in Brazil; it’s a live broadcast on *Mars This Sol.* The President of Brazil was there to greet him when he got off the shuttle. The speeches sounded pretty good; it’s hard to tell because the translation was done by computer. He was given the greeting of a head of state, Ethel.”

“Really? Of course, he’s Brazilian, so I suppose they were recognizing their native son and giving him royal treatment.”

“Perhaps, but there’s protocol to observe, and it was not followed the usual way. He was treated as a visiting head of state.”

“That’s a good sign, then.”

“Yes, I think so. I suspect Louisa Turner will call soon with an analysis. She’ll want to write a protest to the Brazilian government on behalf of the Commission.”

“I suppose quite a few senior staff in the Commission will be unhappy about his visit, since he doesn’t work for the Commission. This makes him a viable alternative to you and the Mars Authority an alternative to the Commission.”

“It does, and I don’t care. The Commission’s sols are numbered, I think. It doesn’t work very well to tell Marsians they can’t govern themselves when the people who run Mars live on Mars, but run it in the name of the Commission instead of the elected Authority. Think about it. It doesn’t make sense.”

“No, you’re right, except for the little matter of eight billion redbacks a year of subsidy from various governments. I wonder whether any other nations will accord him the status of a head of state?”

“The U.S. and China certainly won’t, but he’s going to twenty-one nations; I bet some of the others will.”

“Probably. And has Robert Kampala arrived in the United States safely?”

“Yes, Kent Bytown turned him over to the F.B.I. at Cape Canaveral three hours ago. Our most famous prisoner is now safely behind bars on Earth.” He looked at her. “You look rested and energetic, so I guess the trip went well.”

“Yes, pretty well. Yuri has been going crazy getting the new solar power units set up, but at least we’re no longer blowing fuses.”

“So, all the towers are working?”

She nodded. “We now have power for the 200-tonne per day fractionation towers of Muller Mining and of Consolidated as well as the two 750-tonne per day towers of Mars Metals, so all four are now operating at ninety to ninety-five percent capacity. Muller Mining and Consolidated have both ordered 750 tonne per day towers, and Mars Metals has order two more. It’ll take two years to get them all set up, but at that point Uzboi will turn out 1.6 tonnes of PGMs per sol.”

“Let’s hope the price holds up. Meanwhile we have how much. . . the first tower’s been operating seven months and the second tower two months, at seven tonnes per month—”

“Next month we should have hit at least 75 tonnes total output, plus the fifteen tonnes made here at Aurorae and the ten tonnes at Cassini and Dawes, plus the four hundred tonnes of gold produced this columbiad. . . not bad.”

“It’s a record. The trick is to keep all the subsidies as well, and that’s not so easy. The Europeans will definitely cut their support next year, and I suspect the Russians will follow. The U.S. and China are secure only because they don’t trust each other, and China’s support will keep India in. But Pakistan’s economy is poor and the public pressure on the government is enormous.”

Ethel pointed to the television. “Brazil looks set to stay.”

“Yes, Latin America in general loves Mars right now.”

“What will this do to the fifteen year immigration plan?”

“It means the Commission will fund more and more of it out of metal production profits, as long as the profits hold up.”

“Well, I’ve got to take a shower,” said Ethel, rising. “Shall we go out for an early lunch?”

“That’d be lovely. I have some business, but it should take less than an hour.”

“Connected to the arrival wave in three sols?”

“No, Brian Stark asked for a meeting. I don’t know whether he has to confess to a delay with the reactor or complain about the Chinese.” Will turned off the wall screen television. “I’d better get to the office, he arrives in five minutes. Call me in about an

hour. If I'm still talking to Brian, that'll be my excuse to bail out of the meeting, if I need one."

"Okay."

They both left the living room, Ethel for their bedroom and Will for the front door. He passed through the double hatches that formed a small airlock and into the tunnel leading to Andalus. His office, and the Commission's Mars operation, was located in the top floor of the Gallerie Building, less than 200 meters from his home. He arrived in the office and opened his attaché to see his messages when Brian knocked on the door. He didn't look contrite; more like determined. That meant the Chinese were on his mind.

"Good sol, Brian. How's the reactor?"

"G'Sol, Will. There's not a lot to report about it. We're on track to start chain reaction tests in three months, and the first power production may occur as early as September."

"Dust storm season starts in late December and we have to have it by then, especially with half our spare solar power units shipped to Uzboi."

"I know. I wish you weren't importing that new solar cell technology."

"Hey, neither you nor I can fight technology. Organic solar cells, fifteen percent efficient, mass produced at the cost of one redback per square meter. . .that's thirty redbacks per installed constant kilowatt of power! We can afford to pave over half Aurorae Valley for that price. Don't worry, your power contract is solid."

"We're thinking more about Uzboi."

"We'll need a nuke to provide base power levels; they get a lot of dust storms and the PGM production's profitable even with expensive nuclear electricity. Your problem

with Uzboi will be the competition. The Chinese can make a pretty good reactor at a good price, too."

"I know. Let's sit." Brian sat in an easy chair; Will hadn't yet invited him to do so. Will came around from behind his desk, closed the door, and sat facing Brian.

"What can I do for you?"

"Let me put it this way to you. Today's April first, so here's an April fool's joke for you: where do you think the Chinese caravel's going next year?"

"Do you mean the *Tienan*? It arrives from Earth in August about a week before our second wave of immigrants, then leaves for the asteroid Metis and a few other small rocks in March next year."

"April fools, Will! It's scheduled departure date is two months too early for Metis, and its probable delta-v's 2 kilometers per second too high."

"Brian, it isn't going straight to Metis, it's first going to a little rock in the inner belt; 2036AK6, I think is the designation."

"And why would anyone visit such an obscure place? According to astronomical observations, it's just an ordinary chondritic body 1,500 meters across."

Will shrugged. "It's not my business to ask customers why they are buying fuel to go to the asteroids they say they're going to. 2036AK6 is a perfectly legitimate target, especially since it happens to fall very close to the trajectory to Metis, if they leave for it a little early. And Metis is a good destination; it's a stony-iron and we haven't visited many of them. Finally, after a short stay, a window to Earth opens."

"Very convenient, because the sol the *Tienan* is scheduled to fire its engines is also right in the middle of the launch window to Jupiter, and if one calculates the mass of

a Jupiter mission, the fuel they're buying from you is enough to fly to Jupiter in a bit over a year and brake directly into orbit around Callisto."

"Really?" Will was startled by the idea. "But they'd be sending only one ship on a mission that will last at least three years. That's not wise."

"The *Piazzi* just went to four asteroids in four years all by itself, proving the equipment is capable."

"But they'd need supplies."

"The Chinese launched a big vehicle to Jupiter last August on a two-year trajectory; it arrives at Callisto in the summer of 2047. It had a solid-core nuclear engine and we figure it had fifty tonnes of stuff on board. The Chinese said it was mostly robotic exploration equipment and some supplies for an eventual human mission. We think the supplies are at least forty tonnes."

"That's a lot of stuff. If you're right, they'd reach Callisto in the summer of 2048."

"And they appear to be preparing a second unstaffed launch from Gateway for later this year, which would arrive in the summer of 2048 as well. That could double the supplies."

"And when will the United States launch its Callisto mission?"

Brian laughed. "Now the U.S. plans to wait for a gaseous core nuclear engine. We won't even test our prototype for a year and I doubt we can provide a human-rated engine in less than five."

"So, the United States will be able to launch a mission to the Galileans in 2052. Of course, it won't take much fuel and will get there fast. Meanwhile, the Chinese will

get there slowly with old technology and may have sent five crews there before you send one."

"That's possible, Will. You have to stop them."

"How?"

"Refuse to sell them hydrogen propellant."

"On what grounds?"

"I don't know. Maybe safety; it's not very smart sending two dozen people so far from Earth without a backup plan."

"What? If the *Teinan* is going to Callisto, what makes you think it won't come back in three or four years? Caravels are good, solid, reliable technology. We used to think any trip like that would need two vehicles, so either one could back up the other. But then we designed each caravel to be six separate pie-slice-shaped vehicles. There's a lot of redundancy packed inside each flying saucer. As for the Chinese engines, they've been flying for over ten years now."

"Will, be creative! You have to do something! Your country is counting on you."

"Brian, I am the head of the Mars Commission, and that trumps my citizenship. The Mars Commission has a mandate to settle Mars and advance that world's interests. It is in the interest of Mars to sell propellant to customers traveling anywhere in the solar system."

"Will, you're an American and you can't just ignore your own country and citizenship in a situation like this! This is a huge potential embarrassment. If it happens it will be hard for the U.S. to support the Mars Commission."

Will looked at Brian closely; it sounded like he was delivering a veiled threat, and no doubt it was coming straight from Washington. He didn't say anything for a moment. "Okay, I'll look into the situation. I'm really not sure whether I can do anything more than that, Brian. The Chinese are on the Commission, too, and they are currently contributing about as much money to the Commission as the U.S. is."

"I know that, but we know what sort of world we want Mars to be, Will. We speak English here, we're a democracy, we have the rule of law. The people here won't tolerate a Chinese-dominated Mars. If you want to avoid that, you have to avoid a Chinese-dominated Jupiter."

"That's the ultimate domino theory, don't you think?"

"Will, by the end of this century there will probably be small human settlements all the way out to Triton. We'll have reached just about the entire solar system in the twenty-first century. And we'll set a pattern that will endure well into the twenty-second century; a pattern that will determine the dominant culture. The United States is determined to be that dominant culture. Europe's now waning in terms of population and influence. The Chinese have peaked economically and now have to deal with a huge graying population. The U.S. may enter the next century with six hundred million people. Right now, only India looks able to beat us economically, and they're very limited by natural resources and environmental degradation. You've got to look to the future. Mars is more American than anything else."

"That's true," he conceded, though Mars's diversity made it more like America than its economic or social culture, which was more European or Canadian. "Like I said, Brian, I'll do some digging and find out what I can. We can't support a foolhardy effort."

“Alright, I’ll take that as a promise of action.” Brian rose. “Thanks, Will. Remember, we’re bringing you power in less than a year, and a breakthrough in transportation in about five. That’s worth a lot. Have a good sol.”

“You too, Brian.”

Brian Stark walked out of the office. Will watched him go, then rose and walked to his desk. “Anisa, connect me to Yevgeny,” he said to his attaché.

The screen flashed the word “acknowledged” and he heard a dial tone, then beeps. In two rings, the screen flashed alive with Yevgeny’s face.

“Oh, Will, good sol. Good Satursol.”

“Good Satursol to you as well. Say, do you recall how much fuel the Chinese are buying from us for the *Tienan*?”

“No, but I can ask.” He spoke to his attaché. “Five hundred-ten tonnes of hydrogen and two hundred tonnes of oxygen.”

“Wow! What’s the delta-v?”

“Depends on the mass of the vehicle, but an exploration-class caravel like the *Tienan* or the *Piazzi* masses 240 tonnes. Basically, they’ve got 240 tonnes of hydrogen-oxygen on board. Run the hydrogen through a nuclear engine and add the oxygen in afterburners and you’ve got a specific impulse of 750 and a delta-v of about 5 kilometers per second. That leaves you with 480 tonnes of liquid hydrogen, which run through the same engine produces a specific impulse of 1,000 and a delta-v of 7 kilometers per second. That’s assuming you burn the hydrogen first to push the hydrogen-oxygen and the caravel, then burn the hydrogen-oxygen just to push the ship.”

"I see. A delta-v of 12 kilometers per second. If you burn the hydrogen-oxygen first and the hydrogen second, what delta-v do you get?"

"It's better, because you've dumped your greatest mass first. . ." Yevgeny thought a moment. "Maybe 13 or 14 kilometers per second. But that's not the safe arrangement because if your nuclear engine fails, the hydrogen and oxygen can still give you chemical propulsion. The hydrogen alone can't."

"Of course. There's a rumor I just heard that I want you to study for me, confidentially; that the *Tienan* is really going to Callisto next year, not Metis and a few other asteroids."

"I don't believe it. An expedition to Callisto involves more than just a ship."

"They've already sent a supply ship and will send another later this year."

"Oh. I'll run this through my Astrolabe software and let you know what trajectory they could be looking at."

"Thanks, Yevgeny."

"Sure. Bye."

"Bye." Will closed the circuit and debated calling Dr. Enlai Tang, President of Mariner Institute of Technology and Mars's Nobel-prize winning exobiologist. Tang was also the most prominent Chinese on Mars, the Chinese government's unofficial spokesman, and two years earlier he had told Will he had been chosen to fly to Jupiter. But the topic was an awkward one for a videophone conversation. "Anisa, do you know where Dr. Enlai Tang is right now?"

The attaché checked the outpost's publicly-accessible data on the location of people. Many people blocked information on their location all or part of the time, but Tang usually didn't. "In his office at the university," she replied a second later.

"Thank you." Will rose and headed for the university.

It wasn't a long walk. He had entered the last pressure tunnel when his attaché beeped. It was Yevgeny. "Will, it's quite possible. Astrolabe shows that March 2047 is an excellent time to launch to Jupiter if you want to make a fifteen or sixteen month flight, and the delta-v is just about right for the amount of hydrogen. At the other end, the hydrogen and oxygen give roughly the right amount of delta-v to inject into orbit around Callisto."

"And if the nuclear engine failed?"

"Then you'd inject into an orbit around Jupiter, very close to the planet; that takes less delta-v, but you'd have to endure two passages through the planet's enormous radiation belts."

"And huddle together inside every bit of equipment and consumables you can wrap around yourselves," said Will. "I'm almost to Catalina to ask Enlai. Don't speak to anyone about this rumor, Yevgeny. Anyone."

"Got it. If I think of anything else, I'll let you know."

"Okay, thanks. Bye."

"Bye."

He closed the connection and resumed walking. The last pressure door sensed his presence and began to open. He squeezed through and blinked as he plunged into the full sunlight of Catalina Dome. He walked the forty-meter length of the old enclosure,

entered the grand entrance of Martech's original building—now one of four buildings in two of the old biomes—and hurried up the ramp to the third floor, where Enlai had his office. His friend was busily writing an email.

"Good sol, President Enlai."

"God sol, Commissioner Will." Enlai rose and came forward to shake Will's hand. "What brings you here on a Satursol?"

"A rumor; let me close the door." Will reached over and closed the door, and they sat in Enlai's two easy chairs at the front of his office. "It is being said that the *Tienan* will be heading to Callisto next March, not Metis."

Enlai's eyebrows went up. "I think you're listening to April fool's jokes, my friend."

"Perhaps, but the timing and delta-v is perfect for a launch to three asteroids in March 2047 or to Callisto on a fifteen or sixteen month trajectory. And I understand in the summer of 2047 there will be two Chinese vessels on Callisto already."

"There will indeed; I'm writing an email about some of the tests for organic materials planned for both Callisto and Ganymede."

"And between them, there will be a hundred tonnes of supplies and equipment."

"I don't know the amount, Will. They are big. We have quite an advanced biological and chemical laboratory on its way, able to detect compounds to the 1 part per billion range and able to incubate samples. The lab has nuclear power. It's on a lander with fuel for the landing. There's one for Callisto, one for Ganymede, and eventually one for Europa too. The landers are reusable so they can serve as cargo lifters. They're even man-rated so they can transport crew capsules. They have in-situ resource utilization;

they can drill into the crust, extract water, and make propellant. And yes, they have equipment for eventual human use. We plan a Callisto mission, after all, probably in 2050."

"That's the published date, I know. That's pretty sophisticated."

"Of course. China doesn't launch cheap stuff."

"So, am I to understand that next year you—a Nobel-prize winning biologist—will fly to three lifeless asteroids, then Earth, then to Jupiter three years later?"

"If all goes according to the current plan. We need training time for the crew. We're going to be together at least four years, maybe five."

"Okay. Thanks for the clarification." Will rose. He looked at Enlai. He didn't believe his friend, but he also knew that it was better if he didn't know about a secret plan. "Thanks, Enlai."

"Any time, Will."

3

Arrivals

4-6 April 2046

Two sols later, the caravels *Rigel* and *Aldebaran* blazed into Martian orbit after a three-minute encounter with the upper atmosphere. The first was owned and operated by Lufthansa Space Express; the second by United Spacelines. Both 300-tonne spacecraft were packed with 150 passengers and sixty tonnes of cargo, mostly luxury food items.

Within a sol both vehicles had arrived at Embarcadero, which made a perpetual ellipse around Mars that returned it to its closest point, above Aurorae, exactly one sol later. The two caravels docked to the station and passengers began to transfer to shuttles for delivery to the surface. Two new shuttles had arrived from Earth just hours earlier—they had flown with the *Rigel* and *Aldebaran* on the 110-day journey between planets—and each was equipped to bring 24 passengers to the surface. The Mars Shuttles *Nirgal* and *Kasei* were at Embarcadero as well, able to transport 24 down. Two more shuttles were on their way up to Embarcadero. Once they arrived, shuttles loaded up with people and fired their engines to dip their orbital ellipse into the atmosphere and burn off their speed. Soon shuttles began to descend to Aurorae and Dawes, the latter after making two dips into the atmosphere to change their orbit and move Dawes under their periapsis.

Minutes after landing, each arriving vehicle was greeted by two Conestogas, each able to move a dozen people from the landing pad to Andalus Square. At the Square, each arrival met his or her “buddy,” someone to introduce them to Mars and help them out the first week or two. On the late afternoon of April 5, when the second shuttle of the second sol brought down another twenty-four new Marsians, Father Greg Harris stood in the

square with his ten year old son, John, waiting for a particular passenger with a white clerical collar.

The priest was the last one out of the second Conestoga. Father Karol Miller was forty years old, of average height, with brown hair and bright blue eyes. When Greg saw him he waved and stepped forward so his own collar would be visible. Karol waved and walked over.

"Greg."

"Karol, welcome to Mars." They embraced. Then Karol leaned over. "And this is John?"

"Yes, my boy. He just got out of school."

"It's good to meet you, John."

"Thank you, Father." John reached out and shook hands with him. Greg watched closely to see whether Karol showed any hesitancy to shake hands with the son of a married Catholic priest. But Karol showed no hesitancy.

"You're tall for your age, I think."

"A little; my mother's tall."

"Let me take your bag," offered Greg, and he reached down to grab the large plastic container, which was surprisingly heavy in Martian gravity. "How was the flight down?"

"The usual; it puts you to sleep for twelve hours and makes you finger a rosary the last ten minutes. The whole flight from Earth was quite good. I met some marvelous people, and got to beat some of them in volleyball."

"The two ships had *two* gyms this time, rather than one."

“Well, each had 150 passengers instead of 125, so we needed the space. But as tight as they were, they really aren’t bad for three and a half month flights. I think most people are complaining they got only fifteen weeks of flight pay while the 450 arriving in August will get twenty-six.”

“Everything here’s pretty expensive, as I’m sure you know. Let’s go to the parsonage.”

“Past the church.”

Greg nodded and they set off across the square, heading for its northeast corner. The street entering the square from that corner revealed the façade of a church, toward which they headed. “How was the initial aerocapture with the ballute?” asked Greg. The flight had been the first to use ballutes, huge parachute-like balloons deployed behind the vehicles that were capable of withstanding very high entry temperatures.

“That was interesting. We had to enter zero-gee a few hours earlier and float around with bathrooms that were hard to use for twenty-four hours because they wanted to be sure the ballute deployed correctly. But it did and aerocapture was much gentler. The gee forces never got much above terrestrial gravity, even though we hit the atmosphere pretty fast.”

“You did your deceleration higher up and over a longer part of the arc,” agreed Greg. He looked at Thierry Colmar, who stopped as he walked across the square and waved to Greg.

“Good sol.”

“Good sol, Thierry.”

“Is this the new priest? Good sol, Father, welcome to Mars.”

“Merci beaucoup, Monsieur, je suis tres heureux d’etre ici, sur Mars.”

Thierry smiled; the priest had recognized his accent and had replied in French. They had a quick conversation, then Thierry headed on across the square.

“A nice fellow; a member of the church?”

“Yes and no. Thierry comes to mass maybe once a month. He’s also the leading member of Mars’s gay coalition.”

“Oh? Does he try to take communion?”

“No.”

“How big’s the coalition?”

“They say they have fifteen members.”

Karol nodded, digesting the information. They reached the corner of the square and stopped to admire the façade of the church of Jesus Christ and the Creator, a Nigerian denomination that had been on Mars seven years. The front was of vinyl siding made to look like brick, with two large, square windows over the door. Karol pointed. “Stained glass?”

“Stained plastic.”

“Of course. It looks nice. How many worshippers?”

“About sixty, Sunsols at 9 a.m. Then the mainline Protestants—Baptists and Presbyterians—worship there at 12:30. They have about one hundred.”

Karol looked at the church a moment, then headed down the street. In front of the façade he turned left and walked to the back of the church, where there was another large entrance with another pair of large, square windows overhead. The Catholic Church of

Aurorae. “Open!” he said and pulled on the door, and it opened. “Thank you,” he said to Greg, who nodded. The doors already had his voice print programmed into them.

They entered the church. They had the back half of the Nigerian church, a triangle of sacred space fifteen meters long, a maximum of twenty wide, and twenty high. There were one hundred chairs crowded inside. Karol looked around. “The parish has how many members?”

“Aurorae’s got about 1100 people right now, and a fifth of them are Catholic, so the parish has maybe 220 people. We get thirty at Satursol evening mass. Last Sunsol we had about one hundred for Easter.”

“This place was packed. I suppose this Sunsol when I celebrate mass it’ll be packed again. And by fall, with 1,400 people in Aurorae instead of 1,100, this place will be getting tight Sunsols and impossible on holy sols. Any possibility we can buy the other half of the church?”

“No, the Nigerians are doing well. Their Sunsol services last three hours and they rock the place. They’re getting a lot of non-Nigerians.”

“Then we need a new church.” He turned and headed for the door. Greg led him toward the northeast pressure tunnel. They entered a short tunnel that led to Andalus Northeast, an agricultural cylinder dome, but ten meters down the tunnel, before they reached the second pressure door, they turned right to face an airlock that said “Catholic Rectory” overhead. “I get my own airlock?”

“Indeed. This only leads to the rectory. Open Please.”

The door opened and they entered an airlock three meters square. As soon as the first door had closed and latched behind them, the second unlatched and opened. Sunlight poured in.

“Oh.” Karol was startled.

They stepped into a ten by twenty meter plastic Quonset hut with two large skylights not far from the airlock. The space was empty, except for a tile floor covering the airtight plastic bottom and a five-meter building occupying the farthest quarter of the space. Their footsteps echoed on the patio and Karol surveyed the transparent walls with Martian regolith pressed against it outside, contemplating how he could use the space. They reached the rectory building proper and opened the door. They entered a single room nine meters long and five wide, with a meter-wide ramp on the right side. The room was bare except for a sink, refrigerator, and microwave built into the counters and cabinets at the far end. Karol led them up the steep ramp to the second level, where he entered a small, bare study with windows opening on the patio. Behind it were two doors leading to a bathroom and a bedroom, respectively. The bedroom had a bed, closet, a chest of drawers, a desk overlooking the patio, and two chairs.

“Pretty simple and basic.” Karol nodded.

“We bought you the bare minimum. You can go shopping yourself and get exactly what you want in half a sol.”

“Good. Put the bag on the bed.” Karol sat in a chair, then gestured to Greg to sit in the other. John sat on the bed, watching the two men.

"I'll need your help in everything," Karol began. "Your unusual status as a married priest is unimportant to me because the church approved your continued service."

"Of course, one priest for four or five hundred Catholics is a pretty good ratio; two is extraordinary."

"Compared to what? The United States, which now has one priest for 5,000 Catholics? That's no way to run a church. As far as I'm concerned, there's always a priest shortage. Besides, we already have two parishes and we need to establish at least two more, at Dawes and Uzboi. I'd like to see parishes at Meridiani, Thymiamata, and Phobos as well. We have Catholics at all of them, so we need chapels and occasional services. How much can you travel? Once a month? Twice?"

"At least once. I'll have to talk to Anna about twice."

"Even once will help; you have family responsibilities and I don't."

"How can we afford it?"

"The diocese can afford it."

Greg was puzzled; they were part of the Archdiocese of Houston. "You arranged this with the Archdiocese?"

"Huh? No. I mean the Diocese of *Mars.* We're going to become a diocese. We have to. We've got enough believers to support travel, if they contribute. Have you seen the latest religion statistics for Mars?"

"No. The *World Christian Encyclopedia* surveyed us a few months ago."

"I know; I know the editors and asked them for the results. Mars is eighteen percent Catholic, seventeen percent Protestant, five percent Orthodox, and five percent

other Christian—I suppose that's the Latter Day Saints and the Nigerians. We're seven percent Buddhist, seven percent Hindu, six percent Confucian/Taoist, six percent Muslim, three percent Bahá'í, one percent Jewish, and point-five percent 'indigenous,' whatever that means. We're twenty-six percent secular. Of course, there are other ways of measuring 'secular' that include over half the population. We have a lot of people here who have a religious identity, send their kids to catechetical classes, maybe give a little money, and that's it."

"That's true of maybe half the Catholics."

"We'll work on that. My first priority is to reactivate the Catholics. We'll offer charismatic worship once a month and the Tridentine mass once a month; I can handle both of them and can help you with the Latin. If they prove popular, we'll expand them."

"That's an interesting strategy!"

"Well, you offer what people want. I also want to organize a little conference on 'God on Mars,' preferably at the university. I organized a conference on 'God in Poland' at the Warsaw Technical University ten years ago that worked out very well. It got a lot of people thinking. I hope the conference will work out even better here; I have a Master's degree in physics as well as a doctorate in sacred theology. I want to talk to the Orthodox, too; do they meet at all?"

"Not much. They're mostly Russians and they have no priest or even any deacons."

"Well, we'll invite them to have an Orthodox service regularly. With the new accords between the Vatican and the Patriarchate of Constantinople, my ordination is recognized by them, and I know the Greek mass."

“Really?”

“Greek and Russian are two of my languages. So I hope we can get the Orthodox revived a bit; if we can get their assistance, we’ll be almost one quarter of the population here and by far the strongest, most active religious community. After the Catholics, we need to revive the Christians in general.”

“You have ambitious plans! This is a tough audience; educated, secular, and skeptical.”

“I know. At Warsaw Technical University I baptized a dozen new Catholics, then at the Sorbonne I brought in six. On the flight out I activated one person’s faith.”

“That’s excellent.”

“It is possible. It really is. Our goal must be to convert Mars to Christ, and ultimately to bring Mars into the bosom of the church.”

Sarah Pannakar looked the length and breadth of the Gallerie for Ramesh Pradhan. He had been on the last shuttle to descend from Embarcadero and she had worked all sol at the hospital, so this was her first chance to see him. It had been over two years since she had seen him last, but they had been in email contact daily. She couldn’t wait to see him again.

They should have arranged a meeting point. The Gallerie was a big space, an El twenty meters wide and thirty long with an extension ten meters wide and thirty long. But for the free Welcoming Dinner sponsored by the Commission it was completely jammed with people, mostly waiting in lines to get food at any of the six restaurants and cafeterias. Most of the tables had been moved outside on the square, where the main

action would occur. She pushed through the crowds and walked all the way to the ice cream parlor at the farthest point, then turned around and walked back out the monumental Moorish entrance, where she stood, puzzled, for a moment.

"Sarah?" called a man leaning against a pillar nearby. She turned to look and realized Ramesh had grown a beard since she had last seen him. But he was still as handsome as she remembered.

"Oh, Ramesh, there you are! I didn't recognize you!"

"Sorry; it's not much of a beard and pretty ragged looking, for ten days; I mean sols." He corrected himself; it was the most common error a new arrival made. He walked over to her.

"It's so good to see you again, Ramesh. It's been two and a half years."

"A long time. A lot of changes in our lives." He leaned over and gave her a light kiss on the cheek and she smiled. "Where shall we get something to eat? I'm sorry I didn't get here sooner, I had a meeting."

"Already a meeting?"

"Yes, with Alexandra Lescov, to talk about construction projects."

"Tell me about it later. Deseret's line was moving pretty fast; let's go there." She led him inside.

"Ah yes, the Mormons. They've started quite a little commercial empire here."

"They began doing retail sales and food. Now they have a construction company as well. The Nigerian Christians do a lot of construction, especially skilled artisan work. The Japanese do molds for industrial processes and other specialized tasks for our manufacturing efforts. The Green World Community does large-scale agriculture."

“They’re all religiously or ethnically based, too. The only successful large business, otherwise, is Silvio’s. I’ll have to talk to him about what has to change in the business culture here.”

“They’re trying,” said Sarah. They had reached the end of the line, which was fairly close to the entrance. “How was the flight?”

“Pretty routine, I guess. I’m glad they paid the extra to fly me out on the 110-day trip; I don’t think I would have enjoyed 180 days of it. I’m not into zero-g volley ball.”

“You are a dull, workaholic type, aren’t you?”

He looked at her, a bit disappointed. “Well, I can be fun, you know.”

“Other than being a great conversationalist?”

He flinched, a bit embarrassed. “What do you do for fun, anyway?”

“Hiking. We have a hiking club here. I’ve walked all over the area. You should join; it’s a lot of fun.”

“Introduce me at the next meeting, then. I’ll come.”

“Great! This place has a lot of sports leagues, but I doubt you’ll want to join them. There’s a golf club, too.”

“I know, and I already have a reservation to check out the nine holes. What I want to find out about is the orchestra.”

“They’re pretty good, and they need people. What do you play?”

“Violin.”

They reached the trays and took one each, then went through the food line. There were several tables of choices and they checked them all out before loading up their plates. Then Sarah led him back outside and across the square to some friends.

“This is Jacaranda and Paul Nuri,” she said. “Let me introduce Ramesh Pradhan.”

“Ah, the man Sarah’s been emailing for the last year,” said Jacaranda, extending her hand. “It’s nice to meet you.”

“Thank you.” They shook hands. Ramesh smiled. He could place Jacaranda; she was a light-skinned African-American. “So, my reputation precedes me.”

“Quite a bit,” replied Paul, shaking hands with Ramesh. “Welcome to Mars.”

“Thank you, I’ve heard it many times today—I mean this sol—but I like to hear it.”

“We’re a warm and friendly people,” replied Jacaranda. “Please join us.”

They sat and Ramesh turned to Paul right away. “You said your last name was Nuri? That could be Pakistani or Indian.”

“It’s Iranian; my father was from Iran.”

“But you’re American.”

“Yes. My mother is part European-American, part African-American, and she has a bit of American Indian blood in her as well. So my heritage comes from four continents.”

“Interesting. I asked because I just couldn’t . . . place you.”

Paul laughed. “Many people can’t! I’m a world citizen; or maybe I should now say a citizen of the solar system.”

“As Bahá'ís should be,” commented Sarah, since Paul and Jacaranda were both Bahá'ís.

“And what do you do?” persisted Ramesh.

"Geology. I've been here four years. I started out studying the Tharsis uplift, got reassigned to Uzboi, spent nine months as a member of the team charting the geology of the borough, then got reassigned to the big volcanoes. It looks like Olympus Mons could blow in another few million years."

"Really? I guess that's pretty soon, for Mars," said Ramesh.

"Soon enough for a short story in *Mars This Sol*," added Jacaranda.

"Oh, that's where I've seen your name! You're one of the staff writers!"

Jacaranda nodded. "We've got four full time journalists/reporters up here and four more on Earth. We tend to think of *Mars This Sol* as our local radio station, television channel, and daily newspaper, but it has a thousand times more viewers on Earth. So it's quite a challenge to produce for it."

"You do Mars stories for various terrestrial outlets as well."

"Sure, all of us are stringers. It's the main way *Mars This Sol* covers its expenses, since we're no longer a part of the Commission."

"Now, I'm curious to know what you'll do up here," Paul said to Ramesh. "Sarah was telling us that you were one of the chief construction supervisors of the Molucca Bridge-Tunnel complex connecting Sumatra to Singapore, and that you had worked on the Sri Lanka-India Bridge-Tunnel complex as well. And if I remember right, you were also an engineer on the proposed Calcutta to Guangzhou Highway, and had even been invited to participate in the Korea-Japan Tunnel Project."

"Well, that one won't happen for several more decades. The robotic tunneling technology has to get much better to make practical the construction of twenty-five, fifty, and seventy-five kilometer tunnels—because three tunnels are needed to hop from Japan

to Korea via two islands. I was a pretty low-level engineer on the Calcutta to Guangzhou Highway. I was actually doing a certain amount of geology on that project in eastern Burma."

"It'll be finished in three more years, and India will have a good road connection to China," said Jacaranda. 'It's amazing all the road building going on in Asia right now! The Silk Highway connecting western China to Central Asia, and from there to Europe; just think, one can now drive from London to Seoul!"

"If you'd ever want to," replied Ramesh. "It'd be quite an adventure. The Indian link through Afghanistan and the Khyber Pass will be upgraded in a few years. Malaysia's pushing for good highways to both India and China, so the time is coming when one can leave northern Scotland and drive to Jakarta, Indonesia!"

"He also participated on a team that entered the Gibraltar Tunnel competition," added Sarah, admiringly.

"But we lost that one," added Ramesh quickly. "And now Spain has lost its stomach for a road connection to Morocco."

"So, why Mars?" asked Paul. "I doubt we can afford your salary."

"Well, I have always been a *junior* member of these teams. Don't let Sarah mislead you about that. I've always been fascinated by mechanization and use of robotic technology for road, bridge, and tunnel construction. Tunneling has used robotic techniques the most, for obvious reasons; it's dangerous, and because you're working through reasonably uniform subsurface layers, away from people and animals, the work is fairly predictable. I was on a team that proposed using robotic equipment for building the new highway between Lhasa and India. As you know, India's paying for most of the

road, to tie Tibet into India's economy now that they're semi-independent from the Chinese. I was hopeful we'd get the contract; we were an Indian firm and proposing to use the technique only in Tibet, so we wouldn't displace Indian workers. But *no one* wanted to use robotic highway construction techniques, even at six thousand meters where the human workers can barely breathe. The unions opposed it and both governments didn't want to undermine a major type of work that people can still do."

"But on Mars, robotic highway construction is essential."

"Exactly. We have 1,500 kilometers of heavily trafficked road between here at Uzboi, and 8,000 kilometers between here and Cassini. Then there are the exploration routes: the Circumnavigational Trail around the equator, the Virgo and Pisces Trails circling the planet at 35 north and 40 south respectively, the Polar Trail that connects both poles via Aurorae, the Cassini-Hellas Trail, the Tharsis Trail. . . we have 100,000 kilometers of trails cleared to varying degrees. We've blasted routes up cliffs in several places and built viaducts over ravines. We've emplaced fifty oases, and most have a pressurized shelter, a well, a solar array, a wind turbine, methane and oxygen tanks, a meteorology station, and emergency supplies. It's been very labor intensive and maintaining the system is burdensome. But with new software and some modifications we can use telerobotic bulldozers to maintain and improve the routes."

"How autonomous will they be?" asked Paul.

"One operator here in Aurorae can run three to ten bulldozers at once. Three if they're near each other and have to be coordinated; ten if they're isolated and doing simple work. Right now we're looking at widening Uzboi Trail and renaming it Uzboi Highway, because it'll be eight meters wide. We want to do the entire job in half a year

with six of the new heavy telerobotic bulldozers. The next phase will be a robotic graveler, which could gravel the entire route in four years. Uzboi Highway will be designed for two-way traffic and it'll have a speed limit of eighty kilometers per hour instead of forty, though most cargo vehicles won't go that fast."

"How will you power the construction equipment; nukes?" asked Jacaranda.

Ramesh shook his head. "We'll beam in the power by microwave via Phobos."

"Really?" Paul was impressed. "The highway will make the trip a one-sol affair."

"Exactly. Right now trucks take two or even three sols. The road surface will be better, so fuel efficiency will be better. Even Cassini will be a 75 hour drive if a vehicle averages eighty kilometers per hour. That's three sols."

"You'll revolutionize vacations, though," quipped Jacaranda. "Because right now people take a ten-sol vacation and serve as crew on a robotic truck going to Cassini. The portahab is pretty luxurious."

Ramesh laughed. "Well, they can ride it round trip, instead!"

"Do you think we can ever upgrade these roads to *real* highways?" asked Jacaranda.

Ramesh shrugged. "Well, the highway to Cassini won't look like the Calcutta to Guangzhou route any time soon. But there will be future upgrades, I'm sure. A well-graded and graveled roadbed, robotically maintained, can accommodate speeds of eighty or even one hundred kilometers per hour."

"Really?" said Paul, skeptically.

"Sure. The Dalton Highway in Alaska was built over seventy years ago to facilitate construction of the oil pipeline. It's eight meters wide, the gravel roadbed is one

to three meters thick, it's seven hundred fifty kilometers long, and the speed limit is eighty kilometers per hour. It carries much heavier traffic than any of our highways will see any time soon. Our road won't have to deal with rain, snow, mud, permafrost, vegetation, floods, bridging of rivers, corrosion, mud slides, or eroding slopes. It can be a half meter of gravel on top of regolith in most places. But eventually we could install a nickel-iron roadbed. The gravel extraction machinery will magnetically separate about twelve tonnes of nickel-iron per kilometer of roadbed, which we plan to recover. We already have three million tonnes of processed nickel-iron. Formed into sheets eight meters wide and a centimeter thick, the existing material is already enough to pave 4,000 kilometers of heavily traveled trails."

"That's amazing," said Jacaranda. "I'll have to interview you for a story."

"Then let's consider this 'deep background' only," replied Ramesh, cautiously. "The other project I have is transportation inside Aurorae Outpost. Our population is already a thousand and could be ten thousand in a decade. The old system of pedestrian tunnels with slow, one-way vehicle traffic is reaching its limit. We need to install high-speed vehicle tunnels; essentially a robotic bus system or subway on wheels."

"It's a long walk from one end to the other," agreed Paul.

"Almost a kilometer; about fifteen minutes. If Aurorae's ten times as big the walk will become unreasonable. We have a right of way along the southern edge of the outpost and another one roughly paralleling it, one to three hundred meters farther north. We'll have to build up those transportation corridors."

“It sounds like you’ve got your work cut out for you,” said Jacaranda. She looked at the stage. “They’re getting ready to start the program soon, so we had better get our coffee and desert.”

All four of them rose. Sarah led Ramesh over to a coffee table in one of the restaurants where they could fill cups of Indian coffee made with streamed milk. He sipped it. “How nice. It reminds me of my aunt’s.”

“She was an expert in making it?”

“No, she used cheap coffee beans!”

Sarah laughed. “This is ‘marabica’ brand; our own local type. It’ll get better as we adjust the soil and climate.”

“It’s not bad.” They headed back to the table. “What would you like to do after the dinner?”

“Well . . . maybe a walk around the Outpost. We’ve exchanged emails for two years, we know about each other’s childhoods, educations, dreams for the future. . . what we need now is something deeper and more spontaneous.”

“How deep and spontaneous do you mean?”

“Well, I don’t mean sex; not yet, anyway. Our parents want us to marry, we’re interested in it, we’ve said so, but we need to be sure we’re ready.”

He nodded. “Yes, that would be good. You’re a remarkable woman, Sarah, and a beautiful one as well.”

“Thank you, and I find you. . . charming, Ramesh.”

He smiled; he liked the compliment. They headed back to the table. They were just in time. Paul pointed. “Uncle Will’s about to talk.”

Ramesh looked. Will Elliott was approaching the podium. “I didn’t realize he looks so old. He looks younger on tv!”

“He’ll be sixty next month,” replied Paul. “He’s now been on Mars twenty-five years.”

“That’s amazing.”

Will Elliott stepped onto the stage and walked to the podium on one side. He paused briefly for the crowd to see him and quiet a bit.

“I hope you’ve all enjoyed your free dinner,” he began. “It’s a tradition ever since Columbus 2 to have a big dinner to welcome a wave of people from Earth. We’ll do it again in September when 450 more people will land on Mars, our largest single immigration yet. But that will be the last free dinner, I’m afraid. The tradition can no longer be sustained. Not only has it become expensive, but there’s no one place that can hold us all. The Gallerie has seen several of these dinners, but it’s now too small. Andalus Square can hold several thousand, but safety issues limit the crowd in here. For this reason, Cathay Square is now becoming a focus of commercial development as well, and we will be developing more commercial spaces inside the Outpost to decentralize its facilities. Columbiad fourteen will have a welcoming dinner just for the new arrivals, with a video feed for everyone else to watch anywhere they wish to be.

“To the 300 people who have just landed over the last week, welcome to Mars. Shuttles have taken you to Aurorae, Dawes, and Phobos. Airplanes and mobilhabs have already moved many of you to Cassini, Uzboi, Meridiani, Thymiamata, New Tokyo, and Aram. You have come to a world that, as of this sol, has 1,847 people. By the end of the year, 525 more arrivals—that includes 75 Chinese on their own ship—and a natural

increase of 110 will raise our population to about 2482. By the end of the columbiad, the number of Marsians is projected to be closing in on 2,650; we will have gained almost a thousand in just twenty-six months! We're looking at an increase from immigration of 900 for the fourteenth columbiad. Our fifteen-year plan to increase the population of Mars to 8,000 appears achievable in ten years.

"The three hundred of you are the heavy-duty workers: construction people, road builders, specialists in heavy equipment, welders, roboticists. We need you to finish our preparations for the 525 who arrive in seven months. That wave has scientists, medical researchers, businessmen, and artists. You will work hard for long hours over the next half year and we will be immensely grateful.

"Together, the 825 workers who arrive this year provide Mars with three abilities for making the thirteenth columbiad a success. The first, and perhaps most important ability is to increase our production of platinum-group metals. The discovery of Uzboi's ataxite could not have come at a better time. The outpost already has a hundred people and is producing nearly a tonne of PGMs per sol; by the end of this year Uzboi will have two hundred people and a goal of doubling PGM output. Here at Aurorae, our manufacturing outputs have been modified to support Uzboi. Basically, over half of our arrivals will support PGM production directly or indirectly. If the price remains high, Mars actually has the possibility of becoming economically self-sufficient. That doesn't mean we don't want continued subsidies by governments; we do, and we believe it remains in their interest to provide them, especially to support investment by their nationals. We hope and suspect that Mars is about to reach a breakthrough where private investment is concerned, and national subsidies will help that happen sooner.

"The ability to attract more private investment is our second new ability that you make possible. Each columbiad, our expanded population and resources reach a critical mass for something. This columbiad, our manufacturing capacities appear to be on the brink. We are no longer in the position just to export grain, wine, and plastic office furniture to low Earth orbit and the moon. We're now in the position to send them a complete orbiting hotel, a contract we appear likely to get soon because with our new third-generation 'Arion' Mars-shuttle we can launch sixty to seventy tonnes to Mars orbit at once. This gives us the ability to assemble some pretty substantial, large inflatable structures down here and launch them into orbit, where we can push them to Earth pretty easily. We can also make organic solar arrays and a variety of increasingly sophisticated manufactured goods. With low earth orbit manufacturing finally taking off, we are in the position to provide the factories with some of their crucial components.

"And the third new ability you bring us is greater capacity to explore. Our scientific staffing grows by another one hundred, or fifty percent. Our engineering talent grows about the same. The sol is coming when Mars will be in the position to launch major expeditions to the asteroid belt or even to the outer planets. If India wants to send a ship and crew to Jupiter, this is the place to look; we can make the ships, supply the fuel, plan the scientific projects, and we have enough Indians to provide the entire crew! In short, we can partner with almost anyone willing to spend some money.

"So we are thrilled you are here. The 825 people arriving this columbiad are a cross section of humanity. They are nineteen percent American, eighteen percent European Union, fifteen percent Chinese, nine percent Indian, seven percent Russian, seven percent Japanese, seven percent Latin American, five percent Canadian, Australian,

or New Zealander, five percent from the Middle East, two percent Southeast Asian, two percent Korean, and two percent African, and three percent of various mixed national backgrounds. We are proof that humanity can live together peacefully and in prosperity, under democracy and the rule of law. We are proof that the Earth really is one country, just as Mars is one country. We are proof that a small, dedicated group of people can forge a new nation in the wilderness of space, a nation capable of great cultural and social contributions to the human race while pulling its own weight economically. In short, we already are and can be a great source of hope and inspiration for each successive generation on our mother world. I can't wait to see what contributions you, our new residents, will make. Thank you."

4

A New Term

May 15, 2046

Bright sunlight greeted Helmut and Clara, making them blink momentarily. They had entered a garden ten meters wide and six long. Most of it was grass, but there was a small fountain and pool in one corner with a small statue of a meditating Buddha looking it over.

"Beautiful, isn't it?" asked Simeon Afigbo. He pointed. "The cylinder is a standard twenty meter by ten meter, with housing occupying fourteen meters of the length. In this case we have a two-level duplex townhouse setup; two owners, each with part of the first floor and part of the second. Both have 140 square meters, three bedrooms, two baths. Both have access to the garden. The cylinder has an emergency exit in back to another cylinder that abuts it."

Helmut looked at Clara, who looked up at the balcony level with its living room open to the garden. The design had charm. "And the sale price for each unit is three million redbacks?" she asked.

"Yes. These are already sold; families will be moving in next month."

"And how much would it cost if we asked you to sell us one of these cylinders with a ten by ten meter yard and a two-story, ten by ten meter house? The house would have 200 square meters, I guess."

"Yes, that's correct. About four million redbacks," said Simeon. "If you purchased it inside a dome, it'd cost at least five million. Cowdrey Construction can do it for closer to three million, but without the garden."

Helmut nodded. It was an immense amount of money; but then, on Mars everything cost about five to ten times as much as on Earth.

"When could you have it ready?" asked Clara.

Simeon considered. "This is the worst time to ask me. With three hundred new arrivals, everyone's scrambling for new housing, moving up and leaving the older properties for the new people. And once the chaos settles down a bit, 450 more people arrive and the scramble begins again. On the other hand, I just gained ten more workers. The Construction Department gained two hundred twenty and plans to turn out all sorts of new things more quickly. I'd say my current backlog of orders will last about six months. So some time in the fall I could complete a house of the sort you're asking about. Of course, completion time and cost are both dependent on the final design and the accessories you choose."

Clara nodded; she was satisfied. "Alright, let's make an appointment next week to draw up the contract," suggested Helmut. "We'll get you specifications—the rooms we want, their rough sizes and locations, etc.—in three sols."

"Okay, that'll work. Go to the Afigbo Construction website to see our suggested room layouts and sizes. The choices of accessories and colors are all listed there as well. You can literally design your own home and submit the result to the website for an automated cost estimate."

"We'll do that, then," agreed Helmut.

They all turned back toward the airlock and tunnel that had brought them to the house. "So, you returned from Ceres almost five months ago," said Simeon.

"Yes, and three months ago I started working for the Asteroid Commission as the Director of Ceres Exploration. It's my job to run the equipment we left there—we still have three functioning Prospectors—make sure the data is being used by scientists, and encourage publication of the results. I also end up being the world's advocate; I want to see humanity return."

"It sounded like a pretty interesting place to me," said Simeon. "You will certainly be in the position to purchase a house such as you propose. Do you have one child? Two?"

"One who's six, and one on the way in six months," added Clara. "Meanwhile, I'm working for the Asteroid Commission in Mission Control for the *Heinrich Olbers*, which launches for Vesta next month."

"How exciting," said Simeon. "I keep telling my younger son to plan to study hard at Martech and become an explorer. Of course, he's just four, so he doesn't understand!"

"Our son is into geology already," replied Helmut. "I think he has the potential to become quite a scientist."

"They grow up so fast," agreed Simeon. They paused by the last airlock door and waited for it to open for them, admitting them into Zanzibar. They all walked in and shook hands with Simeon, who went on his way. Clara looked around. The newly completed housing looked like it was made of wood, in imitation of the huge, handsome wooden structures built on Madagascar just south of Zanzibar. They were attractive but expensive. "Let's walk around and get a feel for the neighborhood."

He nodded. “Of course, we could ask for the unit to be built closer to Andalus. He owns options on land between Caribbean and Andalus Northeast.”

“True, but I like this dome, and it won’t be remote for long.”

“I suppose not. I wonder how long it’ll take to sell our unit.”

“I understand units in Columbia rarely last more than a few weeks. We’ll need to clean it up, though.”

“It’s a shame it won’t bring us more money; it actually decreased in value, especially with the inflation.” He looked at the new housing. “I rather like living in a big dome. These units are very attractive.”

“We could afford five million, too. Our place is worth 1.4 million, and it’s half paid for. Our combined salaries are 1.1 million per year.”

“I know, but I also like the idea of having a yard of our own in our own little bubble.”

She chuckled. “With two hundred square meters of enclosure, we could almost feed ourselves! That’s enough to feed and recycle the wastes of two adults. We’d have to build a low house with a rooftop garden.”

“I’ll leave a venture like that to Kristoff and other horticulturalists! I bet it won’t be long before someone asks Afigbo to build them a bubble house in Little Colorado Canyon. You could buy a used ranger from the Commission for two million redbacks, spend another million on a pressurized garage, and commute to work! I doubt the Borough will like the idea because of all the potential problems, but I suppose it’s a matter of time and income.” He looked at her. “So, shall we commission a house from Afigbo?”

She nodded. “Yes. His construction quality is good and there are no formal business complaints against him. I’d like a big house for our soon-to-be two kids. The safety of the bubbles is fine. And it would be kind of fun having our own little piece of Mars.”

“We’ll buy a lot on Little Colorado for that purpose; these enclosures cut you off from the ground itself.” Helmut nodded. “Okay, let’s go home and take a look at the website, so we can work on the design.”

Will didn’t rise an hour before dawn very often. Sunrise was a good time to get up; it rose about 7:15 a.m. normally, give or take twenty minutes, and if he got up then he could usually get to the office by 8:30. The kids were out of the house and no longer consumed an hour of morning, so at times he rose even later.

But this sol was different. His meeting with the Board of Trustees of the Mars Commission—the national representatives—was scheduled to start at 7:10 a.m. It was a strange time and he was still suspicious that the U.S. representative, who had pushed the time, had chosen it to inconvenience him, perhaps hoping he’d be less fresh at that hour. When he entered Andalus Dome from the side tunnel where his home was located, he could tell by the sky that sunrise was just a few minutes away. Will glanced at his watch; it was 6:45, and sunrise was about 7:00 when Mars was at aphelion during northern hemisphere summer, as it was at the time. He called security and asked them to unlock the entrance to the campanile; it was a perfect time for a little detour.

The campanile, attached to the Mars Authority building on Andalus Square, had proved popular. Forty meters high, with ample windows for observation on top, it was

relatively easy to ascend in Martian gravity using a tight spiral ramp. Normally it was open 10 a.m. to 7 p.m. Its windows were covered by transparent plastic so no one could fall or jump; the big potential problem the campanile presented was the fact that its top was just ten meters below the dome and thus could provide a platform for damaging the dome, should someone want to commit an act of terrorism. Marsians hated to have to worry about such a terrestrial problem, but they had to protect themselves. Computers watched visitors to the campanile closely.

Will jogged up the ramp and reached the top a minute or two before sunrise. That morning he was startled to see a haze filling the Aurorae Valley, completely obscuring the escarpment twenty kilometers to the north and rendering indistinct the far end of Layercake Mesa, just a half kilometer away. The haze was not very thick; Phobos, overhead and half full, was fairly clear. No doubt it was a product of 160,000 square meters of enclosures; they leaked minute amounts of oxygen and water into the atmosphere, and the latter, at Martian nocturnal temperatures, became “habitation fog,” as it was often called around Siberian villages in winter.

The moments before dawn had a surprising amount of light. The Martian atmosphere was fairly clear at the time, but it was able to refract some light. A glow in the haze to the north told him that sunlight had already touched the top of the escarpment, 1,500 meters above the valley floor. The various domes were visible as indistinct circular bumps to the east and cylindrical bumps to the west. Andalus never used thermal blankets at night, so it was always wide open to the sky; but the others did, especially the agricultural ones. With dawn approaching, the thermal blankets were lowered on the east-facing side to let in the morning sunlight. Facing west, he could look into the cylinder

domes of Cathay, Punjab, and Zanzibar and see the lights of buildings. A lot of people were up already.

Then the sun peeked above the horizon, immediately flooding the valley with orange light. He could now see colors. The dawn rays formed glorious beams that shone like spotlights through the haze, illuminating patches of the valley floor while other spots were more obscured. He could now see that the haze had billows to it; it was more like a low cloud cover. Even more surprising, now that he had some sunlight to scan the area, was the sparkling coat of frost on the reg between the domes and decking the range beyond. Boat Rock's north-facing cliff glistened in the auroral beams just three hundred meters away.

He had never seen the valley like this before. The haze lent it a mystery while also giving it a terrestrial familiarity. As the disc of the sun cleared the horizon and seemed to gather strength, the haze began to diminish; it was an ephemeral thing and would burn off in half an hour. Beyond the aesthetics, he wondered whether the presence of so much water vapor—for the air was saturated, admittedly at about ninety below zero centigrade, but saturated nonetheless—had an effect on the peroxides in the soil.

He watched for a few minutes, then glanced at his watch. He was now late for the meeting, so he turned and hurried down the ramp to the square. It didn't matter too much; his opening statement was already taped and he had to wait for their questions. That sol, round trip communication with Earth took thirteen minutes.

He entered his office and activated his attaché as soon as he sat at his desk. The video conference call was already coming in. He watched the last few minutes of his personal statement. "In short, over the last twenty-five years or twelve columbiads Mars's

population has grown an average of sixty percent per columbiad, which converts into a growth of twenty-six percent per year. This growth rate will not continue. But let us assume Mars grows at 1,450 per columbiad. We will have 900 arrivals in 2048, 750 of whom stay long term, and those 750 people will have 700 children in the following decade, so 1,450 is based on existing equipment. At that rate, by the end of the century—fifty-four years and twenty-four columbiads from now—Mars will have between thirty-five and forty thousand people. If you assume a mere ten percent annual growth rate, in fifty-four years Mars will have a quarter of a million people; in a century, thirty-two million.

"There is no question that Mars has the resources to support this number of people. Dusty Red has 125 million square kilometers, equal to all of Earth's dry land; currently we are sustaining a population of 5,000 per square kilometer under our domes, several times the density of the Earth's most densely populated nations. The bigger issue is whether Mars can economically sustain a large population. In the last twenty-five years, its economic basis has gradually shifted from complete dependence on government funding to a mixture of private investment and exports in the context of government funding. In the next columbiad, Mars may export enough to cover its sustainability costs, the first time this has happened. Its economic capacities are growing rapidly, and with the expansion in earth orbital manufacturing and lunar tourism, Mars is attracting more private investment. Support by governments can be expected to continue to decrease, but it will remain one of the three pillars in the development of this world. By subsidizing Marsian development, governments guarantee their businesses a supportive environment for investing and a voice for themselves in the planet's expansion.

"In the next five years, I hope we will see a great increase in exports and investment without seeing a decrease in government funding. This world's needs are potentially infinite; so is its potential contribution to humanity. I am excited by the possibility of shepherding Mars's development on your behalf."

Will immediately looked at the faces of the twenty-four national representatives for an indication of their reaction. He had taped the statement the night before and had tried to steer around several possible pitfalls. The image, however, did not have enough resolution for him to see much. The American, Pete Zubko, looked skeptical; the Japanese, Toru Otsu, pensive; the Russian, Tanya Pokorny, was smiling. Also present were a European Space Agency representative; representatives of various European countries with significant space efforts, such as Britain, France, Germany, Italy, Netherlands, Poland, and Spain; Argentina; Brazil; Canada; China; Egypt; India; Iran; Korea; Mexico; Nigeria; Pakistan; South Africa; and Ukraine. The Board was a United Nations in miniature, and just as disunified.

"Thank you, Dr. Elliott," exclaimed Sonia Cassetta, the Italian representative, who was the chair of the day. "I suspect most of us have questions. We'll give you three questions, then take a break for your answers to arrive. I was very impressed by your summary of the past quarter century. It's hard to believe human beings have been on Mars that long, and amazing to contemplate that it has about 2,000 people. Its future does indeed seem bright, though no one knows whether it will prove as revolutionary as the western hemisphere proved to be to the eastern hemisphere. So my question is, where do you see Mars going in the next ten or twenty years? That's a short time frame, but longer

than the five year term you are being considered for." She turned to the American. "Dr. Zubko?"

"Thanks, Dr. Cassetta. My question is very simple. Dr. Elliott has given us a glorious vision of Mars's future. But the fact is that only a small fraction of our citizens think Mars is important, and most think we're spending too much money on the place instead of providing services to terrestrial citizens. So why should all of our nations continue to spend billions on Mars? In the last thirty-five years—since the inception of Project Columbus—the various governments have spent about five hundred billion dollars on Mars."

Cassetta turned next to Pokorny. "My question is related," she said. "What benefits do you see coming back to Earth in the next five to ten years?"

The image from Earth froze; they had suspended transmission so they could get coffee, chat about his remarks, and plan their next batch of three questions. Will replayed the three questions and asked his attaché to convert them to text. He put all three up on his screen and spent a minute jotting notes; his ability to organize a clear and persuasive response was one of his strengths. For some, a thirteen-minute time delay would be a barrier to communication, but in his two and half decades on Mars he had learned how to use the time to his advantage.

"It's good to see all of you again," he began. "I welcome this opportunity to discuss Mars with all of you and look forward to a useful, productive exchange. I think I will rearrange the three questions slightly and get to Dr. Cassetta's last. First, then, why should the citizens of the United States, or any other nation, spend some of their tax money on Mars. I would submit that Mars is quite important to the citizens of most of the

world's nations, compared to the money they are investing. People can easily produce a list of the ten or twenty items that are the most important to them and their tax money. But they spend money on a lot more items than ten or twenty. Mars will make the top ten list of very few citizens. It will make the top twenty list of more, but still a small fraction of all citizens. Meanwhile, those citizens are spending more money every year on French fries than on Mars; more on pet care than on Mars; more on visits to amusement parks than on Mars. Far more is spent by a major city to maintain and improve its roads and bridges every year than the entire United States spends on Mars. At the moment, no government is spending more than two billion dollars per year on Mars. So I would ask, if ten percent of all Americans list Mars as "important" but not as "very important," why isn't the U.S. spending ten billion per year on Mars? That's still a thousandth of its twenty trillion per year federal budget. With that kind of financial support we could commence work on terraforming.

"Another approach stresses all the obvious and measurable benefits. The fuel cells in people's cars, the solar arrays on their roofs, the attachés on their desks, all benefited from our technological investments. Their economic growth has benefited immensely from automation; we are one of the investors in robotics. They can fly to Earth orbit on vacation for half a million dollars because we have helped to maintain the demand for transportation to orbit. So we have played an integral part in the prosperity and comfort they enjoy, and will continue to make a direct contribution to it.

"Finally, there are practical reasons to which I alluded. Government money is followed by private investment and buys a nation a voice in our development. If nations

want a vote, they have to invest. Voters understand that also; the argument is made in the media all the time.

"Now, turning to tangible benefits in the next five to ten years. I've already mentioned a few, such as cheaper fuel cells and solar arrays, to which we have made a contribution, and robotics in general. The big benefit to the Russian people is probably our enclosure technology; bubbles are going up all over your country, Canada, and Scandinavia, either to allow construction of buildings in the winter or to provide more affluent people some comfortable outdoor space in the winter. The former Mars Construction Institute in Moscow now pioneers new construction techniques for cold climates in general. It's even under contract to contribute to the Chinese effort to send a crew to Callisto. Our Public Information people maintain a lengthy web page that just focuses on spinoffs of the Mars program.

"Those spinoffs are some of the results of Mars exploration over the next ten or twenty years. That's one place Mars will be going. Another will be an intense effort to study this planet's climatological history. We now know that the immense polar terrains in the north and south largely melt and evaporate away every few million years and the ice gets deposited in the equatorial regions, though some permafrost has always survived at both poles all the way back to the Noachian era. The Tharsis volcanoes retain ice caps from the last equatorial ice age. The atmospheric pressure varies up and down several fold. If we want to do any terraforming—even simple, crude, cheap efforts—we have to understand the natural variability and what drives it. That has to be a priority in the next two decades, because terraforming won't begin any sooner than that.

"Otherwise, the next decade or two will be times of expanding industrial capacity, with the goal of increasing exports to Earth orbit and other places, and increasing Marsian financial self-sufficiency. We now import 1.4 tonnes of new equipment per new arrival and 450 kilograms per person per columbiad; we'd like to halve those numbers in five years. The less we have to spend, the more we earn, the better."

It was a standard answer. He sent it and dashed downstairs to grab a coffee and a bagel. When he came back up they had replied.

"Thanks, Dr. Elliott, for your replies, and we have a few additional questions." Cassetta turned to Zubko.

"I get a follow up, and it's quite simple: you say a ten percent growth rate per year—twenty percent per columbiad—is conservative, but it projects 32 million people on Mars in 2146, and that would amount to six million arrivals every columbiad in a century. How in God's name do you expect that to happen, not to mention the few million tonnes of imports and exports they'd need and produce?" He moved his right hand dramatically to underline the point.

Cassetta recognized the Brazilian representative. "Dr. Elliott, one issue that simply won't go away for many of us: you are fairly independent. As hard as you try to consult with us, we often feel left in the dark about your day-to-day decisions. We'd like assurances you will inform us much better of your operations."

Several representatives nodded; it was a complaint Will anticipated. Cassetta turned to the representative of Japan. "Another major issue for all of us is employment of our own workers. The growth of Mars's population and industry is good for you; the

decrease of imports from Earth is good for you; but all those trends are bad for us. It is not clear we should pay to subsidize competition."

"One more; the first was a follow-up," exclaimed Cassetta. "The Chinese representative, Dr. Cheng Weiming."

"Good sol, Dr. Elliott," began Dr. Cheng. "You have mentioned on two occasions now that our governments are buying a voice over Mars. That raises the question Marsian independence. We get the impression you are rushing it as fast as you can. We'd like to hear your opinion about this matter quite frankly."

That question chilled Will; it was the hardest one to deal with. Cassetta seemed to feel his embarrassment over ninety million kilometers of space. "Back to you, Dr. Elliott," she said.

The picture froze again. Will considered the questions a moment, then hit reply. "Again, the questions are connected together. Can Mars import six million people during a single opposition? We just imported 750, which is 125 times the number we brought here twenty-five years ago. We couldn't have done it with four-person interplanetary transit vehicles and the first-generation Mars shuttle. We now have 150-person caravels and third generation shuttles. If a larger shuttle is built to carry people to low earth orbit, a much larger interplanetary vehicle than the caravel will be possible; perhaps something in the 500 to 1,000 passenger class. Could Christopher Columbus have envisioned passenger ships carrying 10,000 people across the Earth's oceans? A half century from now we could be using space elevators, tethers, gaseous-core engines, and other promising technologies, and it could be possible to move millions between the planets every twenty-six months, probably continuously and not compressed into a nine-month

window every 2.2 years. So I would not rule out the possibility that investment in technology can't accomplish such a thing. As Mars grows, if it sank two billion dollars per year into advancing space transportation, that's two hundred billion in a century. That can accomplish a lot.

"As for the issue of competition with national industries and workers, Mars is in an intimate economic relationship with all of your nations. The relationship involves imports, exports, government subsidies, investments, economic spinoffs, profits, and other mutual benefits. We are sometimes in competition with each other. That's not altogether bad because it makes us more efficient. Our mutual relationships have advantages and disadvantages, but I think we all agree the advantages ultimately are greater.

"Our communications are never as efficient as we all would like, and we never are able to be as fully informed as we all would like. The distance between Earth and Mars is a hundred million kilometers today; sometimes it is four hundred million. The time delay makes communication tedious. All of us have a tendency to fall back on local face-to-face relationships. The Mars Commission has to have one of two problems: either the Commissioner can communicate easily and smoothly with the national representatives and terrestrial staff, but faces a major communications barrier with the Marsian staff; or the Commissioner is located on Mars and can communicate with the Marsian staff easily, but faces slow, complicated communications with the terrestrial side of the operation. We have alternated between these two difficulties. I visited Earth two years ago and I feel the Commissioner should visit the planet on which he is not located every four years. When transportation gets faster and easier it should be every two years.

The visits provide an essential glue for our operation. When in doubt, the principle should be that the Marsian staff makes the operational decisions, because their presence on Mars is the point of the Commission.

"And this points leads inevitably to the issue of independence. It is increasingly being said here that it makes no sense for Marsians to make decisions about running Mars and spending their own export revenue on behalf of an outside, unelected organization, when Marsians can make their own decisions about running Mars and spending their own export revenue on behalf of their own democratically elected institutions. How does one respond to that argument? There really is only one counterargument that makes sense: that Mars is a project of all of humanity and that governments and peoples other than Marsian ones are involved. These other governments are investing money in Mars, so they have a say. If they stop investing money in Mars, their role in Marsian decision making inevitably will have to diminish.

"So, what's my view of Marsian independence? I see Mars as a partnership involving governments, investors, and residents. The governments have the Board of Trustees, they invest money, and they approve the Commissioner. The investors are represented in terms of their property ownership in the Mars Landowners Assembly. The residents have the Mars Residents Council. The Assembly and Council approve taxation rates and expenditures. The residents elect a Chief Minister via the Council. The relative power of these three bodies and their chosen representatives has changed every few years over the last two and a half decades, and it will continue to change. Obviously, the trend is toward the residents; there are more and more of them all the time and their economic output keeps increasing. The residents are now producing twice as much as the

governments are giving. If the governments give less, inevitably their ability to influence events on Mars will decrease. For that matter, the ability of the Commissioner to 'run' the planet will decrease."

He hit send and rose to stretch. He had had to answer those questions right, but there was no right answer where independence was concerned because no government with power ever wanted to give it up, even for good reasons.

He went for a walk in the Square for ten minutes to contemplate his answer and the situation Mars was in. There were terrestrial forces opposed to Mars's development; nations balanced each other and kept each other's ambitions in check. But the balances were never perfect, and Mars was small and subject to forces it couldn't control.

He returned to his office and found they had already sent two more questions. They had decided to keep the questions coming, to save time. The questions were routine and the questions that followed on his second batch were slightly repetitious, but not tricky.

For two and a half hours they sent questions and he answered them, almost continuously. He took an occasional five-minute break; so did they. Finally they thanked him and he made a quick closing statement, then closed the circuit. He walked home.

"How did it go?" asked Ethel as soon as he walked in the door.

Will sighed. "Pretty well, I suppose. They asked all the usual questions, and the few unusual ones were manageable. The issue of independence came up about seven different ways."

"Of course. What did you say?"

“Basically I said that if they put in money, they’ll have a say, and if they stop they probably won’t.”

“That’s true, whether they like it or not. There are two thousand of us now. Well, I’m sure they’ll keep you; they don’t have much choice, I think.”

“They may be afraid Mars will be impossible to control if they replace me,” Will quipped.

“Maybe. Come into the garden, I’ve got something for you.” He nodded. She usually had a breakfast ready for him when he had very early morning meetings.

They stepped into the garden and twenty people jumped up. “Surprise! Happy Birthday!” they shouted.

“Wow!” replied Will. “I am surprised!”

“Good, you should be! It’s your sixtieth, after all!” replied Ethel. “Come on, enjoy!”

He walked into the garden and started hugging and shaking hands. Roger, Madhu, Carmen, Shinji, Michiko, Lizzie, Paul, Jacaranda, Sebastian, Alexandra, Yevgeny, Enlai, Ruhullah, Greg, Anna, Silvio, Kent, even Yuri from Uzboi and Emily from Cassini: it was quite a gathering. They all sang him happy birthday and made him blow out candles on a cake. Then he cut up the cake and they enjoyed it.

An hour into their party, Will’s attaché beeped with a message from Earth. He stepped out to receive Sonia Cassetta’s call to tell him his reappointment was unanimous. He sent a quick message back thanking the trustees for their confidence in him, then returned to the garden, where everyone was watching the news break on *Mars This Sol*.

“Yeh!” exclaimed Ethel, kissing him while the others applauded. “When you stepped out, I figured we’d better check the news!”

“Yes, it’s a busy sol for me. I turn sixty and get my third term as Commissioner. Third and last.”

“Last?” asked Alexandra, surprised.

Will nodded. “I’ll have been Commissioner fifteen years in 2051; that’s on top of being Commander for eleven years. It’s enough. It’s hard enough being creative after all this time. I’m getting old and set in my ways. Someone else has to take over.”

“Someone on Mars, or Earth?” asked Ruhullah.

“Probably Earth, probably a government functionary; they were complaining about the independent way we do things up here. But in five years Mars will have 5,000 people and if export prices stay high it may be economically independent, which will make it hard for any Commissioner to run this place anyway.” He looked at the others. “We have five years to prepare for independence, folks. That’s what it amounts to.”

5

Launch

15 June 2046

Ramesh was panting as they reached the top of the cliff. “Wow, that’s quite a climb!”

“You can turn up your oxygen pressure a bit if you want,” replied Sarah, who was immediately ahead of him and not panting at all. “But you shouldn’t need to. You’re getting forty percent more oxygen than in the outpost, and its air is only eighty percent as oxygenated as the earth at sea level, so your red blood cell count should have adjusted to that months ago. Ramesh, you’re out of shape.”

“I suppose. I spend most of my time at my computer.”

“That’s the best reason to join the hiking club. Seriously: in this low gravity your body burns about twenty percent fewer calories moving around, but your appetite has been set by three million years of evolution, and our food here has been getting richer in fats and sugars every year. You’ve already put on a couple kilos since you arrived.”

He stopped and turned to face her, so they could see each other through their helmets. “Sarah, really! That’s not a kind thing to say!”

“I beg your pardon, but I disagree. You’re a good man; do you want to be the third Marsian to have a heart attack? It’s hard enough taking care of your body properly in an advanced industrial society, with all its culinary temptations. Add oh-point-three-eight gees and you have a recipe for disaster. We have physical therapists here just to help people with ‘mesogravity injuries’; our bodies were not made for this place. So exercise is pretty important.”

“Hey, I’m pretty busy between meetings, staff training, and now the Mariner Symphony!”

“Ask your fellow members of the orchestra; they’re all on an intramural volleyball team, or they swim, or they hike, or something.”

“Alright, alright.” He turned away from her to survey the view. They had just reached the top of Layercake Mesa, rearing one hundred meters above the rolling floor of Aurorae Valley. Northward was the escarpment, twenty kilometers distant, a mile-high wall of rock and debris that blocked the horizon with surprising effectiveness and startling detail. His eyes feasted on the hundred-meter boulders that had slid half way down the tumbled slope, the fluted breaks in the summit cliff that betrayed the presence of faults, and the noticeable gash that marked the presence of Little Colorado Trail. “There’s nothing like this on Earth.”

“No. You should see it at Candor or Tithonium, where it’s six kilometers high.”

“Have you been there?”

“No, but I’ve seen it in virtual reality. I suppose you’ll get there eventually.”

“I suppose.” He turned to the northeast and surveyed the domes of the outpost, then west at the rolling wasteland. “This reminds me of the deserts of northern Tibet and parts of Shinjang. Cold, and so dry there’s no vegetation to be seen at this distance.”

“When were you there?”

“A road-building consultancy a few years ago. The government gave the contract to a Chinese company, though.” Ramesh looked around the bare top of the mesa, then started to walk toward a nickel-steel tower fifty meters away. He looked up at the rotating

hundred-meter blades of the wind turbine above his head. “How did they get these up here?”

“There’s a road.” Sarah pointed.

“A road? You mean I didn’t need to slog up that trail and over and around the boulders?”

“No. We’ll go down the road; it’s harder going down the trail than up it.”

“I suppose.” He was unconvinced; boulder hopping in a spacesuit was not Ramesh’s idea of fun. Sarah looked away and smiled. She led him across the flat, almost featureless mesa toward its western end.

“Can’t we see the launch from here?” asked Ramesh, a moment later. He turned south toward the wasteland dotted with cleared pads. He could see the shuttle *Kasei* on its pad about seven kilometers away, gleaming in the early morning sunlight.

“Probably, but there’s a very nice public observing area at the end of the mesa. We’ve been building it up for years.”

“We?”

“The hiking club!”

“Oh, yes.” Ramesh followed behind her, looking at the bare rock. There were occasional pits in the surface; some were craters, some cut by the last catastrophic flood to rage over the mesa four billion years earlier. Sarah stopped at one pit and picked up a rock. “What’s that?” he asked.

“We need rocks to build up the observation post, so every time we walk there we grab one.”

“Oh.” He reached down and worked one free, but he ended up with a rather large slab that was heavy in Martian gravity. He tossed it down to break it and picked up a piece instead.

“Be careful smashing them,” warned Sarah.

“Why can’t you get them closer to the observation area?”

“They’ve been picked up. There’s not much up here; the strong winds sandblast the surface and sweep away the debris. That’s also why we make wind power up here.”

“So I see.”

They trudged across the mesa; they had a three kilometer walk from the trail head to the observation post. To relieve his boredom, Ramesh calculated the wind power. Turbines every three hundred meters, a mesa 4,000 meters long and an average of 800 meters wide. . . but the blades overhang the edges, so figure twelve rows of four blades each, or 48 turbines, and apparently every spot has been filled over the years. . . at seventy kilowatts each in a forty-kilometer wind, that’s 3,400 kilowatts; in a dust storm with eighty-kilometer winds it would be eight times as much or 27,200 kilowatts, close to the outpost’s normal minimum demands . . . at a million redbacks each, the total installation cost was fifty million redbacks, a pretty steep price for power when one considers the low average production per sol, but comparable to a nuke per kilowatt hour . . . people have to be careful about tripping over the power cables, too, and the aesthetics of the installation aren’t great . . .

Then he ran out of calculations to make and concentrated on the hike. Even in a spacesuit, Sarah was attractive. He just wished she’d stop trying to reform him, including daily reminders that he could accompany her to church if he’d like. His grandmother, a

devotee of Shiva, most definitely would not approve of that, and he couldn't ignore her opinion even if she was on Earth. If only she'd sleep with him, maybe they'd make some progress.

Finally the end of the mesa was in sight. The observation area was on a rise of rock, the "prow" of the mesa that faced into the Noachian floods and resisted the fierce currents, preserving the softer rock behind. The hiking club had built a waist-high wall along the edge of the cliff so no one could fall off; and it was straight down a hundred meters, including the talus that covered the lower half of the slope. They had also created some wide, space-suit friendly stone benches. There were already a dozen people there; the common channel had the whisper of their private conversations. Sarah and Ramesh tossed their rocks on the stone pile and joined the others to wait. The launch was scheduled for five minutes later.

Right on time, a plume of smoke and flame shot from the shuttle and it immediately rose into the air. The flame intensified and lengthened as it cleared the ground and was soon a hundred meters of orange-tinged blue; methane and oxygen produced a prettier flame than oxygen and hydrogen, which burned almost invisibly. The shuttle left a huge contrail as the water vapor cooled to droplets, then ice crystals.

"Wow! And this is safe?"

"Yes, an explosion couldn't hurt us," confirmed Sarah. She extended her hand to him and he took it in his gloved hand immediately. He even shifted closer to her on the seat until he could feel the pressure from her suit against his skin.

The shuttle was already quite high, a tiny silver head on an orange arrow riding a column of white. In a minute it was already invisible in the eastern sky, which now had a pronounced haziness it had been lacking before blastoff.

"Wow, that was something," he said.

"Martian fireworks," she replied. "I always enjoy watching a launch."

"That one carried the entire crew of the *Heinrich Olbers* to orbit; they leave for Vesta in two sols."

"I know. And I leave for Uzboi in three." He leaned against her a bit more and she backed away from the pressure, so he straightened up. They both stood. "Why won't you sleep with me?" he whispered to her. Spacesuit radios were very smart; a whisper meant he didn't want his voice to go out on the common frequency, only their private channel.

"Why won't you get close to me emotionally?" she replied in a whisper. He turned to her so they could see each other. She looked at him quite seriously.

"Well, maybe there's a way to do that."

"Other than sleeping together?"

"You hide behind your masses."

"And you're always working on your attaché."

"Okay, okay. Truce." He looked at her. "Let's have a nice, romantic dinner. No strings; no bed afterward. I'd like to go to Uzboi with a better sense of where we stand."

"Good, I'd like that too," she replied.

“I’m glad you suggested we meet outside, Will,” exclaimed Yevgeny, as the five of them settled into place around a shaded table. Alexandra had just given the other members of Will’s inner circle a tour of Liberty Dome.

“Why not; a little sun, some solar gamma rays, and a small dose of cosmic background radiation,” replied Will. “But we will have to be careful to pay attention and not get distracted.”

“I find the faint boom-boom of the pile driver a bit distracting, but I can live with it,” said Lisa Kok, Director of Environmental Management and Ecology.

“Sorry; the pile driver near us is one of the new models,” replied Alexandra. “It can handle wider, longer, heavier piles and can emplace them fifty meters into bedrock.”

“For the new hundred-meter width domes?” asked Martha Vickers.

Alexandra nodded. “They need fifty percent more depth to hold in the air against fifty percent more pressure.”

“But won’t that make them fifty percent more expensive?” asked Martha.

“No. The kevlar rope in the dome has to be fifty percent stronger, but the rest of the dome is made of the same materials. The larger pile drivers cost fifteen percent more to operate and the dome materials cost about ten percent more, so we’re getting almost fifty percent more enclosure for about fifteen percent more price. That translates into a price per square meter about seventy-five percent as much as currently.”

Will looked around Liberty Dome. “The wider, higher space will be worth the extra hassle, especially since the overall result is cheaper enclosures. This place is very comfortable.”

“Thank you,” replied Alexandra. “This and El Dorado Dome are the nicest ones we’ve built so far.”

“You oxygenated the air pretty fast, too,” said Will.

“It needed 180 tonnes of oxygen and 120 tonnes of nitrogen and argon,” replied Alexandra. “We’ve been accumulating the nitrogen and argon for the last two years. We had almost enough oxygen for this dome and El Dorado, but we decided since Phobos has a big surplus right now and we have to make regular passenger flights up, we might as well bring surplus oxygen down every two months. We’ve saved money and energy on CO_2 cracking.”

“The surplus is from the Chinese order for liquid hydrogen?” asked Martha.

Yevgeny Lescov, the director of exports, nodded. “We’re making five hundred tonnes of liquid hydrogen for their nuclear engines, which means making four thousand tonnes of ‘waste’ oxygen. We can use only so much of it as oxidizer for methane propellant, so we’re hauling down every spare tonne we can.”

“And we’re already off to a big distraction,” noted Will. “Lisa, I see you have this entire dome planted in corn and rice. How’s productivity?”

“The Department of Environmental Management has a fairly boring report,” she replied. “We completed Liberty and El Dorado in record time and converted the range to polder, then grange in a mere three months. The land here never needed a special crop to remove rare trace elements because we built up the soil using alluvial deposits that were clean of undesirables. Right now Aurorae has 60,000 square meters of built-up urban land and 220,000 square meters of grange; the latter is 160,000 square meters of farmland and 60,000 square meters of bioarchive. Aurorae is already rated for 1,600 people. We’ll

be adding capacity for 500 more in the next two years to keep up with natural population growth and will be planning for an additional thousand for the two years after that."

"It's so complicated now, I have trouble keeping all the figures straight, especially since they change weekly," noted Will.

"How much food are we importing from Aram?" asked Martha, curious.

"The equivalent of enough for 250 people," replied Lisa. "They have 30,000 square meters of farmland. They're planning to double it this columbiad."

"And what's the population of Aram?"

"Forty-five; they just received six more," replied Will. "They have ten who do nothing but construction. They don't use pile drivers; their enclosure technique is to use very long, narrow spaces—fifteen meters wide at most—that don't require more than about ten meters of regolith mass piled on the skirt to hold the dome down. They build housing and work spaces under the skirts. Ten more people develop the polder into grange. Only five do the actual farming. The rest do various administrative tasks or child care, since they now have children."

"They're getting more efficient all the time, too," added Lisa. "We have to raise three hundred different plant species and twenty animal species. They can focus on one crop at a time and do it efficiently. They've undercut our market for most vegetables and corn. That's all they produce."

"And how many do we have in horticulture now?" asked Martha.

Lisa was irritated by the questions. "Forty, and thirty more in bioarchive and research. Environmental management also includes other teams, though; waste management, water purification, and gas separation. Waste management has changed

quite a bit since you were here four years ago, Martha. We now have a huge composting system that digests one thousand tonnes of plant waste per year. It makes a lot of the methane we need for the shuttles; we can digest the organic waste part way to make compost or completely to make methane and liquid fertilizer. Water purification runs about eight small sewage treatment plants because we have one per major dome or cluster of smaller domes. We have evaporative distillation systems also; every dome can recapture some condensation. We have water wells in all these domes for pumping heat into the ground or extracting heat from it, and for desalinating the ground water and obtaining irrigation."

"I am amazed how much this place has changed and expanded in the last four years," agreed Martha.

"What are your impressions?" asked Will.

"Well, if Lisa's finished with her report, why don't I give mine," replied Martha. She looked at the others. "Let me start by thanking Will for inviting me to serve as the Commission's Advisor about Human Potential. At first I wasn't sure what that would mean, but Will and I talked and it became clear to me that human potential development needs an advocate here, and that advocate does not have to be the head of the hospital, the Chancellor of the university, or the minister in charge of the Commonwealth's department to which both report. In fact, there are advantages to not being the person responsible for running everything. In my case, I really don't want an administrative position. They considered me for the position of Chancellor to replace Enlai and I said no. This job complements my current priorities pretty well.

"The four-year trip through the asteroid belt was a fascinating experience in building human community in tight quarters and extreme isolation. We did reasonably well; we had a few bad fights, but the twenty-six of us became bonded together like one big family. We've been back on Mars six months now, and we still see each other just about every sol. Some people have said to me they envy us for what we have. I've drafted two chapters of a book based on the voyage about creating community.

"If there's one change I've noticed from four years ago, the community here has become much bigger, more diverse, and less intimate. Andalus has a rather overwhelming feel to it, compared to the intimacy of Yalta's patio. One hears a lot more linguistic diversity at meals. The cultural weeks, sols, and evenings have highlighted our diversity, but they have also pulled us apart into smaller ethnic groupings. Traditional villages on Earth are usually less than 1,000 people, and Aurorae is now larger than that. It is a town or city, and that means it is more impersonal.

"So that's my principal observation. I've only started formulating the tasks I will tackle, but so far I have three ideas. First, improving counseling. When I left we had ten psychologists or psychiatrists serving six hundred people; now we have eighteen serving 2,000 people. There are entire populations that have not gotten in the habit of counseling, such as the Nigerians. We need more counseling staff and we need people with backgrounds and languages able to reach everyone. As most of us here know, regular counseling for all the details and challenges of life is immensely helpful. Our levels of pathology are much lower than almost anywhere on Earth. But we have been able to help with many things other than illnesses or incipient illnesses; our premarital counseling leads to higher rates of routine 'preventive' marital counseling and that has pushed down

our divorce rate. In short, we've been able to do the things wise grandmothers and grandfathers have tried to do for millennia, and with knowledge of theory and professional experience, we've been reasonably effective.

"Second, I'm concerned about family structure and the impact of Geminale. Almost everyone who starts a family now uses Geminale, with the result that three quarters of the mothers who go to the hospital to give birth have fraternal twins. This has pushed up our fertility rate to 1.9 births per woman, very close to the replacement level. But two babies are immensely difficult to care for; new parents are going absolutely crazy. Day care has helped that, but we need to hire more professional care providers and train them more. Possibly we should create a work area woven around a day care facility where parents can work very close to their children and can alternate between caring for them and relying on the professionals. We have to reconsider our maternity and fraternity leave programs and increase the time available. If six months is available for the birth of one child, why not make it a year for twins?

"Third, I'm worried about the city versus village environments, where the outposts are concerned. Right now, many young people migrate to Mars, go to the other outposts, work very hard, earn extra money for a few years, then come to Aurorae, get a different job, and start their families. But the other outposts want to transition to more permanent populations. Cassini has made that transition; it now has twenty children. The Commission has to look at the quality of life available at the other outposts and strengthen their resources for supporting family life."

The others nodded. "Are you making recommendations to the Commission, the Commonwealth Authority, or both?" asked Alexandra.

"I suppose I'll offer ideas to both. The Commonwealth may want to consider legislation in some cases."

"And you want to plan another 'Living Well' Conference," added Will.

"Yes, we need a chance to discuss the issues of life and how to live it," agreed Martha.

"I can see this will cost the Commission some money," said Will. "But so be it. We aren't on Mars to make profits, but to establish a civilization. The issues you've identified are all excellent ones to tackle. Thank you, and we're glad to have you on board."

"Any idea whether you and Charles plan to stay on Mars?" asked Alexandra.

Martha nodded. "At least two more years; that's when Caitlin finishes high school. We've been on Mars nineteen years and love it here, but there may be some interesting jobs on Earth we won't rule out, and once Caitlin's well established in university we wouldn't rule out four years in the Galileans either. I'm 49, Charles is 50, so we have some time left."

"Well, come back here for retirement," replied Will. "Alexandra, what do you have for us?"

"Not much; my report is short. Construction is going well and is more or less on schedule. We erected El Dorado and Liberty in six months and will have their extensions and the extensions for Punjab, Zanzibar, and Cathay finished in another two years. We also expanded the industrial facility and of course last year we built Uzboi Outpost. In the next two years of this columbiad we are building the vehicle repair facility or VRF, a steel and kevlar airtight structure thirty meters high and thirty meters in diameter; a big,

inflatable cylinder into which Mars shuttles can be rolled so they can be repaired in a shirtsleeve environment. We also have orders for three caravels. I suppose the big question is whether to start on the design of the Caravel-B. It's forty-five meters in diameter and twenty meters thick at the hub. Its interior would have 24,000 cubic meters of space, sufficient to transport 500 from Earth to Mars and 200 from Earth to the Galileans."

"I think it's still premature, but we need to see the numbers," said Will.

"We haven't paid for the caravels we have," exclaimed Yevgeny. "The big problem would not be building and launching a Caravel-B, but filling it with people. A larger shuttle to low Earth orbit would have to be built, and a larger shuttle to bring them to the Martian surface. Otherwise each caravel would require 42 flights to fill it at Earth and 21 flights to land everyone here."

"I think everyone agrees we need to slow down immigration a bit," added Martha. "The growth rate is not sustainable."

"Yevgeny, what have you to report?" asked Will.

"The spaceport is ready for the next wave of 450 arrivals in two months. All nine shuttles are in good shape and we'll launch all of them the week before arrival of the three caravels so that they're available for emergencies. We're getting thirty more personnel for the spaceport and shuttle maintenance, raising our total to one hundred; at that point the spaceport will be able to repair and maintain shuttles under almost every imaginable circumstance. We're also managing the flow of imports and exports fairly smoothly, for the first time in several columbiads, in spite of the much greater volume. Mars will import 1,000 tonnes of new equipment and 500 tonnes of consumables this

year and 200 tonnes of equipment and 700 tonnes of consumables next year. As we get more solar sailers, the load will even out and off-years will receive as much cargo as the year closest to opposition. Some of the cargo coming next year—which mostly left Earth this year—is in fact for the year after, so that we can import less cargo the year the people arrive. The transport price is declining a bit more because the solar sailers are able to haul things from Earth orbit to Mars orbit for 100 redbacks per kilogram, the cost of operating our shuttles is spread over a larger cargo volume, and because the larger transport volume allows us to make better deals for launch from Earth; it'll be 1,700 redbacks per kilo this year and 1,650 redbacks next year. This is unfortunately pushing up consumer demand slightly, so total transport costs for consumer products is staying the same."

"What's your goal? Evening out the cargo arrivals?" asked Martha.

"And departures," replied Yevgeny. "With a typical ten-tonne cargo, sailers take six months to spiral out of medium earth orbit—they can't start out too low because of atmospheric drag and shadowing by the Earth—and a year to reach Mars orbit. We can shorten or lengthen that time by increasing or decreasing the cargo load or using an ion tug or a chemical engine to push the cargo into a higher starting orbit. At the Mars end of the trip, a shuttle can go up and get the cargo at various points in its journey. The big problem is planning three or four years in advance; we need to be launching into earth orbit the cargo for the fourteenth columbiad in the next half year."

"We're now at the point where we need to import 1,000 tonnes per year," added Will. "At twelve tonnes per launch, that's eighty-four launches from the Earth's surface, or one and half shuttles working full time. At our end, the new shuttles can deorbit forty-eight tonnes at a time, so we need to make twenty-one flights."

"We actually have more shuttles here than we need," added Yevgeny. "Because we have the personnel to maintain and repair the shuttles, they're capable of flying a few hundred times in their lifetime, rather than six times in the early days here."

"I don't mean to be a pest," said Martha. "But I do have a professionally related question. I know we're trying to lower importation of consumer goods, but I wonder whether we're doing enough to improve quality. An imported blouse, for example, will cost 1,000 redbacks; 100 redbacks for the blouse itself and 900 redbacks for transportation. A locally made blouse will cost 500 redbacks, but will be of lower quality; the fabric will be less pleasant, the anti-wrinkle additive less effective, the sewing inferior, the color choices much fewer, the cut less comfortable and less stylish. . . so of course people prefer to spend 1,000 redbacks for the imported blouse."

Will nodded. "We've been working on exactly those problems since the early days here. We now manufacture a thousand consumer items here. Quality and price are improving. The number of local items is increasing by about 150 per columbiad. Our diversity makes it harder; we must manufacture saris and kimonos as well as dresses. This columbiad we're getting new equipment for making silica gel dessicant, and it'll be used with new equipment for making disposable diapers, tampons, and such."

"I think you can imagine the problems," added Yevgeny. "The market is small, the equipment to make things has to be rated for launch conditions and use here, operators must be trained and paid a relatively high wage, usually large quantities have to be made and stored for sale over time, there's no competition to force innovation. . ."

"Will, can you add me to the committee or task force or whatever in charge of consumer goods?" asked Martha.

"Sure. The Marsian members are Silvio and someone from Deseret; I've never had a Commission staffer willing to devote time to it. The other members are in Houston."

Martha turned to her attaché and made a note. "I can see this assignment will leave less time for my book than I had hoped," she mumbled.

Will looked at the others. "Any other reports or questions?"

"You have to give us a report, too!" replied Alexandra immediately.

"Oh; yes, I suppose I should," agreed Will. "The meeting of the Board of Trustees—the national representatives—also was an occasion for the nations to reaffirm their commitments to Project New World. At the moment we're ahead of schedule in terms of immigration. They approved the use of a sixth caravel in 2048, which confirms our plans to receive nine hundred migrants. They'll travel in three pairs, arriving six weeks before opposition, three months after opposition, and five months after opposition. We do *not* plan any additional caravels in 2050 or 2052, though we may reconfigure those vehicles to accommodate more passengers. They also approved the focus on greater export of platinum group metals and gold. In the last two years we have exported four hundred tonnes of gold, worth sixteen billion redbacks, and two hundred tonnes of pgms, worth five billion redbacks. Equipment exports, water and food from Phobos, nitrogen and argon from Mars, and fossiliferous rocks have earned us 1.5 billion redbacks, below the projection. Érico's tour of Earth brought in two billion redbacks of investment. Government subsidies are eight billion redbacks. Our budget for this columbiad was originally sixteen billion redbacks, so as you can see, income is nearly double the projection. The next columbiad, pgm production is scheduled to rise to 700 tonnes, worth

seventeen billion redbacks at current prices, so we project continued surpluses. It'll be invested in improvements in the shuttles, ion tugs, sailers, robotics, and we'll save some of it. We are also looking at an additional thousand tonnes of equipment imports if we can get them here and possibly in nuclear power if we can straddle the politics."

"That's a lot of money," said Alexandra. "Let's hope the high price of pgms continues."

"It won't, so we have to plan for lean times," replied Will. "Both gold and pgms could drop in value by as much as two thirds. If that happens, we'll be in the red by billions." He looked at his watch. "I need to get to my office for a meeting. Thanks for showing us around, Alexandra and Lisa."

"We're glad to," replied Lisa.

The meeting broke up; Will and the others rose. Yevgeny and Alexandra were also walking back to Andalus, so they went with Will, chatting all the way.

When Will reached his office, Brian Stark was already waiting, and he looked determined. Will smiled, but inwardly he groaned. "Good sol, Colonel Stark."

"Good sol, Will; or should I say Dr. Elliott? Let's close the door. I suspect this will be quick."

Will closed the door and the two of them sat facing each other. "More evidence the Chinese are really going to Callisto," said Brian. "We've obtained part of the cargo manifest on the *Tienan*. It has three specially modified rangers. You can't drive rangers on Metis or any other asteroid; the gravity's too low."

“True, but I had heard the Chinese were shipping some experimental surface mobility equipment—rangers, I suppose—for testing at their South Pole facility during winter.”

Brian sat silent for a moment, considering Will’s additional information. “If that’s the case, we’ll see them unload them onto the Martian surface, and that will be an indication of their destination.”

“Maybe. I asked Enlai about ‘rumors’ of another destination, and he denied it.”

“Of course.”

“Brian, let me put this as plainly as I can: The Mars Commission will not discriminate against any legitimate customer, and the Chinese are legitimate; in fact, they’re the third largest financial contributor to the Mars Commission, after the United States and the European Union. Even if the Chinese told us they were flying to Callisto, we would sell them the hydrogen anyway. The flight would not be illegal, nor would it be a stretch beyond the vehicle’s abilities.”

Brian looked at him a note of desperation on his face. “Will, I won’t try to appeal to your patriotism again; that didn’t work before. Let’s consider what will happen if the Chinese really do fly to Jupiter next year. The United States expedition won’t be ready until at least 2050; that’s three years later. So they will totally whip our asses and completely humiliate us. Now, space flight is like the Olympics, the nuclear weapons club, and a few other things; it’s a measure of a nations’ prominence in the world. If China beats us badly, there will be a lot of people saying that the U.S. has lost its edge and is no longer the number one power in the world. That has a huge impact on people’s

perceptions, on foreign policy, on our influence across the globe. . . it's huge. Do you want a world where China is the number one power?"

"Brian, China is a country with a vast history, a very talented population, and now a very large economy. It has the same economic system as the world and it is increasingly democratic. Many people—including many Chinese—say that if China does not adopt democracy, it will never be able to unlock the creativity of its people enough to surpass the United States. So I submit to you that either China becomes a democracy and will not be any sort of grave threat to the world, or that it won't become a democracy and will never pass the United States. If I were you, I'd be watching India; its population is bigger than China, it doesn't have the demographic bulge of old people, it's a democracy, its economy is catching up to China's fast, and it's creative. Their role on Mars has been steadily growing."

"You have an interesting theory, but I don't buy it. Will, isn't there something you can do? Be creative here. What if they are lying about their destination? Isn't that grounds for canceling the contract?"

"No, because the hydrogen contract doesn't require them to disclose their destination. Why should it? They're a responsible operator of spacecraft."

Brian looked at his colleague. "Then consider this. If China beats us to Jupiter, all of Project Odysseus is in jeopardy. Why should the United States develop a gas-core nuclear engine to get to Jupiter three years late? By then, the Chinese may have sent three expeditions to Callisto! Their success jeopardizes New Hanford and everything we're doing here."

Will considered that a moment. “Look, I have no control over Congress. Project Odysseus has had a rough time for almost all of its ten years because it’s trying to develop very expensive new technology to do something that doesn’t require the new technology. If the Chinese really are going to Callisto, they’re beating the U.S. by three years because they realized that existing technology is adequate. And it clearly is. What you’re developing is needed for Saturn or beyond; the voyage is too long otherwise. But no one is proposing voyages to Saturn. If I were the U.S., I’d think twice about canceling the development of a gaseous core nuclear engine. The vast majority of the supercomputer modeling is done; the vast majority of the prototype testing on Earth is done; all that’s left is assembly of an actual engine on Deimos and firing it up. No doubt it’ll require a lot of modification, but the team here that will test the engine can also do much of the modification. I doubt the U.S. will assassinate your team to keep it quiet, so if I were the United States right now, I’d be worrying about the team’s loyalty and whether Mars would take up its funding if I pulled out. The Mars Authority might do it. All it would have to do is raise the export tax on gold and PGMs. As you know, the contracts with the various companies say that any tax originating on Mars comes out of the profits and royalties earned by the Commission.”

“You are probably right; that would be a credible threat to national security,” said Brian, slowly. “And a lot of the New Hanford staff has been here long enough to feel Marsian. If the Commonwealth Authority gave nuclear research money to Martech, the staff would probably agree. I’ll be sure to warn them of that possibility in my report.” Brian rose. “We live in interesting times, Will.”

"We do. The American century may be drawing to a close, and it will indeed have been a century. I'm sorry I can't help you, Brian."

"Alright. I did my part, at least. Have a good sol, Will."

"Thanks, you too." They shook hands and Brian Stark walked out of the office. Will watched him go, wondering whether Stark had arrived to protest his plans again, or whether he was just looking for a chance to hear counterarguments so he could repeat them to his superiors in Washington. Will was uncertain where Brian stood, sometimes, since he occasionally was clearly in support of Mars's development and autonomy.

As Will pondered this, his attaché beeped with an incoming message. He looked down. It was a news item from *Mars This Sol*; his attaché was programmed to accept urgent news. A window had opened that said *Heinrich Olbers successfully launched to Vesta.* "Please display the entire story for me, Anisa," he said.

He read the story quickly. The *Olbers* had moved from Embarcadero several sols ago into an orbit aligned properly for the trans-Vesta burn; the engine firing had taken only five minutes. The twenty-four crew, headed by Pete Theodoulos, had no children on board. They were headed for three asteroids, Vesta being the last; supplies were already landed on all three of them, including water suitable for making fuel.

"Anisa, call Sebastian Langlais, please," he said. The attaché replied with "acknowledged" and a few seconds later Sebastian's line was ringing.

"Hi Will," he replied.

"Good sol, Sebastian, and congratulations."

"Thank you. It was a beautiful, clean launch; no problems at all. We've already started training the crew for the Pallas flight next year."

“Excellent; considering how far out of the ecliptic Pallas is, that will be a milestone.”

“And the cargo flights to Pallas have gone well. We’re excited to be in the position to manage two flights at once.”

“It’s quite a sol for Mars, Sebastian,” said Will.

“Thank you. Yes, this is a milestone.”

6

Migrants

25 Aug. – 7 Sept. 2046

Will and Enlai were the only ones on the Conestoga “bus” to the top of the escarpment. In the middle of the day, the robotic bus ran based on demand. Little Colorado Canyon now had a wide, smooth road with a concrete surface on the steepest sections and guardrails on the sharpest switchbacks. In fifty minutes, the bus brought them thirty-six kilometers to New Tokyo Dome on top.

As they approached the complex of enclosures, Will reflected how the area had changed. Nearly seven years earlier—Columbus 10—Yoshiyaki Suzuki, the abbot of a small Zen monastery, had arrived with eleven monks. They had domed over a crater and built their monastery in artificial caves accessed from the bowl; the 160-meter dome, rising eighty meters, was still the most prominent feature of the area. They also excavated a tunnel three hundred meters southward to the escarpment edge, then five hundred meters westward to the Dacha, the Outpost’s vacation spot. Columbus 11 saw another dozen monks arrive—six Pure Land Buddhists and six Shinto priests—but more importantly, the monastery had galvanized the Japanese public and a private corporation had sent a dozen more Japanese engineers and other professionals. The latter group started a dome next to the monastery’s called “New Tokyo” and petitioned the Mars Council to give them incorporation as a village within Aurorae Borough. The twelfth columbiad in 2044 saw twenty more Japanese civilians arrive, raising the total in New Tokyo to 32; the Japanese colony at that point had 54. Their expertise was manufacture of molds, a talent in great demand. Many of the Japanese also learned construction and

spent much of the columbiad building a string of enclosures above the monastery's tunnels, with the result that there was now a double line of domes all the way from the monastery's enclosure to the edge of the cliff.

The bus drove into the garage between the monastery and New Tokyo and in a minute the garage had pressurized. Will and Enlai stepped out. Waiting for them was Ichiro Otsu, the chair of New Tokyo, and Yoshiyaki Suzuki. After warm greetings, they walked through the tunnels, past the monk's main assembly hall, and out into the bright sunlight of their crater, where a table was set for the four of them in the shade of the crater rim.

"This place is a treasure," said Will, sipping his green tea. He glanced at the crosslegged "Mars-witnessing Buddha" carved into a nearby cliff, its hand pointing down toward the ground, and the fantastic greenery of the crater. "I don't know how you make this place so green. Even the cliffs are covered by moss, and the bushes at the base of the cliffs look sculptured."

"They are sculptured," agreed Yoshi. "Everything in here has been shaped and encouraged. Everything is a source of insight and an object of meditation."

"It is incredibly beautiful," said Enlai. "It makes me feel very much at home; your aesthetic is so familiar to me. But that is to be expected, the Chinese and Japanese cultures have drunk from many of the same fountains. While I do not believe in any sort of supernatural power, I am at least appreciative of the results the belief in such a power has produced."

"We get much pleasure from creating beauty," said Yoshi. "This entire crater is our big meditation hall, you might say, so we are meticulous at maintaining it."

“It must take so much time,” said Enlai.

“Yes, of course, but every task is a path to enlightenment. We dedicate every waking moment to something. Much of our time is spent running the agricultural areas.”

“You have some remarkable success with exports,” said Will.

“Yes, our sake is very popular and very expensive in Japan; the same with our tea and preserves. But it only brings in two million redbacks per year after shipping costs are covered.”

“I am not here to take the farmland or anything else away from you,” said Enlai. “The Mars Council asked me to come up with Will to meet with both of you about the debts and determine how they can be paid off.”

“We don’t want to see either New Tokyo or the monastery to close or declare bankruptcy,” added Will. “We are confident that with all your people, your talent, your resources, you can eventually pay off the debts.”

“Our investors in Tokyo are not so confident,” replied Ichiro. “The banks have cut off our credit. This makes it difficult for us to grow out of the crisis.”

“Sometimes attempting to grow out of a crisis just makes the crisis worse,” replied Will. “Sometimes it is better to sell off assets, liquidate debt, and start over from a different point.”

“What would we sell?” asked Ichiro. “All we have is grange. We wouldn’t want to sell our manufacturing base.”

“Then sell the farmland,” said Enlai. “It’s worth a thousand redbacks per square meter. You have seven domes, each with 4,900 square meters of grangeland. Sell three of

them and you've covered your debt to the Mars Commission for construction materials. Sell four or five and you have cash for additional projects."

"That really isn't much money, considering our expenses," complained Ichiro.

"You won't be able to charge more because that's the cost of grange at Aurorae," replied Will. "It represents a fifteen percent profit over construction costs down there."

"But it's probably a small loss for us," lamented Ichiro. "It's incredibly expensive to haul nickel-steel liner and water up here from Aurorae."

"What do you use the nickel-steel for?" asked Enlai.

"Our domes are not open-ground, like yours. The monastery's dome is open ground and still loses a hundred tonnes of oxygen a year, in spite of six thousand tonnes of water that have been hauled up. Consequently, our eight cylinder domes have a welded floor of nickel-steel plate under the construction or the grange. Nickel-steel is dirt cheap and it cuts in half the water we need per square meter."

"With the escarpment edge close, you can't use the usual techniques," noted Enlai.

"We'd really hate to sell farmland," continued Ichiro. "We want it for the future expansion of New Tokyo. Our single seventy by seventy meter dome for housing is now just about filled. We have twenty more personnel arriving in two weeks and we've sold to fifteen Japanese employees of the Commission and thirty other people. The dome will have almost ninety people; that's all it'll hold."

"Then don't sell the agricultural domes closest to the village itself," replied Will. "You could buy them back later."

"There is always room for expansion to the east and west," added Yoshi.

“We have an idea for covering our debt,” said Ichiro. “As you probably know, the last two domes we’ve just pressurized reach to the escarpment edge. We could build housing close to the edge with a view of the valley and sell it for a premium; thirty to fifty thousand redbacks per square meter, depending on the view. We’ll build our next eight domes along the escarpment edge all the way to the Dacha.”

“Five hundred meters of condos?” asked Will, skeptically. “That’s a lot of units. There isn’t that much demand.”

“We won’t build condos along the entire edge this columbiad. We’ll build the domes and a few of the units. We could sell some as timeshare condos, too.”

“Aurorae doesn’t have that kind of wealth,” replied Enlai. “Our people are struggling to support a residence; how many will purchase rights to a condo with a view thirty-six kilometers from town?”

“What about residents of Cassini, Dawes, and the other outposts?” replied Yoshi. “They come to Aurorae for vacation and shopping. They might want a timeshare here.”

“Especially if we build a casino or something exciting,” added Ichiro. “If we expand onto the Dacha, where people already go to relax and have fun, we might increase the tourist business up here.”

“A casino?” said Will, surprised. “I wonder whether our people will gamble very much.”

“We may ask the Mars Council for permission to open a casino and find out,” replied Ichiro. “You see, we have some ideas.”

“Yes, interesting ones,” agreed Will.

Ichiro looked at the empty tea cups. “Let’s walk, and I’ll show you.” He stood and the others followed. He led them into a tunnel that ran southward, to the monastery’s cave and enclosure on a ledge a dozen meters below the top of the escarpment. Sixty meters down the tunnel they passed a pair of pressure doors, then took a side tunnel that rose to New Tokyo. In a minute they were back in bright sunlight; New Tokyo consisted of a square of traditional looking Japanese buildings surrounding a stone-floored plaza. He led them into a building, then out an airlock in the back.

Suddenly they were in an agricultural enclosure instead, seventy meters long and wide. Except for the narrow two-meter access way along the eastern edge, the rest of the enclosure was a rice paddy, lushly green, the blades bending over from a heavy load of nearly ripe grain. Ichiro led them along the access route to an airlock at the far end. The next enclosure was full of tomato plants covered with ripe fruit; a robot was busily picking them. Then they crossed a newly planted, barely wet paddy. The fourth enclosure was covered in clover—a common starter crop—planted to within a meter of the escarpment.

They walked to the edge of the enclosure. The plastic curtain with its network of kevlar ropes and transparent cells descended into a waist-high concrete barrier. “We’d built up,” said Ichiro. “The condos would have balconies almost touching the enclosure on their south sides. The north sides of the buildings would have the entrances and maybe a narrow strip of private garden. There would be private rooftop gardens as well.”

“It’s too bad the plastic doesn’t extend past the edge,” said Will.

“Maybe we’d use that technique on other enclosures,” said Ichiro. He turned westward and pointed. They could see over the foot of the western wall across the

slightly rolling, reddish stonescape to a pair of bubbles. “You see, there’s the Dacha, just five hundred meters away. Plenty of room for enclosures that use the escarpment edge more effectively. This dome was designed for farming, not for its view.”

“It’s prime real estate, that’s for sure,” agreed Will. “And as our tourist load increases, this facility could be crucial for serving them. We’re hoping that with the faster flights and cheaper fuel, in another decade we’ll be flying one hundred tourists here every opposition; an entire caravel load. You’re sitting on gold, Ichiro.”

“How far does the border of New Tokyo village extend?” asked Enlai.

“The Dacha’s part of it,” replied Ichiro. “We have five kilometers of escarpment rim and ten kilometers of rim overlooking the Little Colorado Canyon, plus most of the canyon.”

“You have scenery as your resource,” agreed Will. “As Mars grows, it’ll be more and more valuable, and it’ll be able to compensate for the cost of shipping water and building materials up a long, steep, winding road, especially as you add entertainment resources. So you have to get rid of your debt, Ichiro, in order to buy building materials for this expansion. Sell the agricultural domes. You’ll still have the pressurized right of way underneath, and you’ll have the money to build your other domes. And don’t enclose a bunch of empty domes, then fill them with buildings later. Complete a dome, build your structures, sell them, recoup your money, then repeat.”

Ichiro looked at Yoshi, then sighed. “I fear you are right,” he replied. “This has been Yoshi’s advice as well. Who would ever buy them though?”

“Advertise in *Mars This Sol* and find out,” replied Will.

“I’ll talk to the Board of Directors,” agreed Ichiro.

They all turned and headed back to the village, where they offered Will and Enlai another cup of tea and some cakes. Then it was time to catch the bus back to Aurorae.

"A casino?" Enlai said to Will, amused, on the way back down. "That must have bothered you."

"It did. Bahá'ís don't gamble, and I will discourage the idea, but I won't impose my morality on them."

"I doubt many people here are gamblers anyway."

"I don't know. Ask the hospital; they might have statistics about the number of people who have asked for counseling. There's always internet gambling."

"That's true." Enlai looked at the scenery go by. "This is one of my last official acts as chair of the Council, I suppose. And in two sols, when we both go to Dawes to welcome the crew of the *Tienan,* I will begin one of my first acts as a member of that expedition."

"Yes, it's a big transition for you."

"It is. I'm glad Vanessa Hunter has agreed to serve as Chancellor of Martech. She'll do an excellent job."

"And it's fitting that another eobiologist takes the helm. That's one field of study Mars dominates."

"Until the object of study shifts to the Galileans, and then a decade or two later to Titan."

"It won't be long before the Galileans become the center of attention, too, right Enlai?"

He smiled. "That's true."

Two sols later, the *Tienan* aerobraked into Mars orbit. It was carrying seventy-five Chinese scientists and engineers; twenty-four crew for the upcoming voyage of exploration and fifty-one personnel for the Chinese nuclear and exploration efforts. The ship soon arrived at Embarcadero, where it was met by three shuttles. All seventy-five flew down to Dawes Outpost, where Will, Enlai, and others greeted them. On the occasion of their arrival, the Chinese flung open their 160-meter in diameter dome, fifteen kilometers south-east of the main outpost, to approved visitors, which included Brian Stark. Their growing facility was very impressive.

Five sols later—September 1, 2046—three caravels with 150 migrants each aerobraked into Mars orbit and made their way to Embarcadero. Every passenger shuttle on Mars—five vehicles—plus four cargo-only shuttles were there to greet them, and soon began descending at the rate of two per sol to Aurorae and Dawes. The two newest shuttles could carry twenty-four passengers; two others, eighteen each; the oldest, twelve. A sol after landing the vehicles flew back to orbit to retrieve more. The three caravels also had to be stripped of much of their life support equipment, which would be used on the surface to purify air and water, and they had fifty tonnes of leftover consumables and other cargo to deorbit. It took two and a half weeks to bring everyone and everything down.

As people landed, they headed for their various destinations by plane and mobilhab. But as usual, there was a big dinner after everyone was brought down, with video feeds to unite together the dinners in eight different boroughs on a large wall screen. Half of Andalus Square was cordoned off for the ticketed guests, since not

everyone was invited this time. But the screens and loudspeakers were set up for the benefit of everyone, and many sat in the rest of the square to eat their Satursol afternoon meal and eavesdrop.

As Will approached the head table, he saw that his main guests had already arrived: Susan van de Velde, an engineer who had been on Mars since 2031, and her twelve year old son, Guillaume; Dr. Nathan Rubin, a Canadian philosopher of Russian extraction in his late twenties; Maryam Salih, an Indonesian businesswoman in her mid thirties; Dr. Boris Ivanov, a sociologist at Martech; and Boris's wife Tatiana, an artist and architect. "It's good to meet both of you!" he said to Rubin and Salih, both new arrivals. "I'm very excited that the Van de Velde Immigration Fund was able to pay for two immigrants this columbiad; it's quite exciting. We need the diversity!"

"Thank you, Dr. Elliott," replied Maryam, with a smile.

"Delighted to be here," added Nathan. "I suppose the fund is about the only way Mars can afford a philosopher!"

"We pay primarily for humanities scholars, artists, and businesspeople," said Suzanne, describing the fund named for her late husband. "Three things Mars will lack otherwise."

"And we are grateful, Suzanne," said Will, putting his tray down and sitting at the table. "Maryam, you're from Indonesia, right?"

"Yes; Tenggarong, Kalimantan, to be exact. I'm here to open a consumer goods business; shoes, clothing, and accessories, primarily."

"We could use them."

“That’s for sure! What we have here could be much more comfortable and stylish. Even the choice of materials is still limited, but it can be expanded as well. And therein lies the secret to decreasing imports. We’re importing forty kilograms per person per columbiad of consumer goods of the sort I plan to make; that’s eighty tonnes and one hundred ten million redbacks of cost to the consumers.”

“I suppose that’s why Mariner Bank is loaning you a bundle,” said Will. “Best wishes, Maryam. We’ve been trying to make better consumer goods for years. They’ve been getting much better, especially as our population grows. I gather you’ve imported ten tonnes of equipment.”

“Yes, and it appears we can make even more here. We can obtain the resources to make the goods the Marsian public wants. And the business potential is enormous; with import costs as high as they are, decent clothing can be sold much more cheaply and still generate a big profit.” She spoke confidently and Will could see why she appeared likely to be successful; she exuded confidence.

He turned to Dr. Rubin. “I suppose your classes at Martech have already started.”

“Yes, the semester started last Tuesol. I barely had time to get off the shuttle, move into my flat, and find my classroom. But I only have one course.”

“That helps. What are you teaching?”

“Political Theory. It’s not my main area, but Boris was looking for someone to teach it, and we had a dozen interested students.”

“We’ve been wanting to add it to the curriculum for several years,” confirmed Ivanov.

“What’s your specialty?”

"My dissertation was in logic—a very mathematical subfield, and one the scientists here will appreciate—but otherwise I have a strong interest in social and political theory, which are no longer part of philosophy. I'm very interested in Marxism."

"It's making a comeback on Earth," commented Will.

"It's unfortunate, in my opinion," said Boris.

"Oh, I don't know. The Earth has gone too far toward individualism and laissez-faire. It needs more communitarianism," replied Nathan.

"What do you think of our mix?" asked Will.

"It's . . . interesting. You might say this is an entire culture and civilization based on team-building and conflict resolution workshops. No one has ever tried that approach before; call it 'therapeutic communitarianism.' From what I have seen on the flight out and over the last two weeks here, it works; at least to some extent!"

"I think a crucial difference is our system of elections without campaigning," continued Will. "It's actually a radical commitment to individual human rights, in one sense: no one can infringe on the individual's human right to vote his or her conscience. As a result, rather than two people receiving the bulk of the votes for, say, a particular council seat, the vote is very evenly split among dozens or even hundreds of recipients. Almost as many people receive votes as cast them! It's participatory democracy of a very different sort. And the result is an elected legislative body with no strings; no agenda they have to defend or promote."

"Yes, it's interesting," said Nathan, cautiously. "And you are right, from the point of view of a balance between communitarian and individual tendencies, it represents a different mix of the two. Whether it is better or worse is certainly not proved yet, though.

For example, the turnover rate of those elected may be a problem. Possibly no one who is elected can ever be defeated, because there is no way to campaign against them."

"And in modern democracies on Earth, the reelection rate is extremely high—usually ninety-nine percent—after a period of legalized slander of them and their opponents by each other, paid for by legalized bribery of them by interest groups," replied Will. "The result is leaders who have been bought, and who must be effective after their reputations and integrity have been undermined and the trust in them by the electorate has been severely damaged."

"Mars is so small right now, though, informal checks and balances can operate instead, and cultural constraints such as unofficial term limits can have a big impact," said Nathan. "We don't know how those mechanisms will function when Mars gets larger. They could collapse entirely. The new Lunar Residents Council is functioning well, and its elections were dominated by campaigning. Even the Mars Landowners Assembly functions reasonably well and it has election campaigns."

"I think most observers are struck by its much more boisterous, fractured, even angry and polarized deliberation," noted Boris.

"Of course," replied Will. "It helps that the members of the Residents Council meet informally and get to know each other. They eat meals together regularly and discuss personal matters together. This would be utterly impossible in a place like the United States Congress! And that difference explains why Congress is unable to make rational reforms even when there is a crisis—in social security or health care, for example—while we can wade in and resolve such matters peacefully."

“We are more like the Swiss or Norwegian legislatures than the American or French,” agreed Boris. “But Will, you are too modest; you have a lot to do with the atmosphere, because you feed them at your house regularly!”

“And cook for them personally, no doubt,” added Tatiana. It was widely known that Will Elliott was a very good cook.

Will smiled. “Food is one of the best unity builders there is.”

“That’s the sort of thing that political theory can’t measure,” noted Nathan.

“That’s too bad for the theory,” commented Suzanne, with a chuckle.

“Coffee or tea, anyone?” asked Will, standing up. He grabbed his own empty plate and reached over to take Maryam’s. There followed an exchange of empty plates and Will hauled a stack of them to the place where they had to be returned for washing. He returned two minutes later with a tray of steaming cups and personally served everyone, which made Nathan nervous. Meanwhile, Érico Lopes stopped by. Will patted him on the shoulder and shook hands.

“My good friend, I’m so glad you’re back.”

“Thanks, Will.” Érico embraced Elliott warmly. “I’m relieved to be back. I now have a much better feel for what you accomplished two years ago. Three and a half months in space, a thirty-day whirlwind on Earth visiting everyone and every place you can, then six months in space again! It’s crazy!”

“But you were received as a head of state!” replied Will. “I was so proud of that! Mars now virtually has a head of state! I’m sure the protocol was tedious, but think what it means!”

"I know. Of course, I received the full honors of a head of state in only three countries. Most offered more limited honors. The United States virtually ignored me and treated me like some small town mayor; I didn't even rate a meeting with a cabinet secretary or the head of NASA. The Chinese also. The Europeans and Russians were gracious, though."

"That's predictable," replied Will. "Your trip did a lot of good. Sales of land were stimulated significantly and business investment jumped noticeably."

"And I met thousands of idealistic young men and women who yearned to come here," agreed Érico. "It was really touching and encouraging. They see this place as the future. The idea of Mars as utopia is alive and well, for better and for worse."

Will nodded. "We need to do more than cultivate the idea, too; we need to demonstrate there's at least modest evidence supporting it."

"I suppose a governing system lacking electioneering at least has that going for it," added Nathan. "Whether it really is better or not, at least it's different, innovative, and it avoids destroying the reputations of those involved."

"We can count on the terrestrial media to do that instead," opined Érico. "They're so cutthroat! That was the hardest part for me. While I can manage to pretend to be a politician here, I could never do it there." He looked around at the crowd. "I suppose it's just about time for me to give the speech, too. You sure you don't want to do it, Will?"

"No, I spoke six months ago when the first wave of migrants arrived. The Chief Minister gets to speak to the second wave of arrivals."

"Fair enough; it was the other way around last columbiad when you went to Earth," said Érico. He drank down the last half of his coffee in one big gulp, handed Will

his empty cup, and rose. When he stepped onto the platform and walked to the podium, the crowd began to quiet.

"Good sol to you all," he began. "As I look at all your faces I think of zero-gee volleyball games, long conversations about the future, many aspirations, and above all a determination to settle this new world and build a new nation. It was my great privilege to spend six months with you on the flight from Earth.

"But one truth became clear to me when I traveled around Earth: there are millions of young people there who share your hopes and determinations. Mars has become the goal destination of a very large number of people of every race and religion. Mars represents a new beginning for humanity, a new chance to build a better society, a new opportunity to make a contribution to a great, historic movement. All of you have obtained a great privilege to be on the ships of the thirteenth columbiad.

"And here you are. Welcome to Mars. Now you have to actualize your aspirations and serve the aspirations of millions of others. There are two chief ways to do this. First, you can work very hard so that our immigration can continue to grow and more can come here and join you. We have not reached our capacity yet; no one knows what our capacity is. We know that growth of forty percent per columbiad is extremely difficult to handle, but that could mean a very large numerical growth when Mars has a million people. The bigger issue is where Mars will get the money to fund the growth; but as we grow we will have greater and greater capacity to provide it internally and to obtain private financing from Earth. The last few years have shown that our exports can increase much more than expected. No doubt we will hit temporary plateaus in our growth, but Mars will grow. All of you have the capacity to contribute significantly to it.

"The second way you can contribute is through the quality of your life. Utopian aspirations cannot be maintained through innovative legislation, extensive counseling, and workshops on multicultural team building. Each of us in our daily behaviors can strengthen or weaken—or even destroy—the reputation of this world. We must keep ourselves and others safe, because one large accident will rightly cause many to question whether this is a good place to live. We must maintain good relations with each other, create neighborliness, and build a family-friendly community, for human beings yearn for a supportive and loving community when they face life's tests. And when we face those inevitable personal tests, we must seek assistance from others; we have a marvelous array of specialists in handling debts, grief, conflict, depression, spiritual emptiness, and many other common problems. When we turn to others, we find new sources of inner strength, increase our capacity to serve others, and we become happier. And is that not the real goal of Mars: to create a world of happy people? If we can achieve that, we will become a magnet that pulls people and investment to us.

"So my final advice is simple: strive to become truly happy. True happiness flows from our love of others and our service to them. And help build a society here that will make people happy. It can be hard work and very frustrating. The effort, ironically, can generate temporary conflicts. But if we achieve this goal of a happier society together, we will have achieved a revolution in human history, and we will have built a society that all humanity can learn from and will follow. Thank you."

Érico stepped down to applause. When he walked back to the head table, they all applauded him there. "You're getting good," Will said.

“Thank you. Will, I was hoping we could arrange another of those informal meetings, maybe next week. I still have a lot of family responsibilities this weekend, but after that the time would be good.”

“Okay.” The reference was cryptic; joint meetings of the heads of staff of the Commission and the Authority were potentially controversial, especially on Earth. “A lot of ideas?”

Érico nodded. “Some.”

7

Beginnings

7-15 Sept. 2046

Liz Elliott hurried from her class to the university's cafeteria to grab lunch before her next course. She was putting a sandwich on her tray when someone approached her. She looked up and gasped. "Corrie!"

"Surprise!"

They embraced excitedly. "What are you doing here?"

"I'm back!"

"Permanently?"

She nodded. "I came back to see dad when he returned from Earth, and he and mom and I had a long talk on Sunsol. I enjoyed Cassini, but it's hard to take courses there; I had to take a lot of courses offered here by video. So I might as well take courses here directly."

"Sam's at Uzboi this semester."

"I know, we exchanged emails last week. I don't mind running into him. I just don't want to see the baby."

"Yes, I understand," said Liz sympathetically.

Corrie lowered her voice. "Maybe it won't be so hard in a few years. Seeing her makes me feel haunted . . . I want to have a baby, I know I can't deal with one now, I worry I may never have one again, I worry about her, I wonder how she's doing, I resent the fact that someone else is raising her, yet I'm relieved not to have to do it. . . oh, it's just so complicated." She shook her head and closed her eyes a moment to stop the tears.

Liz reached over and put a hand on her friend's shoulder. "I'm sorry. Come sit with me. Ruhullah and Nadia never eat here."

"I know."

Liz waited while Corrie took a sandwich and salad. They both paid for their meals and sat at a table on the patio. "It's better to be here," said Liz. "Lots of cute young men arrived a few weeks ago. And there's always something happening."

"I know. Cassini's pretty active, too; it may be small, but almost everyone's single."

"Have you seen Martha and Caitlin? They've been back nine months, now, and they always ask me how you're doing. Not that I have any idea!"

"I'm sorry; I've been ignoring emails and messages. No, I haven't seen Martha. I've been getting counseling at Cassini from a very capable counselor who's been really helpful. And Eve was helping me here. I like her."

"All the old timers go to Martha, and I guess we're old timers!"

Corrie laughed. "I guess. How's Caitlin? She must be. . . sixteen."

"Yup, and starting eleventh grade, but she remembers you from before they left for the asteroids. Sometimes she eats lunch here; you'll probably see her."

"I'll look for her. What are you taking?"

"Twentieth Century English Literature, The Culture of Classical Greece, Physical Chemistry, and Ballet."

"I didn't know we teach English Literature or Classical Greece!"

“We don’t; I’m taking the first through M.I.T. and the second through Harvard. Marshall’s actually in the lit class to finish his distribution requirements, and he helps a lot. What are you taking?”

“Calculus, Organic Chemistry, an Ecology Seminar—it actually meets at Cassini and I participate by video!—and Impact Cratering. I’ll probably go into biology.”

“Exobiology, or horticulture?”

She shrugged. “We’ll see. What about you?”

“I don’t know, and I have to declare a major soon, and I don’t want to! I suppose history and English lit. I’ll double major.”

“Good luck! And you must work.”

Lizzie nodded. “At Andalus Day Care taking care of twelve to eighteen month olds. They’re cute, but they’re exhausting!” She shook her head energetically.

Corrie laughed. “No thanks; no little ones for me right now! I’m looking for a job. I’ll probably start with horticulture next week. They pay pretty well, I’ll get to see whether there’s any work there I enjoy, and I’ll be in nature.”

“If you call gardens ‘nature’!”

“Yes. Bioarchive may be more fun; they’re wilder, but they also need less intervention. How’s Marshall?”

“Pretty good, starting his senior year! He’s really enjoying M.I.T. and Boston and keeps telling me to come for a few years. But he’s coming back here on the fourteenth columbiad, so I don’t think I want to go.”

“Your ballet instincts would be all messed up by the change in gravity.”

“Exactly. Mars is fine, and it’s getting pretty big.”

"Yeah, I'll stay, too. I can get a biology Ph.D. here pretty easily." She looked at her watch. "I promised mom I'd stop by her work, so I've got to run. Let's get together."

"Come here tonight about 9 p.m. for ice cream. That's when a lot of us take a study break. I'll introduce you around."

"Thanks, I'll do that!" Corrie leaned over and gave her a friendly kiss on the cheek. "It's good to see you."

"Thank God you're back. We're practically sisters, Corrie!"

"I know; born the same sol, like fraternal twins! I missed you, too, but I had to get away."

"I understand. But let's not be strangers. Ciao."

"Ciao."

As Helmut, Clara, and Charlie approached the door to Kristoff and Irma's flat, they noticed a robotic cart standing outside it. Just then, the door closed and the cart backed away from it, turned toward them, and started down the corridor toward the spiral ramp. They moved out of its way—as smart as robotic vehicles were, it was recommended to avoid their path—and it said "thank you, excuse me" as it passed them, much to Charlie's amusement. They continued down the hall and knocked on the door.

Kristoff opened it. "Oh, there you are! Good timing, the pizza just arrived."

"You mean they have delivery?" said Helmut, surprised.

"Yes, but you have to reserve a few hours in advance. There are only a dozen robotic carts in the outpost." Kristoff pointed to the dining table, where Sebastian was opening up two large plastic pizza boxes.

“We’ll have to try that,” said Clara. She hurried over to Irma, who was struggling to get the twins Mark and Nicola, now twelve months old, into their high chairs. Mark was resisting her. Clara grabbed a small piece of pizza crust and handed it to the boy, who immediately quieted down. “That’s what he wanted.”

“Thanks.” Irma turned to her sister in law and they hugged quickly. “How are you doing?”

“Pretty well; it’s getting hard to do a full sol’s work, though.” She patted her stomach, which was beginning to swell from the pregnancy. “How about you? How’s work?”

“It’s strange to be back full time, but they’ve been begging me to come back and now that the babies are a year old I don’t have any maternity leave left.”

“Time flies.” Clara looked at the little ones, then at her own son, now almost eight. “I’m definitely starved.”

“Then let’s sit,” suggested Helmut, and he pulled up a chair for himself. Charlie sat next to him; Helmut began getting pizza for his son.

They grabbed slices and napkins for themselves, then sat around the table. Sebastian looked at Helmut. “How was the meeting with Afigbo?”

“Pretty good. His team is installing six more bubbles next week between Andalus, Andalus northeast, and Ceylon. We agreed to buy the third bubble. He’ll have the housing contract emailed to us tomorrow some time; he has office support staff in Nigeria drawing up the details.”

“The same cost?”

Helmut nodded. “Four million. The house should be ready for occupancy in four months.”

“So he’s done with all the craziness associated with the arrivals?”

“More or less; people are still reporting leaky pipes and thermal regulation problems. Afigbo doesn’t have that much work when the migrants arrive, though, because most of his buyers have been here one or two years. He doesn’t house many new migrants.”

“Kristoff, we asked him about the rumor that there would be bigger bubbles,” added Clara. “He confirmed that the construction department is looking at making a bubble forty meters long and twenty in diameter. Simeon said he’d prefer the new size; they’d allow three story construction and all sorts of new options.”

“Oh? That’s good to know, but I have a new idea. I contacted Ichiro Otsu up at New Tokyo this morning and he said I should come up, so I took a long lunch and went to see him.” Kristoff smiled and everyone could see that he was almost bursting with excitement. “I asked him about their ad in *Mars This Sol* to sell four seventy by seventy agricultural cylinder domes. He didn’t want to sell just one, though. I finally asked about buying two, and he came back with an offer to sell me all four for the price of three.”

“Really?” said Helmut, surprised. “How much?”

“Twelve million.”

“Wow! What a steal.”

“But an impossible steal,” replied Irma, skeptically. The scowl on her face belied a long and hot discussion she and Kristoff had had an hour earlier.

“Well not quite. I looked at their farm productivity records. They’re not farming as efficiently as I would, partly because they’re raising too many things and partly because they don’t have all the expertise. I’m pretty sure I can make 90 receipts per square meter per year. That’s about 1.7 million per year for the entire farm. The loan will cost about a million a year, equipment and other costs another 200,000 or 300,000.”

“That doesn’t leave much to live on!” said Sebastian.

“The farm won’t take all my time. I could probably continue working for the horticultural department two sols a week. The work is highly mechanized, even harvesting of high-value vegetables.”

“I think it’s marginal,” said Irma, shaking her head.

“Yes, for now, but as we pull down the loan and acquire more experience we can get more land. I can become full time. This is a business that can grow over time.”

“You’d be in better shape if you have a bigger down payment; you’d have a smaller monthly payment,” said Sebastian. “I’ll help.”

“So will we!” said Helmut right away. Then he glanced at Clara; he hadn’t asked her. But she wasn’t disturbed.

“Look, I can give you a million,” said Sebastian. “Maybe more; I have a lot invested in Mars Metals and their stock is strong right now.”

“Why are the Japanese selling?” asked Clara.

“They’re overextended and can’t cover their loans. They want to start building housing in the domes along the escarpment rim on the theory that the view should make them worth a lot. The cash from the sale will cover their payments and give them enough cash and credit to fill one dome with condos.”

“And your farms will be right in between the escarpment and New Tokyo Square. It sounds like your farmland’s value could go up if the land gets converted to urban space.”

“I think there’s a lot of potential.”

“And they couldn’t find a purchaser?” persisted Clara, skeptically.

Kristoff shook his head. “They approached the Horticulture Department. Lisa said no; they didn’t want to start operating a farm up on the escarpment. Then they approached Deseret. The Mormons didn’t want yet another business. Ditto with the Nigerians. The Green World Community said their commitment is to Aram. There aren’t that many potential purchasers up here.”

“What about equipment?” asked Sebastian.

“I’ll lease it from the Horticultural Department. That’s what the Japanese and the Zen monastery already do. Eventually I’d buy my own, but that’s *very* expensive and you have to have a lot of grange to justify it.”

“What about air leaks?” asked Helmut. “They’ve had a lot of trouble up there.”

“They have. The bedrock is dry and porous close to the escarpment. But it isn’t a problem with these domes because they have a half centimeter of nickel-steel a half meter underground.”

“Oh. Don’t plant an orchard.”

“I won’t. Two domes are rice paddies and I’ll keep them that way because the water provides thermal stability for all four domes. If anything, they need a better heat exchanger; the temperature cycles up and down too much and that’s one reason their crops aren’t as large as they could be.”

“The nickel-steel floor isn’t a problem for conversion to residential, either,” added Sebastian. “They’d cut a few holes and drive some pilings into the bedrock, or just reinforce the floor by welding on a few centimeters of extra nickel-steel. It’s almost as cheap as water right now.”

There was a moment of silence while everyone considered the information. “Why don’t we incorporate,” suggested Helmut. “There are five of us, or three households. Dad, Clara, and I have a lot of money from our jobs. We can invest money; Kristoff can contribute time.”

Clara looked at him, nodding. “I think we could afford a million. We could also offer stock as collateral.”

“I could invest up to two million,” added Sebastian.

Kristoff smiled. He looked at Irma. “That would be incredible! We have collateral in this flat and in retirement savings and investments; maybe a half million of potential cash and another half million of collateral. But I doubt we need much collateral because the property is worth at least the purchase price, and maybe more.”

“This will work,” said Sebastian, nodding.

“I guess it will!” added Irma, who had been pretty concerned about the idea.

“We’ll go see Silvio on Monsol and ask him to draw up the incorporation,” said Kristoff, excited.

“I’m sorry we weren’t able to get together sooner,” Will said to the others gathered in his garden. “Érico has been back almost four weeks, and we have all been incredibly busy with the arrivals!”

“How big is everything now?” asked Ethel. “I can’t keep track.”

“Let me check also.” Will turned to his attaché and typed in the question. The current census popped up immediately. “Ah, we really have too much information at our fingertips! As of this morning, Mars has 2515 people, including the baby born here yestersol; Aram 65, Aurorae 1,404 including 117 in New Tokyo village, Cassini 215, Dawes 267, Meridiani 103, Phobos 114, Thymiamata 91, and Uzboi 256. Note that all of Mars outside of Aurorae Outpost itself totals almost exactly as much as Aurorae. Half our population lives elsewhere.”

“That’s impressive,” noted Ramesh. “That makes roads more important than ever.”

“That’s right, your team is scheduled to start upgrading the Uzboi route next week,” said Will.

“No, we started a month ago,” replied Ramesh. “We have two of our six telerobotic regolith movers and I was able to squeeze two personnel out of the construction quota—thank you, Alexandra—so we’ve been running both bulldozers eighteen hours per sol for thirty sols. Each operator can run both from here, you see. We’ve already widened and regraded one hundred fifty hundred kilometers of the route!”

“That’s impressive. What about graveling?”

“It’ll be three months before we have one functioning robotic graveling system. It can gravel about one kilometer per sol under ideal circumstances; in other words, if the ground is such that it can dig a big ditch next to the road, extract rocks and gravel, crush the former, and shoot them onto the road where a robotic distributor and a robotic roller can finish the job. But each graveling system costs one hundred million and takes two

people and a constant 2,500 kilowatts of power to operate. They aren't cheap. Of course, when they're done you'll have a smooth, uniform road surface able to sustain up to ninety kilometers per hour, if maintained."

"With four of them and ten years, we'll have high quality highway from Uzboi to Cassini," said Érico. "Almost ten percent of Mars will be within a thousand kilometers of a good road."

"You mean I'll only get four toys?" replied Ramesh to Érico, jokingly.

"Unfortunately, we keep finding resources we need in the other ninety percent," commented Ethel. "I suppose you've all heard of the enstatite chondrite find in Lucus Planum, south of Amazonis. That's two thousand kilometers off the Circumnavigational Trail and about ten thousand kilometers from any existing outposts. I don't think we'll be developing it any time soon!"

"We don't need to anyway," exclaimed Yevgeny. "Uzboi can expand its production tenfold or more, and won't be exhausted for decades."

"Ten fold," mused Érico. "That means what? About eight tonnes of PGMs per sol? I wonder whether that's enough."

"For what?" asked Hun-jai Park, their economist. "I doubt we can push PGM production much above 2 tonnes per sol, or 1,600 tonnes per columbiad; that covers the Earth's current demand when you include the moon's production."

"Well, we'll need an income of that scale," replied Érico. "Three tonnes per sol is 150 million redbacks per sol, or about one hundred billion per columbiad. If we had an income of that scale, Hun-jai, what population could we support here?"

“At current costs? Assuming the usual formulas to calculate the quantity and costs of imports and the multiplier effect for domestic consumption, perhaps a hundred thousand.”

“But a population of that size would import less per person and export a lot more,” added Yevgeny quickly. “It could be two or three times as much.”

“Perhaps,” agreed Hun-jai cautiously.

“If you’re thinking what’s the minimum for independence, I’d say it’s plenty,” replied Will. He looked at Érico, who nodded.

“Yes, that’s what I had in mind. That was my big insight from touring Earth. Frankly, most people don’t take us very seriously. Government support is already pretty weak, and it isn’t guaranteed. We have a few million fans and a smaller gaggle of a few tens of thousands of fanatic supporters. The economic and political situation strikes me as pretty unstable. In the economically developed countries, the demographic crisis threatens social stability and government surpluses. Environmental degradation has slowed economic expansion significantly in China, Australia, Brazil, and India. And the power rivalries will constantly jeopardize our support. It’s not a good situation.”

“I agree,” said Will. He turned to his attaché and called up some figures. “Look, we have almost 2,600 as of this sol and with births we’ll have 3,000 by the end of this columbiad in early 2048. Then we get 900 arrivals, but we lose our usual fifteen percent of those who return to Earth, so the net gain is closer to 750; add another 600 babies and the columbiad ends with 4350 in 2050. Assume we add another caravel and have 1,050 migrants, but 150 return to Earth and 750 babies are born; by early 2052 we have about 6,000 people, with a thousand more on their way. At that point I will have just retired.

We will have more than half the population of Tuvalu, which with 11,000 people is the smallest independent nation on Earth. We will also have about a thousand times Tuvalu's gross domestic product. It isn't a question of size; we're big enough for independence now. It's a question of whether we want government subsidies."

"We'll need them for a few more years because of the uncertainty of PGM prices," added Hun-jai. "But let's face it, Uzboi's PGM production changes everything, because it will soon bring us more income than all the government subsidies combined."

"I guess you've answered my question, then," said Érico. "I was thinking in terms of several tens of thousands of people, which would reinforce our export muscle with greater size and economic diversity."

"A greater size would be nice, but we'll be able to manage our affairs in three to five years," said Will. "Or maybe I'm just projecting my own retirement onto the picture; I don't know. I don't want a terrestrial bureaucrat running Mars."

"So, how do we prevent it?" asked Érico.

"A subtle diplomatic campaign coupled with use of the media. But it'll be a hard sell."

There was a pause. Then Hun-jai said "I have a question. How do nations get a membership in the Mars Commission?"

"They make a commitment to Mars and fork over some dough," replied Will.

Hun-jai nodded. "Well, as we know, the Authority sets the export tax rates; that's its principal source of income. And by contract, if the Authority raises taxes, it comes out of the Commission's royalty. That's how we transferred the highway department, the university, and the hospital to it; the Authority assumed responsibility for their costs, it

raised taxes on raw material exports, and the Commission's income dropped proportionately. What if the Authority applied for membership in the Commission?"

Will looked at Park, startled. "Intriguing idea. Of course, only sovereign powers are members, but if the Authority offered several billion redbacks per year of money, maybe it could buy its way in."

"Especially with the threat of raising taxes even more!" added Yevgeny, chuckling.

"It would be complicated because the Authority couldn't decide to apply without my permission, and my permission would in turn be dependent on the will of the Board of Trustees," noted Will. "But the threat of trying to raise taxes and applying would be worth something. It's hard to flaunt Marsian public opinion. The Mars Commission is itself a member of the Asteroid Belt Commission. Maybe the Authority should apply for membership in the Venus-Mercury Commission."

"Joining the Mars Commission would give us a big role in running it," agreed Érico. "But it would perpetuate a mechanism that, at some point, should be terminated."

"There are two ways to think about it," replied Will. "The Commission can be thought of as the international mechanism that set up Mars; in that case it is the framework that does its prescribed job and becomes obsolete. Or the Mars Commission is the space agency both of and by Mars; in that case it becomes the NASA of an independent Mars."

"Will, Mars's 'NASA' can't be run by twenty-four nations," said Érico.

Will shrugged. "Perhaps they would withdraw from membership. There are ways to do this."

"Perhaps. The Authority will need a diplomatic presence on Earth; I've been doing a lot of thinking about that problem, and I met various people who might be able to serve."

"I don't see any way of getting independence without strong public opinion behind us on earth," said Yevgeny. "I'd rather not lose government subsidies, either, especially if we want to go for terraforming. If the terrestrial public is behind us, we could get independence *and* keep the subsidies. It'd be classified as foreign aid."

"I doubt we'd manage that," commented Alexandra skeptically.

"Why do you want to investigate terraforming?" asked Lisa. "The climatologists say the weather gets pretty nasty when the atmosphere is thicker; the dust storms become far bigger and last longer."

"What I'd favor is spending a few tens of billions over a few decades studying the climatological cycle intensively and determining what terraforming systems work best," replied Yevgeny. "Right now we don't know."

"I don't know where money like that for terraforming will come from," said Park. "Mars won't have resources on that scale for some time, and Earth doesn't seem willing or able to support it. In fact, a major economic collapse or a war seem possible." He looked at Will. "What's your feeling about Earth?"

Will sighed. "I left my crystal ball on Earth. No one can say what the second half of this century will be like, but the last decade and a half has seen two cities nuked, a computer virus wipe out most computers in North America, and an engineered flu virus kill tens of millions. All four acts of terrorism slowed economic growth. They have galvanized the Europeans to organize themselves more, but have made the Americans

more xenophobic. The price of petroleum's climbing. All those things make government support for space exploration harder to obtain, not easier. We could see something kill a few hundred million people and reverse economic growth for a decade or two. I doubt anything can happen to cut us off from Earth, which would be a disaster. Instability drives up the price of gold and so far it has driven up the price of platinum as well."

"If there's one correlation, I'd say it's between instability on Earth and Marsian independence," added Érico. "And Earth seems destined to be unstable."

"Will they let us have independence, though?" asked Yevgeny.

"How will they stop it?" replied Will. "No one will send the marines here. They're more likely to try an economic boycott. I think Mars can and will have independence when the Marsian public is ready to sacrifice for it. It's as simple as that."

"And we have to prepare the public for it," added Érico.

"Yes, we have to prepare the public for it," agreed Will, looking at Érico. "I'd make it a five year plan."

8

Criticality

December 2046

The lights were on in Andalus Square. That startled Will; it was noontime. A massive duststorm had swept through that morning. He had walked to work through domes filled with hazy sunlight; now they a dim orangey-gray.

He looked up at the sky. He could see swirls of ochre dust shooting by above the dome, which was itself covered by a cinnamon-like film. It was a bit chilly in the square as well.

No doubt every heater in Aurorae had kicked in and was trying to maintain the temperature of almost twenty hectares of enclosures. Fourteen hectares of farms were struggling in the overcast. Power consumption was skyrocketing.

Will turned back to the Gallerie and headed for Mars Control, a complex of meetings rooms and offices surrounding a single large room where up to a dozen technicians worked. Every outpost controlled all or part of its environmental management system, but the Mars Commission still provided overall coordination. That sol Clara Langlais was in charge. “I was just about to call you,” she said as he entered the control room.

“How bad is it?”

“The opacity has hit 4, so the solar arrays are down to ten percent and the solar power units are down to one percent. The winds are still extremely high—70 klicks—so the turbines are making up for some of the deficit, but the front is passing and the winds will soon drop.”

“What’s the demand?”

“Right now? . . . She leaned over her console. “Sixty-two thousand.”

“Sixty-two thousand? You should shut off the power uplink.”

“It *is* off. Phobos set an hour ago, and when it comes back up we won’t be beaming power up. Uzboi already knows; I told them.”

“Sixty thousand kilowatts without the uplink.” Will contemplated the number. Aurorae’s usual daytime power consumption was now about fifty thousand kilowatts, half of it for production of platinum-group metals, but it beamed surplus to Phobos, which stored it as hydrogen and oxygen and eventually beamed it to other facilities around Mars. The power link could transmit twenty-five thousand kilowatts, of which fifty percent arrived back on Mars if it had to be stored and reconverted and seventy percent returned if was beamed directly back down. Dust storms reduced the transmission quite a bit. Uzboi still had an enormous, unmet need for power, the other mining outposts had irregular power demands that could be evened out by power sharing, the exploration teams were mostly powered via microwave links, and now the road construction systems had large needs.

“Who else is socked in?”

“No one yet. Thymiamata has deteriorating conditions and that storm will spread east to Meridiani in one sol and to Dawes in three. A front is approaching Uzboi and it’ll be socked in tomorrow or the next sol. Aram is still calm for another week, Cassini for maybe two.”

“Category 5?”

Clara nodded. “That’s why I wanted to talk to you. The meteorologists just raised their prediction for the season from category 4 to 5.”

“We haven’t had a global storm for a decade. Bad timing; our operation is big and complex.”

“I’ve started reviewing the power rationing plan, but it’s out of date. It barely has Uzboi in it and doesn’t have the highway construction department’s new equipment at all.”

“We’ll have to cut them off. I hope we’re not powering the graveler right now?”

“No, but we’re powering three reg movers via Phobos. They’re scattered along Uzboi Trail and none are socked in yet. The graveler’s scheduled to start up in an hour or so.”

“Cancel it, and cancel the reg movers for now. How are reserves?”

”We’re set for category 4, but 5 will require rationing unless we can get power from New Hanford.”

“I’ll call. The reactor’s supposed to be ready. Get to work on the power rationing plan. We’ll need something to implement by tomorrow morning. If this is category 5, we have to prepare for nine months of partial obscurity.”

She nodded. Will turned and headed for his office down the hall, where he immediately called Brian Stark. “Hey Brian have you looked outside?” he said when Stark answered the call.

“No, we’ve been pretty busy; why?”

“Let’s just say the bus taking you back here tonight will be feeling its way down the road via gps.”

“It’s that bad?”

“Well, not quite; the front has past. You’ll have visibility of a kilometer or two. But solar power production has dropped to maybe five percent of normal and wind power, which is strong right now, is dropping as the winds weaken. And the meteorologists have upgraded their predictions: this season will be category 5.”

“Damn. And dust storm season supposedly starts December 21; that’s still two weeks away. I suppose you’re calling about the reactor. We’re still aiming to go on line December 21, though this morning they were talking about it slipping a few sols.”

“At what power level?”

“Low; maybe ten percent. The reactor’s not supposed to reach full power until February or March.”

“Can you look into the schedule? We’re certainly facing an emergency. Aurorae’s now way too big to store nine months of minimum power, which is defined as 20,000 kilowatts; we’d have to have tanks for 65,000 tonnes of methane and oxygen. We have 20,000 tonnes available, which can produce 10,000 kilowatts for six months; that’ll keep the lights on, but we’ll have to shut down all PGM production and some manufacturing.”

“What about Phobos?”

“They can make 25,000 kilowatts with their solar panels, but the dusty atmosphere will absorb up to three quarters of the power they beam down.”

“What about their hydrogen and oxygen storage? Phobos has five hundred tonnes of hydrogen and four thousand tonnes of oxygen, I believe.”

“Brian, you’re referring to the hydrogen purchased by the Chinese! That’s already sold!”

“I know.”

“Brian, I hope you’re not planning to postpone the reactor in order to force us to dip into the Chinese hydrogen, because it won’t work. With the dusty atmosphere and other factors, we wouldn’t get all that much.”

“Well, Uzboi could extract a lot more value in the form of PGMs than the hydrogen’s worth.”

“Yes, and we have a contract; with you, as well as with the Chinese. In fact, we have *two* with the Chinese, the other for a seventy-five thousand kilowatt reactor for Dawes; and we can award them the hundred-thousand kilowatt reactor for Uzboi to them if you’d like.”

Brian raised his hand. “Look, Will, you’re the one who jumped to conclusions about the Phobos hydrogen. No, we’re not postponing criticality. If anything, we have the capacity to accelerate our timetable; not to mention build a second, bigger reactor in Uzboi in record time.”

“I agree. The Chinese are already behind schedule at Dawes and the storm will put them farther behind. I doubt they’ll have their reactor fired up by next dust storm season. If you can get this reactor going sooner but in a safe and reasonable fashion, I’d think that would count toward the Uzboi contract.”

“I would hope so. Look, Will, I’ll talk to the staff and see what they say. We know how serious category 5 is.”

“Thanks, Brian. Can you give me an idea by tomorrow morning? We’re draining down reserves about three times faster than we want, we have to initiate a rationing plan.”

“Okay. Ciao.”

“Ciao.”

Will closed the line and shook his head. He wished he could pave Mars with thin-film organic solar arrays; their politics was simple and straightforward compared to that of reactors. But even with the new, cheap, solar arrays, reactors had a role to play; even if the arrays were big enough to make enough power through a dusty sky, there was no easy way to keep a square kilometer of array dust-free. The decision who to award the Uzboi reactor to was coming, and the reactor would have the capacity to make over a hundred kilograms of plutonium per year. He hesitated to award the contract to either; he worried what the Chinese would do with that much plutonium in space, but he had his doubts the Americans would make it available to the Europeans or the Russians. Both sides were probably shunting some Martian plutonium illegally to military uses.

The phone rang; it was from Ramesh Prathan. Will activated the line and saw an angry face. “Good sol, Ramesh.”

“Ah, hi. Will, we need power for the graveler.”

“Ramesh, do you know what ‘category 5’ means?”

“Yes, Clara explained it even though I already knew. Will, if we upgrade Uzboi Highway, we can haul methane and oxygen back and forth.”

“Ramesh, by the time you gravel 1,500 kilometers of road, we’ll have reactors at both ends.”

“Look, if we can get the power, we can keep the project moving forward; otherwise we’re stuck.”

“I know, but the atmospheric opacity is 4. That means insolation is only a tenth of normal.”

“But the wind turbines are turning like crazy!”

“They are now; the front came through as cold air displaced warm. But behind the front, the atmosphere is heated from the top and relatively little from the bottom because of the scattered dust, so a thermal inversion sets in and winds die down. The dust takes months to settle; meanwhile, there’s virtually no wind.”

“Oh. I gather the dust absorbs microwaves, though not as badly as it absorbs light. Can’t we truck oxygen and methane, or silane, to the graveler and power it that way?”

“Ramesh, we used to keep enough cryogenic fuels to power Aurorae through a category 5, but the outpost has grown so much that has become less practical. Once the reactor is on line we can consider trucking power to the graveler. If the reactor produces as expected we’ll crank up silane production to the max and use it to power everything. But that may be a month or two. Meanwhile your people will have to consider other tasks that are less energy-hungry. I’m sorry, Ramesh.”

He looked at Will. “Alright, we’ll find a plan B. What about the reg movers?”

“They have to stop as soon as they’re socked in. If our power situation improves, that can be reconsidered.”

“Alright, we’ll shut them down.”

“Thanks. The various science expeditions will have to head for the nearest outpost as well; we don’t explore the surface in category 5 conditions because it serious impedes rescue capability. This is difficult, Ramesh.”

“I understand. Let me know if there are any changes.”

“Absolutely. Ciao.”

“Ciao.” They closed the circuit. Will looked at his attaché; while talking to Brian and Ramesh, he had received several calls. But before he could turn to his videomail, another call arrived, from General Zhou Qisheng, administrator of the Chinese Nuclear Facility at Dawes.

Will activated the circuit. “Good sol, General Qisheng.” He used the General’s first name, as was the custom on Mars. “I trust you are well? How is your wife?”

“Good sol, Commissioner Will. You are kind to ask. The operation was very successful and she is now recovering well. And your family?”

“Oh, they’re fine. We—”

“I suspect your life is beginning to become very complicated. I just heard the forecast has upgraded the storm season to category 5.”

“Correct. We haven’t implemented our power rationing plan yet, but I assure you we will do everything we can to provide you with every kilowatt of power we can manage—”

“Yes, of course, but that’s not why I am calling. The *Tienan* arrived with three solid-core nuclear engines, as I am sure you are aware. Not known is the fact that it brought two one-thousand kilowatt power reactors. These are our prototype reactors for the Jupiter project. One was destined to be flown on the Metis mission and deployed there as a test. The other was to remain at our station on Deimos. I just spoke to our people on Deimos. They could fly both reactors to Dawes in three or four sols; they haven’t been activated yet and thus are not radioactive and relatively easy to handle. We

could leave one of them here during the entire storm season; the Metis reactor will have to go back up to orbit in late February."

"Oh, that would be an immense assistance! Aurorae should be fine once the American reactor goes on line in a few weeks, but the outposts in the Central Highlands will be severely limited. We'll transport as much silane and methane to them as we can, but they're going to have shut down most gold production."

"We'll be happy to do it. We'll need most of the power output, but with conservation we'll have surplus to sell to Dawes at the existing contract price. I'll have my people contact you once we have more details."

"Thank you, General, we are grateful."

"You are most welcome, Commissioner. Have a good sol."

"Thank you. Ciao." Will closed the circuit with a mix of relief and worry, because Dawes would now be in much better shape, but no doubt he'd owe the Chinese a favor. He turned back to video mail; even more had accumulated, with messages from Alexandra, Lisa, Ruhullah, and Yevgeny. It was going to be a long sol.

Helmut looked around the big, bare cylinder. The ground was black with organics and soaking wet, but had only scattered rice stubble rising from it. When they walked, the crunch of gravel on the walkway echoed faintly across the space. Outside was a featureless gray sky except for a dull yellow blob high in the east.

"This looks less promising than the vegetable cylinder," he commented to Kristoff and Sebastian.

"It's pretty chilly in here as well," noted Sebastian, tugging on his sweater.

“Temperature isn’t much of a problem,” replied Kristoff. “The infrared films on the dome retain heat pretty efficiently, and I have all of them in place. The lack of sunlight is a bigger issue.”

“Quite a few crops were developed for our Ceres mission,” noted Helmut. “They’re genetically modified to grow in ten to twenty percent of terrestrial light levels.”

“I know, and they are a possibility. The problem is quality; they generally don’t have the taste of the high-sun varieties. Horticulture plans to haul sun lamps into some of its fields if the emergency power rationing plan permits it, which it will once New Hanford goes on line.”

“But that would be rather expensive for us,” noted Sebastian.

Kristoff nodded. “I have a different solution in mind: hard winter wheat. On Earth it usually is planted in mid September, grows for a month or so, then goes dormant during the snowfall. It starts to grow again in March and harvests in May. I think there’s enough light for it to experience the autumn growing season. We can then leave it dormant until the long-term forecast is favorable. It needs at least a month or so of cold weather in order to produce a harvest, but otherwise its life cycle can be shortened to as little as ninety or one hundred sols; it can be lengthened if the weather improves slowly, too.”

“How will it sell?” asked Helmut.

“Pretty well, because it’s ideal for breads and rolls. Horticulture usually plants it when we get a bad dust storm season. It stores indefinitely. No one likes to grow it when we don’t have a dust storm because it takes longer and has complicated climatic requirements. As a result, it fetches a pretty good price.”

“That’s good news,” said Helmut, looking at Sebastian.

“I can plant both rice paddies with hard winter wheat. I may be best off planting something in the vegetable cylinders for animal fodder, because its price goes up during these events as well. Even hay would be possible; it adjusts to conditions pretty well. At any rate, I have to decide pretty soon; otherwise Langlais Farms won’t have any cash flow to cover the mortgage.”

“Whatever you decide is fine with me; you’re the expert,” said Sebastian, with Helmut nodding in agreement.

“When can we expect income, then?” added Helmut.

“It’s now mid December. . . at least April, probably May or June. But we can reduce expenditures. Lisa Kok has agreed I can shift my work hours, and Irma has agreed to it as well. That’ll allow me to come up here on the 6 a.m. bus, work two hours, then get to work by 10. I’ll need to take a sol off to set up each cylinder, but after that, two hours a sol will be more than enough to maintain them.”

“That’ll help our cash flow,” said Sebastian, nodding.

“Good,” noted Helmut. “Because Clara’s really worried about our finances. I suppose it’s partly because she’s about to give birth.”

“No; Irma’s worried, too,” replied Kristoff.

“Everyone wants us to succeed; the pressure to privatize is pretty strong. So I’m sure the bank will be flexible,” commented Sebastian.

“Right now, they don’t even have to be flexible,” noted Helmut. “We can go until May.”

“I’m more worried about what happens after that,” agreed Sebastian.

“Gray, gray, gray,” Sarah said to Ramesh, shaking her head. She waved her fork at the main entrance of the Gallerie. “Did you notice how no one wants to eat outside? Everyone’s coming inside here for their meals.”

Ramesh was unmoved. “Is the hospital getting an upswing in depression?”

“A little. Most people are dealing with it fairly well. Maybe I’m the exception.”

“Why does it bother you? I couldn’t care less if it’s gray out. I’m inside buildings all the time anyway. Have you stopping hiking?”

“The club has cut way back. Visibility is fine for hiking, but the views are lousy. The escarpment is still invisible.”

“Don’t worry, it’ll still be there when the dust settles.”

“You aren’t sympathetic at all, are you? With the reactor still not on line, horticulture’s talking about cutting back on crop diversity, so our diet will become rather boring in a few months. The holidays won’t be very exciting, either.”

“At least many residential domes will have a white Christmas.” He said it in a neutral tone; he was Hindu and didn’t care. Ramesh took a swig from his coffee cup. “Look, Sarah, the bigger issue is work. If this storm goes on and the nuke doesn’t go on line, there will be unemployment. My crew has been idled.”

“You mean they’re doing nothing?”

“Well, nothing for me. Highway construction is completely shut down; the dust absorbs half the microwave beam, so we’d have to transmit 12,500 kilowatts from here to Phobos for 2,500 to arrive at the graveler. Even the bulldozers are stopped.”

“So what are your people doing?”

“Construction; running pile drivers, mostly. They only need a hundred kilowatts each.”

“Well, they’re not idle. What are you doing?”

“Looking at Aurorae’s internal transportation needs; wider North and South Main Tunnels, the various connecting tunnels, future traffic. We’re also evaluating the five kilometers of gravel roadbed we already made. You can’t make a good dirt road without water, really. I’m not idle, just bored.”

Sarah was not impressed by that complaint. “Well, that’s useful work, too. Say, why is it that all your construction workers are Indian females?”

“It makes an interesting point, doesn’t it? Telerobotic construction doesn’t take big muscles. Besides, everyone says Mars has more men than women and I thought I’d help even the numbers.”

“You imported some rather beautiful women, too.”

“Beautiful and smart, I assure you. They’re finding spouses pretty fast as result and their mothers are grateful to me. Why are you bothering me about this?”

“Oh, I’m just trying to figure you out.”

“I see. Well, I’m not going out with any of my workers. You work with some handsome, unmarried doctors and therapists, if you ask me.”

“I do, and I’m not going out with any of them, either.”

“And the Hiking Club hasn’t produced results, either, or the church.”

“I’m not going to those gatherings just to find a husband, you know!”

“I know, I know. I’m sorry.” He leaned close to her. “Maybe this grayness is getting to both of us. We’re both short-tempered.”

“You’re right, I’m sorry.”

“And I’m sorry.” He leaned down and picked up his attaché case. He pulled out a small box. “I have something for you.” He handed it to her.

Sarah took the box and opened it. She gasped. “Pearl earrings! I love pearls!”

“I know; I noticed.”

“Where did you get them?”

“Pearls may not be native of Mars, but they are sold here.” He leaned close. “Sarah, I am very attracted to you.”

She batted her eyelashes. “Ramesh. . . thank you.” She leaned over and gave him a kiss.

“Thank you. Look, we’ve been sparring for months, and it isn’t getting us anywhere. We don’t need dinner, we don’t need counseling. . . we need a weekend together at the Dacha. What do you say? It isn’t as gray up there, the air is thinner!”

She was startled by his bold suggestion. “I . . . don’t know what to say.”

“Sure you do!” He smiled.

She smiled back. “Okay.”

It was twenty kilometers to Hanford Flats, a barren, nearly featureless plain northeast of Aurorae where the Americans had built their nuclear facility. The 160-meter dome rose like a silver soap bubble out of the gray sky as Will drove the gravel road to the facility. As he approached he saw the second, smaller construction bubble attached to the east side, 100 meters in diameter, enclosing a concrete dome; the reactor.

He drove his ranger into the facility's airlock on its west side. Brian Stark was there to meet him and Enlai Tang, whom Brian had invited as a courtesy.

"How are you doing, Enlai?" he asked, as they walked through the 160-meter dome to the reactor control facility. The B-160 was fully pressurized and oxygenated, with a pleasant climate and an east-west "mall" of pine trees and grass lined with buildings.

"Oh, pretty well. As you know, I'm now preparing full time for the launch in March."

"Yes; to Metis." Brian emphasized the destination. "How's your team? You now have a lot of folks in Dawes. You must be making good progress on the reactor, and on the gaseous core engine."

"Not really. A lot of them are helping prepare for the launch. The heavy work on nuclear science follows. How about you?"

"Well, we finally have the reactor ready; we're just six sols late. We even worked yestersol, in spite of Christmas."

"I appreciate that," added Will.

"And the gas core work?" asked Enlai.

"It was delayed a bit by the last-minute work on the reactor, but not by much; that work is by a different team. We should be ready to fire up the engine on Deimos in the spring."

"Oh! Congratulations." Enlai was surprised. Will was even more surprised; he hadn't heard the gaseous core nuclear engine was that close to its first test firing. He had

to wonder why Brian had disclosed the secret to his chief rival. Perhaps Enali already knew.

They stepped into the reactor control room. It was an advanced facility with highly autonomous systems, but a dozen technicians watched large computer displays anyway to make sure nothing went wrong. Dr. Reggie Pearson, who was in charge of the reactor project, was calmly directing everything. Will knew him from the university; he was also a professor of nuclear science at Mariner Institute of Technology. They nodded greetings to each other. Dr. June Addison, who was in charge of the gaseous core nuclear engine project, was also present.

They sat in the back of the room with June and whispered greetings, then turned to watch the technicians. They had just started to rotate the reaction control drums away from the reactor, causing the neutrons from splitting uranium-235 to collide with more atoms. Bathed by liquid sodium, the reactor core's neutrons were slowed enough to collide with uranium-238 atoms and transmute them into plutonium-239, thereby breeding more fissile material than was used up.

The energy output dials began to rise, slowly. The control room was hushed and calm, almost boring. Pearson ordered the power production backup subsystem to be activated and they watched as a few kilowatts of power began to trickle out of the reactor. It slowly rose.

Finally, after an hour of terse, technical conversations, Pearson turned to the audience in the back. "I'm pleased to say that we are now making 5,000 kilowatts of electrical power. That's only ten percent of our rated output, but that's as high as we go this sol. We'll ratchet her up every sol, though."

“How long before we get to twenty-five thousand, do you think?” Will asked. Twenty-five thousand represented the minimum daily consumption of the outpost.

“Ah; I think two or three weeks, Will.”

“Thanks. Even five thousand helps because we can rearrange our plans to draw down our methane and oxygen supplies.”

“Don’t worry, we’ll get to fifty thousand in month or so,” said Reggie. “At that point, Aurorae will have a surplus for agriculture.”

“And a surplus that will allow us to truck methane and oxygen to Aram; they’re in serious trouble there,” said Will. “Thanks, Reggie, we are in your debt.”

“Remember our conversation of four years ago, when you said fifty thousand kilowatts of electrical output was too big?” reminded Brian.

Will nodded. “We never thought we’d manage to grow this fast or that we’d increase our production of platinum-group metals this much. You were right, Brian.”

9

Milestones

Jan. 2047

Father Karol Miller, Father Greg Harris, and Deacon Eammon O'Hare walked across Andalus Square, still littered with tinsel, confetti, and "Happy New Year 2047" signs. They crossed a pressure tunnel to Cathay Dome with its Chinese architecture; then another tunnel to Punjab Dome with its Indian-inspired buildings; then another tunnel to Zanzibar with structures resembling the big, traditional wooden buildings of Madagascar; then another tunnel to Liberty Dome and its slowly rising American suburb around a square dominated by the newly completed Mormon Temple; then another tunnel to El Dorado Dome, their future architectural expression of Latin America. The central plaza was still a roughed out square in the dirt, stakes marking where the fountain and trees would go in the middle. Greg led them to the north side of the square and stopped.

"This is the proposed location of the cathedral. It'll be thirty meters wide, like the square, and sixty meters long. The twin steeples can soar thirty meters to the top of the dome."

"Molded vinyl with a veneer to look like stone." Eammon shook his head. "They do a good job, but it's too bad we can't use real stone."

"The expense would go through the roof; besides, it'd become so labor intensive, no company would agree to do it." Karol looked over the site. "They'll want something that looks typical on a Latin American city square."

"Right," agreed Greg. "But there are plenty of choices; Gothic and Baroque would be traditional, and anything would be suitable if it were modern."

“And eclectic; I’ve seen some strange architecture in Latin churches,” said Karol. “What about location? This is a long way out.”

“It’s on the edge of the outpost, but the outpost is expanding westward,” replied Greg. “In two years there will be four or five more domes beyond it. Mars’s population is growing a bit more slowly, but it still doubles every five or six years. El Dorado will be central in a decade.”

“And there’s North Main Tunnel,” added Eammon, pointing to a line of stakes crossing the square in front of the future church. “It’ll be extended to here in the next few months. Apparently Ramesh plans to double its width when the tunnel is extended further west; busses bringing people east will have to stop here and move over to South Main Tunnel, which will be one way to the east. So El Dorado Square will be a big transit stop.”

“Interesting. It is a good place for the cathedral. But whoever heard of a Latin American city having an El Dorado Square? How about Saint Joseph of Cupertino, patron saint of astronauts?”

“‘Plaza de San Juan Cupertino’?” asked Greg. He nodded. “Much better. We’ll have to lobby the Borough Council vigorously, though; the choice isn’t ‘neutral’ and therefore might look offensive.”

“Of course, he’s got to be one of the church’s stranger saints; how many saints are known for levitating and flying through the air? But never mind, I think it works.”

“Let’s hope they don’t look him up on the web,” replied Karol. “This is a good plan. It’ll be cheaper to build several escape tunnels from the church to North Main Tunnel than to build a cathedral capable of remaining pressurized in an emergency, so

let's plan on that. That way, we can concentrate our money on the stained glass—I guess I should say stained plastic—and on statues and paintings."

"I asked Suzanne van de Velde about statues the other sol," added Eammon. "She told me the Crafts Division could make a copy of anything if we had an exact three-dimensional image they could input into a computer. They can build them up from metal carbonyl or sculpt them from certain plastics with lasers. The prices aren't bad."

"Excellent; the Vatican can get us a phenomenal range of sacred statues and objects to consider." Karol nodded. "This will be an incredibly beautiful cathedral. Let's go to the Borough Hall and sign the paperwork for the land."

They all turned and headed back to Andalus, chatting as they went. After passing through Liberty and Zanzibar, Eammon said to Karol, "how are the plans going for the 'God on Mars' conference?"

"Pretty well. So far, we have two distinguished speakers from Earth—they've agreed to take questions by video as well—a panel of three profs from Martech, and both Roger Anderson and Friday Nnah have agreed to speak, so we'll have some Protestant perspectives."

"You're not asking for Muslim, Buddhist, or Bahá'í representatives?" asked Greg.

Karol shook his head. "This is a Catholic sponsored event with other Christian representation. It is not an interfaith event."

"That may generate controversy, you know," noted Greg.

"Not everything we do here has to be interfaith."

"True, but then people will remember your conference as the ecumenical conference, not the 'God on Mars' conference."

Karol scowled. He didn't like that. "I'll have to think about the problem."

They traversed the pressure tunnel connecting Punjab to Cathay. As they were walking across Cathay, a golf cart-sized passenger vehicle blocked part of the alley, and as they were squeezing by it, Clara and Helmut Langlais came out of a building. She was waddling very awkwardly; he was carrying a small bag.

"Is it time?" asked Greg.

"It sure is," said Clara.

"I'll say a prayer for the baby," promised Greg, and he stopped to give them both a kiss.

"Who's that?" asked Karol after they continued toward Andalus.

"Helmut and Clara Langlais. He's been here a long time; since Columbus 6, I think; and they went to Ceres."

"Ah," said Karol, who still didn't know everyone at the Outpost. They entered the tunnel leading to Andalus. When they came out the other end they were in a short alley leading to the square. The right-hand wall, the side of the Mars Authority Building, was simulated stone, and Lyle Quincy, an American school teacher who had just arrived from Earth four months earlier, was putting up a poster on the wall.

"What's this? 'Vote for the Independent Slate'?" asked Greg.

"It's an election poster. The vote is in two weeks."

"You know we don't campaign, right?"

Quincy shrugged. "There's always a first time. The five of us have some concerns we think need addressing. This place needs more interior space, better consumer goods,

higher income from exports, possibly a subsidy on imports, and ultimately we need a timetable for independence."

Greg frowned. "Well, bring them up at the Future of Mars meeting this weekend. That's what it's for."

"Oh, we plan to bring up our ideas there as well!"

"Are you aware of the fact that a substantial number of people here feel it is their human right to decide who to vote for without campaigns trying to influence them?" asked Eammon, concerned.

"Well, they're infringing on my human right to free speech!"

"No, we've had a perfectly good, workable compromise going for years," replied Greg. "People talk about what they think is needed. You've just listed five excellent issues. Print a poster about them, not about people."

"But shouldn't we have the right to say whose ideas they are?"

"Sure," replied Eammon. "Put the names on the bottom of the poster as the sponsors."

"That's not just advertising people, either; it's ethically responsible," added Greg. "Because people are responsible for their speech, even in a free society."

Lyle shook his head. "What kind of human right is this, the right not to have people ask for your vote? They can always look away."

"And anyone who is opposed to nudism can look away when people walk through the outpost naked," replied Greg.

"There's a law against nudism, and there's no law against putting up posters," concluded Lyle, and turned back to his work.

"Come on, let's go," said Karol. He had said nothing during the exchange, and once they were in the square well away from Lyle he said "I don't know what the problem is with campaigning. It's been done since time immemorial. It isn't unethical if done properly. And it isn't un-Christian. I think this is just an example of too much influence by Elliott."

"No, I think there's something to it," replied Greg. "I think a lot of campaigning *is* un-Christian; at least, it should be un-Christian to grub around for as much campaign money as possible while making pseudo-promises not to be influenced by the donors, and pandering to the electorate. That's basically how big campaigns work in most countries."

"I suppose, but there's original sin, you know? We don't expect people to be perfect."

"Original sin has been used to justify a lot of practices that eventually were abolished," replied Greg. "Many election practices are cultural and can be changed and improved."

"I take a very pragmatic approach to our elections," said Eammon. "We don't choose the principals of schools or the heads of departments based on who can talk smoothest and sometimes loudest. The current system is more professional. Besides, it takes less time and energy."

"Until a demagogue comes along, invests a lot of time and energy, and gets elected," snarled Karol.

They were half way across the square. Greg spotted Sarah Pannakar crossing the square toward the Gallerie. She looked like she was walking on air. Her happy expression was quite striking, so he waved. When she saw him, though, she looked startled.

“Good sol, Sarah,” he exclaimed.

“Oh, Good sol, Father Greg and Father Karol, and Eammon.”

“We just saw Clara Langlais heading for the hospital to have her baby.”

“Oh? I’ll be there in another two hours; I’m on the second shift. I guess I’ll see her there.”

“I’ll be along to see how they’re doing, probably about suppertime,” added Greg and he waved. “Ciao.”

“Ciao.”

Sarah continued toward the Gallerie, wondering what her face had looked like. She was still thinking of her time with Ramesh at the Dacha; three sols had become five, and the sex had been incredible. She felt loved like she had never felt before, and she was smitten by him.

She walked into the Gallerie a bit more humbly, wondering whether—or when—she would confess her sin to one of the fathers. She stepped into Silvio’s to buy a few things; like Deseret, the department store had expanded after more people had arrived and now had a total of two thousand square meters of merchandise on three floors. She found pantyhose, deodorant, and a special cologne she wanted for Ramesh, and stopped to try on some new hats; because of the radiation protection they offered, hats were a common part of the Marsian wardrobe. Maryam Salih had several designs, and they were quite attractive.

As she stepped out of Silvio’s, she thought of handsome, tender Ramesh again and the feeling of walking on air returned. This time it was Martha Vickers whom she encountered, for Martha was on her way into Silvio’s.

“Sarah! Good sol, how are you?”

“Oh, pretty well.” She smiled mysteriously because inside she was thinking: can I say anything? Should I say anything? I want to tell someone!

“Haven’t seen you for a few sols, including at New Years, so Happy New Years.”

“Thanks. No, I missed New Years here; I was up at the Dacha.”

“Oh?” No one went to the Dacha alone; that was quite a hint. Martha Vickers, the marriage counselor and informal match maker, was good at recognizing them. “That’s a fun place to be for New Years. I hope you had a good time.”

“Oh, I did. Ramesh Prathan and I spent a few sols up there.”

“With Ramesh?” Martha smiled. “A nice man, and very interesting. I hope it goes well.”

“Thanks, so do I.”

“Listen to your grandmothers and take your time, and come visit with Auntie Martha if she can help.” It was ironic advice; Sarah’s grandmother would be opposed to her marrying a Hindu and she doubted Ramesh’s Hindu grandmother would feel much better.

“Thanks. We may want to pay a visit to Auntie Martha together some time.” Martha smiled and put her arm on Sarah’s shoulder encouragingly, then headed into the store.

Martha glanced at Sarah as the latter headed out of Silvio’s and across the Gallerie towards the food. Martha liked Sarah and worried a bit about her; she wanted Sarah to find happiness and knew that getting married was important to her, especially since she had turned thirty. She reflected on the deep-seated human need to pair up with

someone that was reflected in the joy on Sarah's face. Her own teenage daughter was now dealing with the urge, and fairly well so far. But of the 450 people who had just arrived from Earth—she didn't count the 75 Chinese at Dawes because she didn't know them—only 178 were already married, and most of the other 272 were searching for partners. Many were now coming to Mariner Hospital for all sorts of advice and premarital counseling, and the hospital had ten group sessions running simultaneously.

Finally, Martha found a perfect little gift to give one of her clients; a memento that would help the person remember a difficult struggle and its successful conclusion. She loved to help celebrate someone's success. She bought the item and headed out of the store. Will was just coming off of the spiral ramp leading down from the Mars Commission offices. "Hey, Martha, good sol," he exclaimed.

"Good sol and Happy New Years."

"Thank you. Do you have any resolutions?"

Martha laughed. "No, I don't do them, though this is the year Caitlin turns seventeen, so I suppose I'm focusing the year on her."

"Sure; two and a half more years of high school."

"What about your resolutions?"

"Oh, I drew up a list of resolutions for Mars, you might say. We have to recover from this dust storm and get back to normal, especially Uzboi; platinum group metal production has been cut to a fifth of expected, which will be a huge financial problem if we don't do something. Fortunately, New Hanford will be up to its target power output in a few weeks, so I think at that point we'll be able to dismantle much of Aurorae's solar power production facility and ship the panels and units elsewhere."

"That's a big job, but it'll help Uzboi and the other mining boroughs quite a lot."

"Exactly. We'll be shifting people back here from the other boroughs because we'll have the power to employ them. You may see some new faces at Mariner. Got to run. Ciao."

"Ciao." They waved at each other and Will headed for the Gallerie's main door. He was making his usual round-the-outpost walk and inspection; it was something he did at least twice a week. It always proved a useful chance to run into people, spot minor problems, and refresh his experiences, because the Outpost was constantly changing.

Outside the Gallerie, he turned right and headed for Cathay. As he headed down the alley toward the pressure tunnel he spotted the campaign poster Lyle Quincy had just pasted up and stopped to read it. His first reaction was to be offended by their request for votes for Borough and Mars Council. Pictures of the five people was a particularly irritating detail.

Will reached up and grabbed a corner of the poster, which was essentially glued to the sand-covered vinyl. He pulled and the poster slowly peeled off, bringing a disturbingly large amount of the sand with it. The poster left a ghostly mark on the freshly re-exposed wall.

Will crumpled up the poster and headed into the pressure tunnel. Once out the other side, he headed for Cathay's Riverwalk, where there was a public trash container. Not far from it he spotted a second poster; he peeled it off as well. Lyle Quincy had just finished putting it up and hurried over to intervene. "Hey!" he shouted, then he realized that Commissioner Elliott himself was removing the poster. "Hey, Commissioner Elliott, I have a right to put these posters up!"

“If you have a right to put them up, I have a right to remove them,” replied Will, tossing both the first and second posters into the trash.

Satursol afternoon a hazy sun shone through the dusty sky, illuminating Andalus Square more brightly than in the past three weeks. A team of volunteers rapidly put up a thousand chairs for the audience expected for the “Future of Mars” Forum.

Will was among the crew setting up chairs and soon felt overwhelmed by the scale of the gathering. Andalus Square was sixty meters by eighty, almost the size of a soccer field; indeed, it was used for soccer games at certain times. The stage and chairs filled almost half of the space. He was even more startled when he opened his attaché and logged into the Forum’s agenda section.

“Ethel, almost 200 people have registered to speak!”

“Really?” she glanced over his shoulder. ‘Wow, that’s incredible. But it makes sense, Mars has 2,700 people, and the 60,000 landowners on Earth can tape remarks as well.”

Will pointed at the sea of chairs. “I can’t believe this! Do you remember this dusty plain twenty-six years ago, when six of us huddled in two small habs?”

“Times have changed, dear!”

“And how! But the size worries me. We can’t continue this direct democracy forever; it’s just too big.”

“We’ll have to abolish the series of universal forums and start local forums instead.”

“But even that won’t work; look at all the chairs here!” Will’s voice rose a bit.

"Calm down, dear. Democracy can be messy, so let it be."

"I'm more worried about boredom and confusion than controversy."

"Yes, that might be a problem." She considered. "We may have to divide Aurorae into districts and hold separate forums in each. Of course, the Future of Mars Forum has lots of discussion boards and places where people can post ideas and comments, and *Mars This Sol* is carrying everything live. And everyone mixes and argues at the Gallerie. I doubt our democracy will succumb to excessive participation."

"True enough." Will looked out over the crowd and began to prepare himself mentally for a huge task.

The crowd rapidly built in size until 500 adults were present. That seemed more manageable to Will, and on reflection it wasn't bad; Aurorae's nearly 1,500 people included 750 children, and many parents were probably at home watching kids and the television at the same time. A hundred or so older children sat on chairs or hung around in the square. More worrisome was the several dozen folks sitting at the two restaurants in the square, though they were probably listening as well.

He stepped up to the podium in front of a series of large television screens that showed similar gatherings in other boroughs around Mars. "Good sol, everyone," he began. "We do this every twenty-six months. Elections are held four to six months after the last ships of the columbiad arrive; that gives the new migrants a chance to settle in and assimilate before casting their first votes in Marsian elections. This time around, Aurorae elects nine persons to its Borough Council and eleven representatives to the Mars Residents Council. Cassini, Dawes, and Uzboi elect Councils of five members and three representatives to the MRC. Phobos and Meridiani elect five-member Councils and

two representatives respectively; Thymiamata and Aram, three-member Councils and two and one representative each. The Mars Residents Council will have twenty-seven members. These numbers are set by legislation, which gives boroughs a three-member council of officers until they have one hundred residents, then two more council members until there are 500 residents, two more until there are a thousand residents, then two additional members per two thousand additional residents. The Mars Residents Council elects one member per hundred residents per borough until the borough reaches a thousand residents, then one additional representative per five hundred residents.

"The purpose of this forum is to discuss and debate where Mars should go in the next twenty-six months. It is not a campaign forum, though voters no doubt will ponder the comments and ideas presented and the personalities expressed when they vote in two weeks. There will be two more forums, on the next two Satursols, the last one occurring just hours before election sol. We have two hundred people who have expressed a desire to speak at this gathering, which is physically impossible in two hours. Clearly, most will have to offer their views next week. I suggest that we specialize the third forum to a discussion of the ideas presented in the first two, because it is impossible to discuss ideas thoroughly with such a large group. Next columbiad we will have to consider videotaping remarks, use of local forums, and other measures.

"Turning now to the speaker list, which has been forming for almost two sols, let me remind everyone that with so many requests to speak we must insist that no one exceed their two minute time slot. Louise Tremblay is first."

Louise, their chief shuttle engineer, rose and devoted her two minutes to the importance of exploration. She noted that Mars had nine shuttles and they had plenty of

spare launch capacity, so expeditions to near-Mars asteroids should be resumed; they could easily send out two missions a year. Will then recognized a newcomer, Dominique Piriou, a Swiss equipment technician working at Uzboi, who spoke from there about the need to provide more comforts to the hard workers at the various outlying boroughs. It was a classic comment, heard every time.

After a speaker discussing the improvement of child care and a landowner in Kansas rambling about the privilege of supporting the settlement of Mars and asking for more mineral extraction efforts from the plots of small land owners—they received a royalty for minerals removed from their property—Ramesh Prathan rose to stress the importance of developing the road system more, noting that almost all land owners abutted a road and the new graveling system extracted nickel-iron from the surrounding land, thereby paying the royalty requested by the previous speaker. Will couldn't help but be irritated by Ramesh's promotion of his own projects, but most speakers did that.

Madhu Gupta-Anderson was recognized and devoted her two minutes to the Mars Museum just chartered, to be housed in the original first two habs and in the original building they built. The problem was raising fifteen million redbacks; the two habs were to be restored to their original condition, removing the effects of several retrofits, and bringing four legacy spacecraft, including Viking 2 and Mariner 9 to the museum. Mariner 9, however, still had to be found in Mars orbit.

The next speaker was Jose Olivera, a Venezuelan who had arrived four years earlier and had made the transition to private business just a few months earlier, when he opened Mars's first Radio Shack. He spoke about how great it was to be in business, thanked people for their support, and talked about the difficulties, concluding with three

small suggestions how to improve the business climate. Will hesitated to call on the next speaker—Lyle Quincy—but decided not to depart from the order. Quincy rose. “I want to introduce everyone to the Independent Circle,” he began. “No, we are not openly campaigning for office any more. So many people came up to us and warned us about the cultural barriers to that, that we have changed our focus and our name. We are a ‘circle’ in the sense of a gathering of likeminded people concerned about the future of this world. First of all, we think that an independent Mars should be our publicly stated goal.” He emphasized that and paused to gage the audience reaction; it was positive overall, but no one applauded. “Mars in a few years will have nearly as many people as the smallest nations on Earth, but will have a gross domestic product larger than the dozen smallest terrestrial nations. We are already the source of a significant volume of deep space traffic, and as Louise has noted, we can send out more. We are growing fast. We are isolated, and in consequence we have been largely self governing almost from the beginning. There are very few things the Mars Commission does that the Commonwealth Authority could not do, with the same people and the same income stream generated by our exports. An independent Mars would have a seat in the United Nations and could receive foreign aid equal to the government subsidies it already benefits from. We have our own dialect, flag, culture, lifestyle, holidays, customs, and institutions. It is time to plan for sovereignty.

“There are six of us who started the Independent Circle, but in the last few sols we’ve been joined by several more. Our names, profiles, and views are all stated on the web, so go check us out. We’re also planning our next meeting for Monsol evening, 6

p.m., in the meeting room in the Gallerie. So please come!" Quincy sat to scattered applause.

Quincy was followed by Bruce Cowdrey, President of Deseret Construction. Will recognized him and he rose. "I had planned to speak about the importance of developing the private sector here, but that has already been discussed, and I am sure it will continue to come up. It is essential. Rather, I want to thank Lyle for his courageous efforts and encourage him and the Independent Circle to continue their efforts. We are getting so large here, we have to encourage opportunities for ideologically like-minded people to exchange their ideas and develop common understandings.

"I am a member of a group who has been discussing political issues for two or three years, now. I suppose if we were to name ourselves, we are the Freedom Circle. Mars is too dependent on the Mars Commission. That dependency means we buy our land from the Commission, our housing, our food, our communications, our heat, our light, our water. . . everything. If one wishes to start a private business, there are no legal restrictions, but the materials you need to do your work are either unavailable or are delayed because you are low on the priority list. So what we need is a new freedom ethic, where individuals are freer to start businesses, to obtain materials in order to produce items for everyone else, to advance this world through their own dreams. If there is anything we need to debate, it is the role of the Commission in this world's future. That debate goes beyond independence, though it includes independence. We have to privatize many of the Commission's functions intelligently and open larger sectors of our economy to private enterprise. I'd like to see that discussion in two weeks."

Bruce sat to scattered applause. Many eyes turned to Will, who had essentially been criticized. “Thank you, Lyle and Bruce,” he said. “We must welcome discussions that will build up Mars and our community on Mars, as opposed to discussions that insist on the status quo or on personal agendas. I think we all have taken your comments in that positive spirit.”

The parade of speakers continued, asking about greater access to the bioarchive areas as parkland, complaining about the militarization of Deimos, stressing the building of community over the exploitation of Martian resources, praising the possibility of terraforming Mars, calling for the expansion of the outlining boroughs, questioning the low salaries and long hours of the new arrivals compared to those who had been on Mars a few years, and a dozen other topics. Some speakers modified their intended subjects and commented about other speakers’ remarks; independence came up several times, and even the question of campaigning was raised by two people, once in favor and once against. When the two hours ended most people were full and ready to devote the rest of the sol to other matters. But most walked to the Gallerie for a snack and sat in groups to chat about what they had heard.

As Will prepared to head home with Ethel, Érico hurried over. “Thank you again for your able chairing of the meeting.”

“Oh, thanks. It felt rather long and at times it was boring, but that’s the nature of the process.”

“I agree that we need a different format. I count twenty-five discrete topics of any significance that were raised this sol. I assume you have a team on Earth analyzing and summarizing?”

“Yes, six people, all of whom are coming here next columbiad. They’ll email the result tomorrow. I’ll copy you.”

“Please. As always, the gathering has produced several ideas worth pursuing. But I was think we should also select four to six topics from the mix and suggest that all discussions in the third forum be addressed to them.”

“Good idea. I suspect three of them are independence, the role of the Commission, and the election system.”

“I agree. I think terraforming is another; I counted three references to it. Then there’s the individual versus community and capitalism versus socialism, which was hinted at in six or eight people’s comments. But seeing a breakdown of topics will help.”

“We’ll have to put something on the Forum’s website.” Will sighed. “I hate to see some of these subjects coming up every election.”

“Yes. The issue of private enterprise is unfinished business for the Commission and the Authority; they’re right, the business environment is still difficult. The question of campaigning comes up because we’re out of step with the Earth.”

“And some would say, thank God! But campaigning clearly is creeping in, election after election, and it will be hard to stop it. Obviously, if a few people are organized, publicize themselves, and cultivate a specific image and platform, they’ll get some votes; and in an environment where votes otherwise are poorly coordinated, they will win. These ‘circles’ are just a clever way to sneak in political parties under another name.”

Érico shrugged. “Well, maybe that’s okay, Will. As we get bigger, it’ll get harder and harder for voters to know the people who already run things. The scale of this place is getting so large, no one feels they really understand it any more.”

“True, but there are other ways to fix that problem. You create smaller electoral units, like domes or groups of domes. Aurorae could be divided into districts, each electing one or two members to the Borough Council and one representative to the Mars Council. Each district could have its own forums.”

“And then people have to remember who’s in their district and who isn’t. There’s no easy solution. By the way, I’m sorry you were implicitly criticized by a few speakers. I was impressed by the way you handled it.”

Will shrugged. “I’m used to it; worse is said about me on Earth, both behind my back and directly in the media. Most people don’t know I’m one of the architects for the dismantling of the Commission.”

“And they can’t know,” added Érico.

10

Launch

Feb 28/Mar 3, 2047

The hazy ball of sun was well above the horizon and shedding weak warmth on Andalus Square when Will arrived from his morning walk around the Outpost, ready to grab a cup of coffee and a bagel, then head to the office. As he came out of the Starbucks and started across the square to his office on the fourth floor of the Gallerie, he spotted Sebastian Langlais and Charles Vickers eating breakfast and talking together at a table nearby. They waved.

"Hey Will, good morning!" exclaimed Sebastian, and he beckoned him over.

"Good morning," replied Will. "How are you this sol?"

"Pretty good; sit down," said Sebastian. "Charles and I were reviewing the history of the Asteroid Belt Commission's various plans and proposed plans, and we want to talk about near-Mars asteroid missions with you."

"Sure. Congratulations, Charles, on your elevation to Commissioner."

"Oh, thanks, but Sebastian's still got two months."

"A good transition period," noted Sebastian.

"And then you get to retire," said Will.

Sebastian scoffed. "Retire? Damn it, they elected me to the Mars Residents Council. Thank God I wasn't elected to the Borough Council as well, that would be just what I need." He pointed his finger at Will. "You see, this is the down side of no campaigning. People get elected to something that they don't want!"

"Then resign. It's allowed," replied Will.

“Nah; I might as well give it a try. I guess I’ll still have enough time to write a few books. I want to do some grand synthesis of Martian geology, but my memoirs will sell better and make more money, and that’s what I’m being pressured to do.” Sebastian shrugged. “So I guess I’ll start with them.”

“You’ll be our first retiree on Mars.”

“If I ever get to retire. The grandchildren are taking time, too.”

“That’s right, how’s the little one! What’s his name?”

“Oscar. It was my father’s name. He’s a month old and refusing to sleep on any regular schedule, so Clara’s utterly exhausted. But he’s a healthy boy.” He smiled. “Seventy years old, living on Mars, with two sons, two daughters in law, and four grand children. If anyone had told me thirty years ago, I would have said they were crazy.”

“How true.”

“How’s Marshall, anyway?”

“Oh, pretty good. He’s graduating from MIT in June, then he’ll travel around the world all summer. He’ll be at MIT the next school year working on his Masters in geology, then fly back here with Columbus 14 in late April next year. And he won’t be the youngest person on that flight, either! That’s the amazing thing.”

“And Ethel’s going with you?”

“And Lizzie; she’s earned the trip. All four of us will have some time together on Earth, and I’m spending a few days on the moon as well. Roger and Madhu are going back as well for a month to wrap up family ties on Earth.”

“Martha, Caitlin, and I are going as well,” added Charles.

“So, Sebastian, when’s the MRC meeting? Do they know yet?” asked Will.

“I think it’ll be in another week; March 6-10. There have been some real logistical problems planning the first session. It’s pretty important, since we finalize the choice of Chief Minister and everyone gets sworn in.”

“Good, I’ll be around then. I’m at Dawes March 2-5. Ethel and I always invite the Mars Residents Council to dinner, preferably the first night of its session. It’s good food, and I want to make sure the Council members develop bonds of friendship; that’s the main purpose of the meal.”

“Twenty-seven; that’ll be a big gathering,” said Charles.

“Yes, but we have the space and most of the meal is catered anyway. I will do a little cooking for it.”

“Are you worried about the campaigning situation?” asked Charles.

“Yes, more than anyone else I think, but then it’s a religious value to me as well.”

“I think a lot of people are upset that Quincy was almost elected to the Mars Residents Council,” agreed Charles. “But then, he got 67 votes out of a possible maximum of 500 and the person elected with the lowest vote total had 95, which is a lot more.”

“But it means he might fill the next vacancy,” said Will. “Of course, Ramesh got 45 votes without saying anything, so maybe campaigning didn’t help all that much.”

“Ramesh has 45 people working for him and has a reputation; Lyle is just a school teacher with no one to boss,” replied Sebastian. “So I’d say campaigning helped him a lot.”

“Bruce Cowdrey, too,” added Charles. “I was talking to him yestersol. He said he was actively asking people to vote for him, just one at a time and not publicly.”

"I know, and there were rumors to that effect two years ago." Will shrugged. "There's only so much we can do. People are not opposing the ban on electioneering directly; they're chipping away at it quietly."

"Anyway; missions to asteroids," exclaimed Sebastian, bringing them back to the topic at hand. "Charles is interested in pursuing them."

"I think it's a great idea," said Charles. "The Asteroid Belt Commission plans to purchase its own shuttle. We'll use it to launch crews into orbit from Mars, haul up cargo for our missions, and we'll lease out cargo space to others. We've been talking to Louise about the spaceport and its support facilities. They can repair and maintain the shuttle under contract for a reasonable price."

"We already have such a contract with the Chinese, and Lufthansa plans to fly out a shuttle next columbiad to inaugurate private launch services," added Will.

"Well, I was looking at our tentative schedule," continued Charles. "Our shuttle arrives in early July 2048; sixteen months from now. By then the *Piazzi* will be mostly prepared for its mission to Pallas; it launches in late August. By early September our shuttle will be done with most of its work and won't be needed again for eight or nine months unless we compete for cargo transport contracts. There are several asteroids that could be reached by a three to six month mission. We'd need to lease or even buy an interplanetary transit vehicle; that'd be the safest way to conduct a mission. But frankly, I think the mission should be jointly sponsored by the Asteroid Belt Commission *and* the Mars Commission."

"Both?" Will considered, then nodded. "Sure, I could sell that. We might even be able to contribute a shuttle, so we'd have two of them and a larger crew."

"And that would be safer." Charles nodded. "Yes, that's a good idea."

"Alright; let's draw up a plan, then, and I'll take it to the Board of Trustees, who have to approve the budget. I'd aim for exotic destinations, like a former comet nucleus. One reason we stopped asteroid missions is because the targets had become so routine, it was hard to justify the potential risk. And we didn't want to compete with the Asteroid Belt Commission."

"That's a good plan," agreed Charles. "The ABC is sending out twelve robotic explorers to asteroids every year, so we really don't need manned missions. But the shuttles are now safer than they were even a few years ago, so the risk side has improved. Tell you what. I'll get my people to work on the various options and we'll get you some recommendations, probably in two to four weeks."

"Great," replied Will." He rose. "I had better get to the office. I was just out on my morning walk around the outpost. I now walk through every dome every morning; it takes about half an hour and is good exercise."

"Since none of us get outside much any more, that's a good alternative," replied Sebastian.

Just then Will's attaché beeped. He looked at it; it was an urgent message from Rostam Khan, Mars Control's Day Officer. "Oh, got to go now! Ciao."

He hurried across the plaza, into the Gallerie, and up the spiral ramp to the fourth floor. Mars Control was there: two large rooms filled with consoles, one of which was usually devoted to telerobotic operations all around Mars and elsewhere in the solar system, the other monitoring systems in Mars's twelve outposts, its various shuttles and surface vehicles, and its dozens of unstaffed oases. But Rostam had diverted staff to a

new phenomenon: a large, fast moving plume of hydrogen plasma jetting from the north pole of Deimos.

Will took a look at the false-color infrared image of the moon and its long plume. “They’re a few sols early.”

“I suspect Stark decided to steal some thunder from the Chinese launch,” replied Rostam. “This will dominate the space news for at least two sols.”

“And the departure ceremony is two sols away. What can you tell me?”

“Not much yet, but the seismometer network on Deimos is very sensitive; I am sure we can determine the miniscule acceleration the engine imparts on the moon and calculate the thrust. The astronomy department has been alerted and they’re turning the Olympus Mons telescope on Deimos; they can do a spectroscopic analysis on the plume.”

Will nodded. “That’ll give temperature, and the doppler shift will give exhaust velocity. You can’t hide, can you?”

Rostam looked at Will. “Should we really be doing this, though?”

“Yes. This isn’t spying; this is publicly available data to anyone with the right equipment. If we want the Americans and the Chinese to be honest with us, they need to know we’re watching.”

“Will we release the data?”

“I suspect we won’t have to because the Americans will do it. But no one can prevent our astronomers from publishing their spectrometry in *The Bulletin of the Mars Astronomy Network*.”

Two sols later, Will Elliott, Érico Lopes, and Brian Stark took a jetwing to Dawes. The global duststorm was still fairly extensive, but the dust was settling out of the atmosphere at Dawes and Aurorae, so flights were possible.

The jetwing landed them just in time for the big departure dinner of the crew of the *Tienan.* A ranger drove them straight to Kalgoorlie Dome, Dawes's newest enclosure. The new Borough Clerk, Mikhail Golvashchenko, greeted them at the airlocks.

"Good sol to all of you," he said. He shook Will's hand. "It's good to see you again, Commissioner Will."

"Congratulations on your election," Will said to him, shaking his hand.

"Thank you; it was a surprise." He turned to Érico. "Chief Minister Érico, we are very grateful you could come down and stay a few sols. We want to show you the new gold extractor."

"The driver took us past it on the way in. What a behemoth! He said it was twenty meters tall, eight wide, and ten long."

"Yes, and masses fifty tonnes, but it can extract a lot of gold through centrifugal separation. We're building one for Cassini and one for Meridiani, and then we'll build another one for use here. Dawes intends to keep itself in the lead."

"You're second largest because of the Chinese," noted Will.

"Correct; the seventy-five of them pushed us ahead of Cassini and Uzboi. We're going to miss the twenty-five heading for Metis."

"Are we sure they're going to Metis?" asked Brian.

Mikhail extended his hand to Stark. “Welcome, I’m so glad there will be an official American representation to their departure.” He shook his head. “It’s a persistent rumor they want to fly to Callisto, but there’s no substantiation.”

“What sort of neighbors are they?”

Mikhail was clearly irritated by the question. “They’re not just neighbors; they’re an integral part of Dawes. They don’t live out at their nuclear facility, they live here. Most have bought flats and they’re mixed with the rest of us. They often sit together in the cafeteria and speak Chinese, but that’s their privilege; and some are always sitting with other people.” Érico nodded, knowing the situation was more complicated than that; Brian looked skeptical, for he had heard complaints as well. Mikhail pointed. “This way, please.”

He led them through the building and into Sutter Square, the outpost’s new downtown. Forty meters square, with dark basalt paving and potted palm trees, the plaza had a few businesses opening on it, but otherwise was dominated by residential units clad in red and yellow “sandstone” vinyl siding. The south side of the plaza was open to the rest of the dome, which was idyllically agricultural.

“I can see why the Chinese want to live here; very pleasant,” commented Will.

“It’s a scaled down imitation of Andalus; very nice,” replied Mikhail. “It has given us a sense of civic pride and identity, too.” He pointed to a grand entrance to the right and led them inside, into the cafeteria. He hadn’t needed to take them through the square to get there, but the tone of his last comment offered an explanation.

Everyone in the borough was there; Will noted about twenty children, mostly babies and preschool infants. The buffet tables were piled high and food was still being

brought out. As they entered, everyone turned to them in greeting. Mikhail led the guests over to the head table where three Chinese waited: General Zhou Qisheng, the head of the Chinese nuclear facility; Dr. Tang Enlai, their old friend; and Li Xiaoqiu, the commander of the *Tienan*.

They all shook hands and exchanged greetings, and as they sat at the head table a cafeteria worker came over with a cart containing seven plates of food, which he distributed to everyone present. Will glanced at the mouthwatering diversity and resolved to get his own seconds. “General Qisheng, how are you doing? I trust your wife is now well?”

“Thank you, Commissioner Will, yes she has recovered well from the breast cancer operation. Our health is well, and now we live in this beautiful facility, the food is good, we have places to walk around inside. . . life is good, Commissioner Will. My daughter and her husband are coming here next year. How is your family?”

“We are all very well, thank you. Liz will be here in a few months when the Mariner Ballet Company gives for two performances. You’ll see her, no doubt. And how is your facility?”

He sighed. “The dust storm has slowed down construction, as I am sure you can imagine, but we diverted some of our people to Deimos to build up our station there and to equip the *Tienan*, so we are ahead in our work there. We also brought the *Tienan’s* power reactors down to augment our power supply here. We think our main reactor will go on line on schedule, January 2049. At that point we will either turn to the Uzboi reactor, if we get that contract, or back to the Deimos facility.”

“We’ll be announcing the contract in a few months, as you know.”

“Of course.” Qisheng eyed Brian, his chief competitor for the reactor contract. “Colonel Stark, I hope all is well with you and your work.”

“Yes indeed. Thank you for asking. Our reactor is now fully on line; that was a major accomplishment. And as you no doubt know, we just tested our gaseous core engine on Deimos.”

“It was a very impressive test! Two minutes of operation, fifty tonnes of thrust. . . you are well on the way to producing a workable gaseous core engine.”

“With a robust specific impulse as well,” added Will. “Clearly, you’ve overcome some materials limits.”

“And containment issues,” added Qisheng, nodding. “We saw relatively little plutonium leakage.”

“Well, it’s good to have friends watching and advising us,” replied Brian, a little irritated by the monitoring. “We’ll be sure to provide you with similar input.”

“A mix of competition and cooperation is very healthy, if they can be balanced,” commented Will.

Brian turned to the Commander of the *Tienan*. “I trust, Commander Xiaoqiu, that your preparations for the launch are mostly complete?”

“We are very satisfied,” he replied.

“How long will it take for you to get to Metis?”

“What difference does it make?” interrupted Enlai, shrugging as he ate rice with his chopsticks. Then he casually added “I’m sure someone will visit it eventually.”

Brian stared at him, startled. Will stopped eating for a moment. The General and the Commander barely flinched, but they seemed uncomfortable. “Then how long will it take you to get to Callisto?” asked Brian, deciding to take the plunge.

“Sixteen months,” replied Enlai. “Not bad, for solid nuclear core propulsion.”

“It really is possible primarily because of the cheap cost of your hydrogen, Commissioner Will,” exclaimed General Qisheng.

“You’ve created quite a challenge for us,” replied Will. “Because we now have four thousand tonnes of liquid oxygen and we can’t vent it easily because of the new astronomical observatory! We’ve been burning chondrite into carbon dioxide and converting it into methane for the fourteenth columbiad.”

“And beaming power to us from Phobos; we appreciate that,” added Qisheng.

Will turned to his food. He could feel Brian positively squirming in the seat next to him, chewing a bit violently, trying to vent his anger as inconspicuously as possible. No doubt the conversation about waste oxygen angered him further. Brian took his glass of wine and downed it in one gulp, then poured a refill. While he felt Brian’s anger churning next to him, Will patiently ate and contemplated the implications. America’s gas core accomplishment was trumped. Its Project Odysseus was potentially undermined in a fatal manner. China’s new international prestige helping it to claim to be America’s equal. Jupiter was falling into the Chinese camp, its exploration to be coordinated primarily from Beijing. The outer solar system would soon be opened to humanity, or part of humanity.

Will finished his plate and walked to the buffet table for seconds. Enlai saw him and trailed along. “I think I blew Brian’s mind,” he whispered to Will over the Mongolian beef.

“Oh, you got him good. I gather your colleagues were not completely comfortable, either.”

“They’re too secretive; we have the hydrogen on board, we’re ready to go, no one can or will try to stop us. Mars deserves to know. I told them and my government I was going to say something, and they knew they couldn’t stop a Nobel laureate.”

“I see.” Will smiled, amused in spite of the risk his friend had taken.

They returned to the table and resumed light conversation about terrestrial politics: the Southeast Asian Union and its plans for a common currency, the Latin American Union’s financial woes, the African Union’s efforts to coordinate its laws, the still useless Arab Union, Israel’s stalled bid to join the European Union along with Russia and several other former Soviet republics, and where all these unions put the United States and China, who were increasingly isolated. Finally Qisheng nodded to the cafeteria people. “It’s time for the toasts,” he said to the others at the head table. By prior agreement, Enlai, Will, and Brian were to offer toasts.

Small glasses of liqueur were brought to each table. Will took one gratefully and put it down in front of him, then turned to Qisheng and apologized that he would be toasting with water for religious reasons. Qisheng nodded and asked for a shot glass of water to be brought to him; Brian, meanwhile, grabbed the extra for himself. Once the distribution was completed, Will turned to Enlai, who rose and raised his glass.

“Dear Friends, I wish to offer a toast, but first I would like to offer a few words. Almost twenty years ago—it will be twenty years in June, to be exact—Columbus 4 arrived on this world and I became a resident of Mars. At that time I planned to stay two or three columbiads. Instead, I have sunk roots deeply into the culture and community of this world, and I will dearly miss all of you. If fate brings me back here—and it may in eight or ten years, who knows—then we will all see each other again.

“Mars has become a community unlike anything I could have imagined. Not only has it grown faster than anyone could have foreseen, but it has become inclusive and successfully multicultural. This is not an easy accomplishment, and one that holds lessons for Earth to follow.

“But tomorrow I will leave you. For months—for years—our destination has been a mystery to everyone, including to ourselves. A voyage to deep space—the asteroid belt, Jupiter, Saturn, beyond—is not something one undertakes lightly. Too many systems must work perfectly. Both this opposition and the last, we received some equipment suitable for a voyage to a series of asteroids and other equipment suitable for a voyage to the galileans. The *Tienan* is ready to transport twenty-five crew to deep space, and its shakedown cruise from Earth to Mars went flawlessly. Its three solid-core nuclear engines are all in excellent shape. Its two power reactors are working well; they’ve been supplying power to our facility during the storm. Our two shuttles are working well, also. Consequently, three months ago we were given permission to launch to Callisto. That is where we will go, starting tomorrow morning.

“So finally, my toast.” He raised his glass. “To Mars and all it has made possible, in my life and in yours.”

There were various exclamations as they all sipped from the shot glass. The crowd was excited to have the privilege of learning the secret, but since *Mars This Sol* was covering the dinner live, the news would now travel at the speed of light to everyone else.

Enlai sat and Will stood. He raised his glass. “I have a shorter story, but a longer toast. For two and a half years Dawes has been the home of a substantial number of Chinese scientists, engineers, and technicians. They have enriched the food, culture, and society of this place and have strengthened Dawes’s future. As a result, Dawes has moved beyond being a mere mining borough and has become the center for development of this entire region.

“And now, you bring a new privilege to Dawes and to Mars: you have made us the launching point for one of the greatest chapters in human exploration. Mars is a world dedicated to exploration and discovery, and you have both cemented our primacy and reinforced our capacity. So to my toast: To the continued presence of China on Mars, and the continued expansion of your home at Dawes. And to Mars; may she ever guide the explorer on his way.”

“Here here!” said several, and they drank.

Brian Stark rose next. He had had time to recover from his shock and anger. “I wish to extend heart-felt congratulations to my Chinese colleagues and to their nation, both from me and from the United States of America. They are about to embark on a voyage farther from humanity or any outpost of humanity than has ever been attempted before. They go to a diverse, complex miniature solar system fraught with its own hazards and filled with its own rewards. They will explore an entire miniature planet

directly, one that may have life; three other galileans will be light-seconds away, and lording over everything will be mysterious Jupiter, king of all planets, whose gravitational influence even extends over Mars. So—" He raised his glass. "To the crew of the *Tienan*—may they travel safely, discover much, make a new home for humanity, and return to Earth and Mars to much celebration and gratitude."

"Yes!" shouted someone, and they all drank.

The dinner settled down to coffee, tea, and small talk. There was entertainment; many of the residents were skilled musicians. Residents began to drift out, first those with children, then others. Will, Brian, and Érico stayed until the end, then retired to their rooms for the night.

Within a minute of settling into his room, there was a knock at Will's door. He guessed it was Brian, and he immediately saw he was right. "Come on in. You did well tonight; very gracious and respectful."

"I can do gracious and respectful," replied Brian, who was slurring his speech, but otherwise was lucid. "But I just checked my attaché; I have a dozen messages, mostly from email addresses I can't disclose."

"I'm sure I'll be up an hour or two dealing with messages; I haven't even looked. Come sit." He offered Brian the chair; he sat on the bed. Dawes's accommodations were rather simple.

"I don't think you realize what a mess you've partly caused," Brian began. "There will be at least one message asking whether we can still stop the Chinese launch by some sort of clandestine operation. Considering the effort might kill people and spread radioactivity over all of Deimos, including our half, that suggestion won't be taken

seriously. There will be a serious discussion about ways to spin their launch to downplay it; probably the route they'll take is to dismiss it as a dangerous, risky effort to trump us using outdated, unreliable equipment. That argument will be vindicated if the Chinese screw up. It will also protect our gas-core research."

"Anyone could have told the United States a decade ago that advanced propulsion is not needed to go to Jupiter," said Will. "It's a long trip using existing technology, but life support systems are now reliable enough for such a mission using existing propulsion. Gaseous core will open up Saturn and the other outer planets, but it isn't necessary for Jupiter."

"That's your angle. Many would say a sixteen month voyage is about four months too long for a crew. People went stir crazy on the twelve-month Mars to Venus to Earth voyage a decade or so ago. I know; I was there."

"The *Tienan* has more usable space, though, and they'll be busy with telerobotic research in the Galileans probably starting with launch. And they could have bought more fuel and gone faster, if they had wanted to."

"Never mind, Will! That's not my point. I'm telling you what I have to deal with. Several people will demand that you be fired. That's impossible, but you can expect the United States to be hostile to your administration for the rest of your term. Several emails to me will ask whether you really knew."

"Of course not. I'd be a fool to ask, wouldn't I?"

"Some would say that as Commissioner, you had an obligation to know where the *Tienan* was going."

"Nonsense. They're paying customers, and they aren't shady customers either."

“That isn’t the way my colleagues will view them.”

“What does that say about your colleagues?”

“That they’re patriotic Americans, Will!”

“And I’m not? Come on, Brian.”

“American and Marsian-American aren’t the same thing.”

“Brian, the Chinese have as much a right to come here and buy hydrogen and fly to Jupiter, Metis, or anywhere else, as the Americans. I’ve said in private and in public and I will say it again in both places. Their lease of the southern part of Deimos and of their nuclear research reservation here at Dawes were approved by the Commission’s Board of Trustees, including the United States. Those are bigger deals than their mission to Jupiter.”

“True, but this one may deal a death blow to the civilian side of our operation here, and leave in place the military aspects you won’t like. Our gaseous core research could get cut by Congress, which would also eliminate the big civilian demand for Martian plutonium. There will be a Congressional investigation why the Chinese beat us to Jupiter with half a decade to spare, and we know what that report will say: that NASA is a gigantic pork barrel operation spending tens of billions of dollars on pie-in-the-sky research projects that were not needed, when the Chinese used off-the-shelf technology. Frankly, I have my doubts that NASA will survive this scandal. So much of it has been privatized or spun off to international Commissions, there isn’t a core left that can embrace a practical mission.”

“In other words, it’s going to have its eighth identity crisis in eighty-five years, always over the same issues; cost and vision.”

“This could be much worse; the timing is different. If Congress pulls the plug on gas core and Project Odyssey, the U.S., will no longer be a major exploration player. The Chinese will pull back; they will have won and they don’t have the money to tackle the technology for Saturn. So we will be left with no major exploration plans for humanity.”

Will considered that. “Brian, the United States has spent how much on propulsion in the last decade? Maybe twenty billion? Gas core is ninety percent ready to go. The billions on life support systems and exotic plastics haven’t been wasted; they’ve gone into the caravel. And billions more were spend creating low-temperature equipment to function on Callisto, which have opened up our polar regions. So you tell your people in Washington this: if they cancel gas core, Mars might pick up with the research using the people here, finish it, and plan a mission to Saturn. Titan is the big jewel in the outer solar system, and a rush of robotic vehicles to explore that world is already being planned. Mars can partner with the United States in the exploration of the Saturnian system, or it can do the job itself, and cheaper. If we can’t buy plutonium from New Hanford, we know there will soon be another source on Mars, won’t there?”

Brian laughed. “I don’t think they’ll believe that! The Mars Commission ain’t going to Saturn; the trustees will veto it.”

“I didn’t say the Commission, Brian; I said Mars. We have three thousand people now and are growing at thirteen or fourteen hundred per columbiad. In six years we’ll have seven thousand people. The Mars Commonwealth Authority will be in the position to do all sorts of things.”

“You don’t control the Authority.”

"No, but I have influence, and it's getting more ambitious. Look, tell them this: They need to continue Project Odyssey, but its goal should be to go to Jupiter on the way to Saturn within a decade. No one will beat that timetable, and all it needs is completion of gas core engines. Mars will partner with the U.S. to do it, I'm sure. And if the U.S. declines, Mars will go to Titan; and it won't take much more than a decade, either."

11

Harvest

June 2047

Kristoff looked at Helmut and Clara's future garden. "Hey, there's a lot of potential here," he exclaimed, raising his voice a bit so that Helmut could hear him.

"Definitely," Helmut agreed from the living room, which opened on the bare future garden through double doors. "It's only five meters by ten; we want to use it primarily as an extension of the living room. You should go up on the roof."

"Really?" Kristoff looked around and spotted a ladder that started about a meter off the ground; too high for Charles, no doubt. He clambered up onto it and attained the roof easily.

"Wow," he said. The house was a single story, so there was a two and a half meter clearance above the flat roof, which consisted of a single sheet of heavy polyethylene. The dome-shaped ceiling was supported by nickel-steel arches every two meters; the apex was a skylight four meters wide running the twenty-meter length of the cylinder. Most of the skylight was only indirectly visible from the yard; the light shown through a meter of clear ice. The rest of the cylinder was buried under three meters of dirt, enough to block most cosmic radiation.

Kristoff walked the length of the roof, inspecting it, then walked back to the edge. He judged the distance down, then jumped. He landed with a loud thud.

"What was that?" exclaimed Irma.

"My God!" said Clara, startled. Oscar, nursing at her breast, stopped and looked up.

“Don’t do that!” added Irma.

“Why? This is Mars; a three-meter jump isn’t a problem.” He turned to Helmut. “So, what will you do with it?”

“Eventually we want to install a staircase and a rail; we don’t want the kids jumping or falling. I was thinking of just grassing it over and maybe putting some bushes along the edges. When Charles and especially Oscar are older, they can play up there.”

“With *all* their friends,” added Clara. “No one else has 150 square meters of lawn anywhere, so we can expect a lot of kids!”

“I don’t want Mark and Nicola up there yet,” added Irma, looking at her twenty-one month olds playing in a corner of the living room.

“Well, I could use it,” said Kristoff. “It isn’t big, but it has potential.”

“What would you use it for?” asked Helmut.

“Hum. I think the best use would be raising flowers. They’d be easy to take care of and easy to harvest and take to the stores every morning. Charles could even help.” Kristoff smiled at his nephew.

“That’s be fun!” he agreed.

“Flowers, huh?” Helmut thought about it. “There never seem to be roses available for purchase.”

“We could raise a lot of roses on 150 square meters,” said Kristoff.

“It’d be risky around kids, though,” noted Irma.

As they were thinking about the idea, the main airlock opened with a clank and Sebastian entered, followed by a robotic cart piled high with food from the Gallerie. “Sorry it took so long,” he said.

“I think you went overboard, dad,” commented Clara.

“Not at all. This is a special occasion.”

The cart followed him to the dining table, where everyone helped unload it. Then the cart turned and headed back to the Gallerie all by itself and they sat to eat.

“Think of something without thorns,” said Clara to Kristoff.

“What?” asked Sebastian.

“The roof,” said Helmut, pointing. “It’s got pretty good sunshine and we don’t want Oscar up there for a few years, so we’re thinking of things to raise there.”

“Orchids!” exclaimed Kristoff. “They need partial sun, which is what you have up there.”

“How elegant,” said Clara, smiling. “No one is raising them, right?”

“No, but we have several types in bioarchive. We could raise potted impatiens, too.”

“Potted flowers might sell quite nicely,” said Clara.

“And I can help.” Sebastian raised his hands. “Because as of next week, I’m retired!”

They all cheered and applauded. “And you’re going to help with the grandchildren?” asked Clara.

Sebastian nodded and reached over to pick up Oscar, just four and a half months old. The baby smiled when he saw his grandfather. Sebastian looked at Kristoff. “And how was the harvest?”

“Well, not great. I’d say the harvest was sixty percent of what I’d like to get. The sunlight’s still too weak. But the price was good because our crop came in before anyone

else's, and because the sunlight's much better up on the plateau. So we won't lose too much money."

"When can you plant again?" asked Helmut.

"I'm taking off tomorrow from work; no reason to wait."

"Good," said Sebastian. "That's why I brought so much food. We have a lot to celebrate: my retirement, Helmut and Clara's new house, and Kristoff's first harvest."

Will had difficulty doing anything but watch the television signal streaming over *Mars This Sol*. The crisis at Concord Station, Mercury's primary settlement, was gradually waning. The central dome had depressurized over an eight-hour period and was now largely airless, but at least no one had died. Pictures from the interior showed rapidly dying trees draped by the heavy dome material. The housing and living areas next to the dome could still be used, but two of them had small leaks and the station's cylinders were separated into two sections because the only connection had been through the dome. Concord's fifty personnel were desperately staunching the loss of oxygen.

Another icon appeared in the videomessage window; Will noted it was a reply from David Alaoui, his friend and head of the Venus-Mercury Commission. He immediately activated it.

"Hi, Will. Thanks for the concrete offers of assistance. I'll have our construction supervisor email the latest inspection results to Alexandra. There's no way that kevlar support cable should have snapped and torn the dome. They just checked the acoustic records again and found no evidence of a micrometeoroid strike, which is highly unlikely considering the dome had a roof of kevlar, nickel-steel, and water tanks. She's right, there

may be fatigue problems, but whether it was caused by cosmic radiation, extreme temperature changes, exposure to vacuum, or what, is not clear. Your domes may or may not be vulnerable as well, but your people are the other set of experts, so I definitely want their input.

"And thanks for authorizing Pete Theodoulos to contact us. We are sending a relief flight to Mercury and the U.S. has offered a LANTR engine. A launch window opens in just thirty-three days, it's a really tight schedule, so we'll need to tap your hydrogen-oxygen supplies at Gateway, but of course the moon can send up replacement supplies well before your launch windows later this year.

"I've got to run. Thanks for your support, and say some prayers for us. The real impact is psychological; no one died and there's plenty of food and life support for the residents, but now they'll feel insecure, their morale and work will suffer, and everyone on Earth is questioning why there are fifty-five people on Mercury, which means the governments will question their financial support and the European Greens will attack our use of nuclear engines and reactors. It makes everything complicated. . . though who knows, these crises often become opportunities as well. Bye."

The line closed. Will thought back about his days exploring the moon with David and considered his friend's nearly bald, white-fringed head. They were both getting old, and a crisis like this would not be easy on David. If it happened to Mars it wouldn't be easy on him.

He decided not to reply to David; all he could say was said, and David was busy. He'd email him in another six hours when David might be able to catch his breath. He

closed the *Mars This Sol* multimedia site and called General Zhou Qisheng. The Mercury crisis had been a convenient distraction, but it was now time to bite the bullet.

The General answered immediately. “Good sol, Mr. Commissioner. Isn’t the situation on Mercury terrible?”

“Yes. Thank God no one died or was injured, but now everyone’s rationing their food and trying to repair the damage.”

“It was pretty frightening; I spoke to one of my Chinese colleagues about an hour ago, while he was back inside to change life support packs. The gash in the dome won’t be easy to fix, he said, and they’re worried about food and recycling. Their water purification system was attached to the dome and it won’t stay pressurized now.”

“Yes, I heard. Thank God they have glaciers of ice to melt, and plenty of solar energy. I was just talking to David Alaoui and he said they’re mounting a relief flight. But I didn’t call because of the Mercury situation. As you probably know, I met with my senior advisors, Earth and Mars, last night and we finalized the decision about purchasing a nuclear reactor for Uzboi. We also decided that the unforeseen expansion of our gold production and our generally larger mining population necessitates the purchase of a seventy-five thousand kilowatt reactor for Cassini. We also will purchase five one-thousand-kilowatt portable power reactors. The American proposal for Uzboi costs slightly more than yours, but they can get the reactor completed a year earlier, so we are accepting their bid. However, we suspect you have the edge for the Cassini reactor for these reasons: it’s the same size as the reactor you are building at Dawes; the Americans will be busy with Uzboi, so you will be able to complete the Cassini facility before they; and you’re much closer to Cassini, so you’ll have lower transportation costs.”

Qisheng said nothing at first; he was digesting Will's words. "Naturally, we are disappointed not to get the Uzboi contract. But your offer of a reactor at Cassini sounds like adequate compensation. We would prefer to build a one hundred thousand kilowatt reactor at Cassini; that way we would be able to use the existing design we prepared for Uzboi. I suspect we could complete it just months later than the Uzboi timetable we submitted."

"Give us cost estimates for both, General. But right now we don't anticipate Cassini will need one hundred thousand kilowatts; the gold supply is only so large. Our export of platinum-group metals looks very strong and the price is holding up, so it is possible we may be able to accept the larger reactor, but I think it is unlikely. Can you also give us bids on the portable reactors?"

"I'm sure we can give you a bid on them, just send us the specifications."

"Yevgeny will get back to you later today with the details for both requests. Thank you, General."

"Thank you, Mr. Commissioner. Ciao."

"Ciao." Will closed the circuit, relieved that their compromise was well received. Now he had to call Brian Stark and give him the good news. But just then there was a knock on his door. It was Érico.

"Have you a minute?"

"Sure, come in."

"I've just spent an hour with Rachel Evans," he began, referring to the Mars Authority's Director of Safety. "She's concerned about the implications of the dome tear at Concord."

“She should. I was just talking to David Alaoui. He said that it wasn’t a micrometeoroid strike; the microphones didn’t pick up a hit. The kevlar cord tore and broke. So there’s a fatigue issue.”

“That’s what we were thinking. We’ll launch a Board of Inquiry to check the safety of our domes.”

“You should, and the Mars Commission will cooperate fully.”

“Thank you. Are they sending a relief flight?”

“Of course. They won’t be raising food and recycling wastes for at least six months, maybe a year. Caloris Station doesn’t even have a greenhouse. They’ll need about a hundred tonnes of food.”

“Hum.” Érico considered. “You may have heard the rumor that the Mars Authority has been trying to buy a shuttle.”

“Yes, the shuttle that I am sure the Trustees will regard as going beyond the ‘domestic’ sphere of the Commonwealth’s authority, the shuttle they will pressure me to oppose publicly if I hear about it. Of course, it makes sense for Mars; it’ll strengthen its application to join the Mars Commission, give Marsians prestige and pride, and hasten the possibility of independence. I suspect if a Hermes shuttle were under consideration, it will still be available because the relief flight won’t need one. There are already four Hermes shuttles on Mercury and they haven’t been compromised.”

“That would be my guess as well,” agreed Érico. “I wonder what the Trustees think about the idea of Mars applying to join.”

“I can’t imagine. I suppose the Chinese and the Americans would be the big opponents; they’d fear an upset in the balance of power. The Europeans and small

countries might see political advantages." That was all Will could say; speculatively, of course.

"That sounds like a good guess to me," agreed Érico.

"Of course, the rumor that the Mars Authority wants to expand the Emergency Corps probably won't help."

"Ah, but I don't think the Council will support such a position; it's a rumor only. The Council will have to consider the question of a police force pretty soon. We've been relying on Aurorae Borough's constabulary, but the rest of Mars is now as big as Aurorae Outpost. And a Marsian Constabulary will have to have some emergency capacity, won't it? That's one of the chief tasks of a police force."

"I suppose eventually that would include capacity in low Mars orbit and the moons." Will sighed. "Of course, the constabulary could always lease space on our shuttles. The Chinese are getting another one and the Americans have one to get their equipment to Deimos."

"And Lufthansa plans to base a shuttle here as well. So many standard service and support arrangements. . . if companies can own shuttles, it's hard to argue the Mars Authority can't, it's like owning rovers and conestogas, after all. I suppose another standard service agreement would not be hard to make under those circumstances."

"It'd be hard to avoid; it'd be bad politics to refuse the Authority."

"Yeah. We'll get back to you about the Dome Safety Board."

"Thanks. Ciao."

"Ciao."

Sarah watched the conestoga pull into Arrival Hall. A moment later the door opened and out came the road construction crew. Ramesh was last. She waved; he spotted her and smiled in surprise.

"Hey, what are you doing here?"

"Thought I'd come down and say hi."

He walked up to her and smiled. "Hi." He embraced and kissed her. She felt his strong arms around her and smelled the cologne she had bought him mixed with his sweat, and kissed him passionately.

"Wow," he said. He held her, looked at her. "What a nice welcome."

"You've been away ten sols."

"I missed you."

"I missed you, too. And you have to go back out, huh?"

He nodded. "Yeah, the graveler is basically breaking down every hour, being repaired, and the broken part is scrutinized, redesigned, and the new part is later installed. This is not a machine that can be designed and tested on Earth; the conditions are too different. But it's gradually working better."

"At least you have power to run it."

"Yeah. It's still pretty gloomy out there, but the reactor has freed up the methane and oxygen supplies. We're burning through a lot of them, too!"

"Well, it's less gloomy up at the Dacha. They say there's half decent sunshine."

"I believe it. Driving in, we could see the top of the escarpment, but the cliff disappeared into a dust bank." He looked at her. "So, are you propositioning me?"

"Yes." And she giggled a bit.

He smiled, as if he was playing hard to get. “Oh, I don’t know, I have all this work to do. . .”

“Right.”

“When do you want to go?”

“I suggest soon, so we can eat supper up there. I hear the food at New Tokyo’s cafeteria is better than the food here. With the poor sunlight, the crops have really shrunk down to a few staples, but they have conserved their supplies better.”

“Hum. A nice Japanese dinner, a little *sake*. . . who can refuse?”

“Good. Shall we catch the 5 p.m. bus?”

“Sure. I need to run to my flat to get some things.”

“I have to pack my bag, too.”

“Good.” He offered her his arm and she took it. They strolled across Arrival Hall and out the airlock into South Main Tunnel.

Almost immediately they ran into Father Greg and Father Karol walking toward them. Sarah, embarrassed, unhooked her arm from Ramesh. The priests nodded a greeting. “Good sol Sarah, Ramesh.”

“Good sol, fathers,” she said, wondering how her voice sounded. “Ah. . . how was your conference?”

“Marvelous. I’m sorry you missed it!” said Karol, beaming.

“What conference?” asked Ramesh.

“‘God on Mars’; we just left it. A smashing success,” replied Greg.

“Nearly one hundred people came, and it was Frisol. We’ll have another session tomorrow,” added Karol. “Please come.”

“No, I’m afraid I have a commitment,” replied Ramesh, looking at Sarah. “But congratulations. I’m tempted to say ‘which God do you want on Mars?’ I’d prefer Ganesha. He’s the elephant-headed god of luck. Or perhaps Kartikeya, Ganesha’s brother, the god of rationality and science, who is also Mars himself. Or his mom, Parvati, or his father, the great god Shiva.”

“Clever,” replied Greg, and he chuckled. Karol was not as amused, but managed a wan smile. Ramesh waved and they continued down the tunnel.

He could feel Sarah’s tenseness next to him. “Oh, come on,” he finally said when the priests were out of earshot. “Don’t react like a guilty school girl.”

“Well, I feel guilty!” she said in an urgent whisper. Sarah looked at him, then smiled. “Don’t worry, I’m okay. If we decide to get married, you won’t object to my going to mass, will you?”

“No, but please don’t drag me along. And if I manage to get a temple built to Ganesha, Kartikeya, and their parents, will you object?”

She smiled. “No, I’ll even come and perform puja occasionally, just like my aunt does.”

12

Vacation

late August 2047

Will Elliott's office in Martech's Geology Department was a cramped cubicle with a small window overlooking Catalina's garden-like yard. He sat behind the table that dominated the space, occasionally glancing at the sunny day outside and moving electronic tablets covered with texts and figures around as he searched for one piece of information or another. He wrote on a large e-tablet in front of him, his careful, neat printing converting to Times Roman twelve-point type as word followed word. Other times when the ideas flowed fast he pushed a button and dictated the text instead, but he preferred the pace that handwriting forced on him.

Sam Anderson appeared in the door. "Will, I've finished making the additions in that table for you."

"Oh, thanks." He gestured to the spare chair; Sam came in and sat while Will grabbed a particularly big, fat e-tablet—about the size of a large photograph album—and moved it forward so they could both see. The cover said *The Geologic History of Mars* with four authors listed: Will Elliott, Roger Anderson, Samuel Anderson, and Marshall Elliott. The decision to add their sons as coauthors had caused others peripherally involved in the project to refer to the work as "Elliott-Anderson Squared" or simply "EA^2." The cover image over which the title and their names were superimposed continuously cycled through a dozen different photographs, charts, and maps, giving the work's front cover an ever-changing appearance. Indeed, it took some getting used to, to sit at a desk and work with the cover of one's book constantly changing its appearance.

EA^2 had started twenty years earlier as a textbook, but Will and Roger had constantly updated the work, and the progress of technology demanded the addition of more color, more images, more sound, and more video with every new edition. The result was no longer called a textbook, but a *multi,* highlighting its multimedia aspect. An e-tablet could constantly download the latest version off the web. Sure enough, when Will opened the e-tablet and flipped the slightly thick, plastic-electronic pages to page 347, he soon found that the chart was no longer on the page it used to be on.

"Oh, dad has been revising chapter six," apologized Sam. Will flipped quickly through chapter six and found electronic handwriting all over the pages, with paragraphs struck out and others penciled into the margins.

"It must have just downloaded. Let's assume he made the chapter longer; multis never get shorter. Oh, hell, never mind." He raised his voice slightly. "Anisa, where's the revised Martian geological column in our *Geologic History of Mars* multi?"

"Page 349," replied the disembodied electronic voice of Will's attaché from a microphone embedded in one of the e-tablets somewhere on his desk.

"Thank you." Will triumphantly flipped to page 349.

The chart actually took up two pages and he scrutinized it carefully. Their extensive drilling of the ice and dust deposits at the north and south poles had revealed the cyclical waxing and waning of the snow caps in detail. Sometimes Mars's axis stood straight up, keeping the poles in a constant and only slightly moderated deep freeze and allowing ice to accumulate deeply. Other times Mars rolled on its side, tilting under Jupiter's titanic pull as much as sixty degrees, alternately roasting and freezing the poles every annum, a condition that eliminated permanent caps and caused ice and snow to

accumulate at the equator instead. Superimposed on the hydrological cycles were atmospheric cycles, for a Mars of moderate axial tilt—as it was currently—tended to have more frozen carbon dioxide, whereas the steeply tilted or the untilted Mars tended to have more CO_2 in the atmosphere. Superimposed on the hydrological and atmospheric cycles were times of thicker and thinner atmosphere because of volcanism or asteroid impact, sometimes producing a Mars of snowstorms, glaciers, trickling meltwater arroyos, temporary lakes, and groundwater outbursts. Other times—such as the current epoch—served up a freeze-dried, frigid world.

"This is very good," said Will. "Imagine; we now have identified 2,467 axial cycles."

"It's a better record than Earth; but then, Earth's climate is so dynamic the geologic record gets erased," replied Sam. He pointed. "I spoke to Nigel Stanfield this morning and he gave me the latest corrected chronology for the Plio-Amazonian. Note cycle 34 is now longer than before. It coincided with a major outburst from Alba Patera, hence the hydrologics."

"That's been suspected for some time." Will touched his stylus to the entry and a window appeared with details and links to references elsewhere in the multi to specific floods that occurred at that time. Then Will turned to the Neo-Amazonian, the last of Mars's eighteen geologic time periods and the shortest, since it referred to the last hundred million years only. He touched it and it expanded to fill the page with information on the last forty-five axial cycles, all but two of which had been dry and cold. Mars's climatological engine was slowing dying, literally running out of gas as the atmosphere thinned.

“Oh, this is great.” He touched the Eo-Noachian, the oldest epoch next, and looked at the three hundred sixty-nine active, wet, and relatively short cycles. “I’ll plan to study this in detail this afternoon. I have to tape the video accompaniment tomorrow.”

“Are we going to have this ready by next month?”

“We have no choice! We have a contract with the MIT-Sorbonne Distance Education Consortium. They’ve marketed the course on 320 university campuses around the world. There are 4,900 students registered to take it, with 345 collaborative support faculty. It uses this multi.”

“I suppose we’ll be able to make additions right through the fall semester.”

“I’m counting on it. That many faculty eyes reading through the text; you can be sure they’ll find things to fix.”

“How are you going to schedule your participation around the flight?”

Will shrugged. “The launch to Mars orbit and trans-Mars injection will only take a few hours; the rest of the time I’ll be available to answer questions. We’re scheduled to answer questions during six one-hour time periods per week, and if any fall at a bad time your father will handle it.” Will glanced at his watch. “It’s noon. Come on, I’ll buy you lunch.”

“Oh, okay.” Sam jumped up, obviously delighted to eat lunch and that someone else would pay. Will was equally pleased because it meant he’d sit with the students, which he always enjoyed. Will grabbed his “Medora”—a very attractive Marsian fedora hat with a wide, thick brim of radiation-absorbing polyethylene, which he liked very much—and they headed out of the cubicle. “I was talking with Marshall this morning about the multi and he said his girlfriend is coming to Mars,” continued Sam.

“Yes. They’re almost engaged, I gather. I suspect they may get married while Ethel, Liz, and I visit Earth; that way their friends at MIT can attend the wedding.”

“They won’t return to MIT for a while. We can always throw them a party here when they arrive.”

“Exactly. I suspect this will be my last visit to Earth.”

“You aren’t so old that you couldn’t go again.”

“It’s not a question of age. My term as Commissioner ends in 2051 and I plan to retire at that point. I suppose I could always apply for a free trip; I’ll have earned one. But I’m not sure I’ll want to go back. It takes a long time, you know, and as safe as it is, you always wonder whether you’ll be in an accident.”

“I suppose; I’ve never worried about that so much. I’d like to go to Earth for two years, some time.”

“Are you putting in for asteroid missions?”

“I plan to. I’ll be rotating to Deimos next year for six months and that’ll strengthen my credentials.”

“Good.”

They entered the tunnel to Yalta and a moment later emerged in full sunlight there. Will adjusted the brim of his hat to shield his eyes from the glare. The dust storm season, after eight months, was finally over, and the atmosphere was clear enough for ninety percent of the sunlight to shine through. Already the trees and flowers in Yalta looked much lusher, and the outpost’s agriculture was rapidly recovering.

They entered the Martech cafeteria, a spot favored by students, professors, artists, and intellectuals. It was quieter and cozier than the Gallerie, less commercial than

Andalus Square, and less glitzy than the eateries springing up along Cathay's Riverwalk. They grabbed sandwiches and salads, Will paid for their meals, and they sat at a big, round table where a half dozen geologists were arguing about the chronology of the Argyre Sea's comings and goings, with side conversations about personal relationships and about expeditions people were proposing to lead or applying for.

After forty-five minutes, conversations began to wane and the students began to bus their trays and leave. Will rose to do an errand in Andalus before returning to his cubicle and continue work on the multi. As he entered Andalus, Lyle Quincy spotted him and hurried over. "Commissioner Will! Commissioner Will!"

Will stopped and turned, wondering what Quincy wanted. "Good sol, Lyle."

"Good sol. Commissioner Will, what more can we do to join the Mars Commission? I couldn't believe it when the Trustees turned down our application last week."

"Well, the Trustees explained their decision: the Mars Treaty specifies that sovereign nations can join the Mars Commission, so the Mars Commonwealth Authority doesn't qualify. It's very simple."

"But, that's a bogus reason. Whether we're sovereign or not, the Mars Commission is *our* Commission! Who else's could it be?"

It's humanity's Commission. All these Commissions are set up the same way; any nation can join that's willing to pay, the exploration is theoretically done in the name of humanity, and the resources are the common heritage of humanity."

"That makes sense for Venus, where there will never be a nation, but we're going to be a nation soon! It seems to me that the Commission's terms of reference have to

change. The ocean bottoms beyond national borders are the common heritage of humanity; New York state isn't!"

"The terms of reference are set in the Mars Commission Treaty, which has been signed by over one hundred forty nations. The sixty that haven't signed are all very small. Have you any idea how hard it is to change a treaty?"

"No, but it doesn't matter in a way, because the current arrangement's unfair and it'll just push Mars toward independence. Common heritage of humanity!" He spat out the last phrase.

"I don't have a problem with Mars being a common heritage. No one owned this place originally, so everyone owned it in common. When any of the land is sold—and even the land the boroughs own was sold to them, just for a nominal fee—a five percent royalty was collected as common heritage. A small amount of that went to science education projects on Earth. Most of it was put into developing the infrastructure here, so that the common heritage here would be worth more. I think that's a good, fair arrangement."

"Look, I have no objection to recognizing our obligation to our fellow human beings. But we can sell our own land and make our own decisions who will benefit on Earth; we don't need a committee appointed by the Commission do it for us. I don't object to the notion of common responsibilities to humanity, just the idea that our world isn't ours."

"Yes, I understand, Lyle, and gradually we're moving in that direction. But don't forget we're a community of less than three thousand people."

“But we’re at least three light minutes and a three-month trip from the rest of humanity; we have to decide most things on our own because of isolation; and we have an economy worth twenty billion redbacks per columbiad. If the nations want to give us eight billion redbacks of subsidy, great; they can have a thirty percent say over how we do things. Countries with loans from the International Monetary Fund are in that situation.”

“These arguments are all very familiar with me; I make them to the Board, you know. We’ll get there.”

“Come to the Independence Circle and debate the timetable, then. We’re meeting Frisol to talk about this subject, right there.” He pointed to a spot on the Square outside the entrance to the Gallerie.

“I can’t Frisol; Ethel and I are going to the Dacha.”

“Then next Frisol.”

Will shook his head. “No, not next Frisol, Lyle.” He turned away.

“Then when?”

“I don’t know. Ciao, Lyle.” Will walked away feeling torn because he couldn’t reveal his true feelings to the Independent Circle without encouraging trouble or undermining his credibility with the trustees.

He walked into the Deseret “Department Store” and headed for the baby section. He had to buy a present for a baby shower, and a scan of the websites for Deseret and Silvio’s that morning revealed that the former had just received a shipment from Earth. He looked through the choices—the mother was expecting a boy and a girl—and stopped

in front of the soft, fuzzy blankets. He called Ethel. “How do these look?” and turned the attaché’s camera toward the blankets.

“Hold on; this little screen is inadequate. . . okay, I’ve switched to a big screen nearby. I guess those are good. How much?”

“Three hundred redbacks. There are locally made ones for fifty, but they’re bigger and they aren’t as soft and fuzzy.”

“No, no, nothing local. They can’t afford the imports and we can. Can we get two, one blue and one pink?”

“Sure, I’ll get both.”

“Thanks. Got to get back to the fractionator controls; I’m running them this sol. Ciao.”

“Ciao.” He walked to the front of the store, went through the self-service checkout, waved to the person in the video screen who was watching—and running several stores at once—and headed back to the university. Half way back, while he was walking through Colorado Biome—which was in a glorious spring, with lots of flowers—his attaché beeped with an incoming call. He activated the audio only, so he could keep walking. “Hello.”

“Will, this is Brian Stark; no video?”

“I’m walking through Colorado right now.”

“Can I come by your office?”

“Sure, but I’m heading for my cubicle at the Martech Geology Department.”

“I’ll be right over.”

Will acknowledged him and said ciao. He was surprised that Brian arrived in the dome at the same time he did, though from the opposite direction. “Where were you?”

“I was in Arrival Hall; I just got here from New Hanford. I need privacy; we can sit at this bench.” He pointed to a bench nearby.

Will nodded and walked to the bench, which was sunny and warm, though it was also blasted by solar radiation. He decided to enjoy the warmth; it’d be a quick stop.

Brian sat next to him and looked around; the yard was deserted at the moment. “It’s looking very bad for gas core research. In spite of four test firings—all successful—some Congressmen are aiming to close down the program completely and cancel Odyssey.”

Will shook his head. “This is the history of space exploration. Since when is Congress ready to concede international leadership to the Chinese? They don’t know for sure the *Tienan* will be successful.”

“Well, it’s the liberals; feeding the poor is more important.”

“Of course, if they were conservatives, the money would go to tax cuts instead.”

“Conservatives wouldn’t concede international leadership to the Chinese. They’d just approve too many huge pork barrel technological development projects, then get mad when the costs spiral out of control.”

“What does Addison and her team think of the situation?”

“Oh, don’t get her started! She’s ready to denounce the entire U.S. government for spending ten billion dollars on this research and losing nerve before they spend the last billion. I’ve forbidden her to talk to the press, but I think she’s already been giving deep background to *Mars This Sol.* I’d rather have you call some Congressmen.”

“How much money per year are you talking about?”

“The gas core research is half of New Hanford—three hundred million redbacks per year—and about three hundred million more in terrestrial support.”

“That’s beyond my discretionary spending powers. It would be quite controversial if the Commission tried to take over the gas core research, too, though I suppose the Chinese would support the move!”

“What about the Authority, then? Getting the Mars Council to authorize the expenditure wouldn’t be that hard, especially if it was a joint Commission-Authority effort.”

“Then it might all fit inside my discretionary authority, or at least the threat to do it will be plausible.”

“I think that’s all we need for now. If you could talk to Érico to see whether the Authority will collaborate, then call a Congressman or two—”

“When?”

“Well, it’s Thursday morning and Labor Day weekend’s coming up fast. They’ll probably receive and reply to videomails for the rest of today, then the weekend starts.”

Will nodded. “Alright. I think you just destroyed my afternoon of research, but it’s worth it. If they cut spending entirely, what would happen to the facilities here?”

“They’d be mothballed and a lot of equipment would be shipped back to Earth, but most of the people would stay here, and they have the knowledge in their heads.” He tapped his head. “The solar sailers with next year’s equipment are already on their way to Mars and other equipment is due to be launched via chemical rocket in two months. They’d be hard to recall.”

"And they're paid for. We should at least offer some sort of deal to pay part of the operational expenses. We could guarantee secrecy of the technology being developed."

"You'd have to."

"Okay, I'll see what I can do."

The sun was slanting low over the domes of Aurorae when Ramesh and Sarah reached Arrival Hall with their weekend bags to catch the bus to the Dacha. It was already getting crowded; they were catching the busiest run of the week, so two vehicles were available. When they got on the rear vehicle they found only one space for them; the two seats right behind Will and Ethel.

"Good sol," they said to the older couple.

"Good sol," Will and Ethel replied almost simultaneously. "It should be a lovely weekend up at the Dacha," added Ethel.

"Yes, lovely," agreed Sarah, though she didn't mean it. Ramesh sensed her hesitation, but said nothing.

"We'll see you around up there, no doubt," he added.

They settled into their seats and two minutes later the bus moved forward into the airlock. Two minutes later it emerged from the lock and headed around the Outpost, then turned north and drove at eighty kilometers per hour across the stonelands, toward the mouth of Little Colorado Canyon.

"Are you okay?" Ramesh whispered to her.

Sarah nodded, but she looked stiff.

"You get spooked so easily by authority figures," he said.

“It’s not that.”

“What is it, then?”

“I’ll tell you later.”

He nodded. Then a minute later he added “This isn’t the best way to start a weekend at the Dacha together. I don’t get back to Aurorae so often, right now.”

“I know, Ramesh. We’ll talk later, okay?”

“Okay.” He stared out the porthole window near him and contemplated the newly graveled road surface the bus was cruising down, and felt every slight bump. It was one of the results of his graveling system, which was now working fairly well.

It was a forty minute drive to the Dacha, across twenty kilometers of rolling valley floor, then up the talis slope on a road bed of gravel and dirt frozen against and into the loose boulders, then into narrow, winding, spectacular Little Colorado. Twice on the way up the canyon widened into a valley, then narrowed again into a deep, narrow ravine at the end of which the road had to climb up the steep eastern side on a ramp blasted out of the rock. At the very top of the valley two switchbacks and a lot of blasting took the road up the last hundred meters of cliffs and conveyed it to the plateau above. The ground there was ancient, crater-saturated, buried under shifting dust and then reexcavated dozens of times over the aeons, blizzarded by countless snows and even a few rainstorms, soaked by liquid water, eroded and gullied in places, freeze-dried by millennia of profoundly cold drought, blasted by solar ultraviolet, sterile and lifeless, all the while watching the sun, clouds, and twin moons make their constant daily passages. The Martian range conveyed an ancientness like nothing on Earth could.

The road turned west, then back south. The bus skipped New Tokyo—the other vehicle headed there—and went straight to the Dacha. Two minutes after it entered the Dacha's airlock it pulled into the small open space within the bubble and discharged its sixteen passengers.

Sarah and Ramesh grabbed their bags and headed for room 304, which they had previously reserved via the web. Ramesh stuck his credit card into the door mechanism and it opened, incidentally billing him for the reservation as well. They unpacked their bags, then Sarah headed to the window, opened the curtains, and drank up the late afternoon view of the Aurorae Valley. The outpost was visible through the slight haze on the valley floor twenty-five kilometers to the south, as the crow flies. The fading light of sunset cast a purplish hue over the rolling ground which she gazed at in wonder.

Ramesh came up behind her, looked at the scene, and began to massage her shoulders. She turned to him, put her hands on his shoulders, then pulled back a bit. "Ramesh, I. . . ." her voice faded into hesitancy. She looked into his eyes.

"What is it? Are you still spooked by seeing people we know on the bus?"

"No. Ramesh, I. . . I'm pregnant."

The words seemed to reverberate through him; his entire frame shook a bit from their vibration. He was startled. . . shocked. "What? Pregnant? I thought you were taking precautions."

"So did I, but you know, you aren't here all the time, and I have to take birth control pills every sol to be protected, and that proved difficult when you were here, then away, then here again, then away. I'm. . . sorry, Ramesh."

"How long have you known?"

“Just two sols. I should have found out sooner, but I’ve been irregular occasionally in the past, so I didn’t suspect right away. The baby’s due in mid March.”

“Mid March. Mid June. . .” he thought back to his return from Uzboi in mid June, then nodded. “And you want to keep the baby.”

“Ramesh, I can’t have an abortion, it’s against my religion.”

“So are a few other things we’ve been doing!”

“I know, but that’s different. I can create a life, but I can’t take one.” She looked at him and tears began to appear in her eyes, then she began to cry. He took her in his arms and comforted her. “You can’t imagine how terrible the last few sols have been. I have felt so much shame. . . so much shame.” And she wailed.

He said nothing but held her tight. He was uncertain about his own emotional reaction. “I’m still in shock,” he finally said. “Pregnant.”

“Pregnant. And I have no idea how you feel about the situation, or even about me; we’ve been going out almost a year and you have never asked me to marry you. I don’t know whether you want to be a father to this child, whether you’ll help support him or her, what this will do to our relationship. . . oh, it’s such a mess!” And she cried again.

“Sarah, I care about you deeply, I really do. . . I love you, Sarah!”

“Do you?”

He nodded. “I do.” It sounded funny, even flat. He leaned over and kissed her to prove the point.

“But. . . marriage?”

“This is too fast, I don’t know what I think about that.” He looked at the valley below them. “I’ve always wanted to get married and have a family, and I imagined I’d get married here. And at 35, I guess I’m not getting younger.”

“No, neither of us are.”

“But things have never worked out. And I feel like I’m still getting settled here, I’ve only been here a year! The road development efforts are still rudimentary and demanding. . . this is a bad time.”

“I suppose it is.” She said it with disappointment in her voice.

“No, don’t take it that way, I didn’t say I wouldn’t marry you! It’s just. . . I can’t ask you now, like this. I don’t know whether I want to marry you, I don’t even know whether you want to marry me!”

“Ramesh, I love you, and I’ve wanted to marry you for months. But now everything is so much more complicated I don’t know what I think.”

“Then we need to think about this very carefully.”

“Good luck on that!” Sarah turned away. She looked out at the Aurorae valley, now dark except for the glowing domes of the outpost so very far away.

Ramesh walked back to the bed and sat on it. Sarah looked at him; he looked at her; she looked at the outpost again. “Look, come over here,” he finally said. “Sit down.”

She sat on the bed as well. “Let’s try to be rational about this. I will marry you, Sarah. I feel very affectionate toward you.”

“Do you love me?”

“Love. . . Sarah, I don’t know what that word means—”

“You and your rationality. Do you love your mother?”

“I suppose I do.”

She smiled at that. “If you’re willing to marry me, will you come to marital counseling with me? I think I can convince Martha to work with us.”

“Counseling? We don’t need counseling. Everyone up here is into counseling, it’s ridiculous.”

“Oh, you and your colossal ego!”

“You watch out!” he shouted back, angrily. They looked at each other for a moment while he calmed himself. “I don’t need any counseling.”

“Suit yourself, I’ll get it myself. I could sure use it. It makes you stronger, you know.”

“I’m strong enough.”

She shrugged. “That’s what you think.”

Will and Ethel didn’t emerge from their room until mid morning the next sol. They went downstairs to the small cafeteria, then strolled hand in hand along the escarpment edge. “Look how far the enclosures stretch!” she said, while they stood on a prominence sticking out from the cliff. The western end of the Dacha’s bubble stretched over air in a few places, but covered much of the prominence, giving a fine view in every direction.

“Let’s see; one, two, three. . . four enclosures. The Japanese have been busy in the last year. Let’s take a look.”

“Can we walk through them?”

“I think so. The first bubble has buildings and they look finished.” He held out his arm and she put her arm through the loop, then they strolled across the Dacha’s enclosure.

“What do you think of watching that Red Sox game? Marshall’s going to be in Fenway Park watching it in person.”

“That would be interesting, though I still have no idea how baseball is played.”

“I still remember and can explain, as long as you don’t feel obligated to explain cricket to me.”

“Only if Marshall goes to a cricket game.”

They laughed. “How do you feel about going back to Earth?”

“Hum.” She thought about it. “A big bother: we have the fright of launch, aerocapture, and landing with the inconvenience of zero-gee and cramped low-gee quarters for months. Then after we get there, it’ll feel like a funeral; I’ll be seeing all these people probably for the last time. And there’s no way Liz will get a sense of the Earth in a bit over four weeks.”

“You don’t have to go.”

“I want to see the place after a quarter century.”

“Four weeks are better than nothing. We might go back again. My ticket will be paid for in another four years. But I’m not sure I want to go back after that; this place has plenty of excitement.”

“Maybe too much; I’m getting worried about all the conversations in the Gallerie about independence.”

“It worries me, too.”

They reached the eastern end of the enclosure and spied a new airlock connecting to the neighboring enclosure. They entered, closed the door behind them, then opened the door into the next enclosure. They walked into a new bubble seventy meters wide and long filled with new buildings. Ethel sniffed. “Why, it even smells new!”

“They must have finished in the last month or so.”

“They’re going to build enclosures like this all the way along the escarpment?”

He nodded. “That’s the plan. It looks like there will be a cliff walk, with buildings behind.” He pointed to the metal walkway crossing the enclosure to the next bubble.

Ethel taped the metal floor; it was good nickel-iron from the platinum extraction facility. “And these will be condos and stores?”

“Time-share condos!”

“Maybe we should get one.”

“Especially if we can have nights like last night again.”

She chuckled and squeezed his arm. They walked down the cliff walk, looking right at the valley and left at the buildings. The first storefront had an unfinished restaurant; the second door said “casino.”

“Casino?” said Ethel, surprised.

“I guess the borough has no ordinance against gambling.”

“What about Texas law?”

“Lately, no one has been worrying much about Texas law; we have enough of our own.”

She glanced in. ‘It’ll be a pretty small casino, though! I guess they don’t anticipate a big audience.”

“Not yet. I bet bankruptcy will their big danger for the next five years. They’re here now to be among the first. Oh look.” Will pointed to the third and last door. “Silvios.”

“Really?” Ethel walked over and looked in. It was indeed a small department store, already stocked with full shelves. They strolled in. “I didn’t know Silvio had opened a branch.”

“Neither did I! I guess he has a jump on Deseret.”

Inside was a self-service checkout area and Silvio’s electronic presence presided over it; at the moment he was in his store down in Aurorae and they could see he was helping someone find something. “Good sol, Silvio!” Will exclaimed, and Silvio looked up, startled. Apparently there was a screen in the ceiling with a video camera not far from him; he looked at it, then waved. “Good sol, Will and Ethel. Do you like the new store?”

“It’s beautiful! When did you open it?” asked Ethel.

“Just two weeks ago this Monsol. I put a lot of spare merchandise up there. Business is bad right now, but in another year it should pick up; people will want to stroll and shop when they go to the Dacha. Look around and let me know whether you need anything.”

“Will do,” agreed Will.

They headed back through the shelves and racks. “Most of these clothes are locally made,” said Ethel. She looked at the label. “Maryam Salih.”

“She has revolutionized apparel here; God bless the VandeVelde Immigration Fund,” replied Will.

“Well, her designs are simple and basic, they’re comfortable, and they’re suited to the cloth available here. It doesn’t make sense making something requiring velvet out of polyester-cotton mix.”

“I like her hats; stylish, but they provide good radiation protection,” said Will, pointing to the medoras. He walked over to them and tried on two.

They continued back through the children’s section. Then they noticed Ramesh and Sarah in the baby section. “Good sol,” Will called out.

“Oh, good sol,” replied Sarah. She was startled, but seemed to recover immediately. “How are you this sol?”

“Oh, we’re doing well, how about you?”

“Not bad,” replied Sarah.

“Are you shopping for Neveena’s baby shower?” asked Ethel.

“No,” replied Sarah. She turned to Ramesh. “Baby shower. Not a bad idea.”

“Some one else has to plan it, though.” He looked at the Elliotts. “We’re expecting.”

“Oh, congratulations!” exclaimed Will. “What marvelous news.”

“We hope so,” agreed Sarah. “Life has a way of getting complicated.”

“Children will do it, but it’s worth it,” replied Will. “If you want to learn about love, have a family.”

“So, what do you think love is?” asked Ramesh.

“What is love?” Will smiled and there was a twinkle in his eye. “It’s a commitment to someone, trusting someone, lusting for someone, having a deep emotional connection with someone, dedicating part of one’s life to someone. . . it’s a lot of things.”

Ramesh looked at Sarah. “That’s a pretty good definition.”

13

Meteor Strike

Oct. 2047

Helmut contemplated the huge map of Ceres on the wall of the Ceres Research Center. He turned to his attaché and pushed a few buttons; the wall map changed, zooming in on a relatively small, ten by twenty kilometer area. Then he walked up to the map and looked closely at several areas; he could easily see objects a meter across as dots, and if he increased magnification he could see objects as small as a tenth meter. He contemplated several sinkholes caused by evaporation of subsurface ice. Then he returned to the controls of the Prospector C-500, a special telerobotically controlled mobile science exploration vehicle, and plotted a course on a map from its current location around several sink holes to a reasonably fresh crater sixty meters away. With weak solar energy, that was all the C-500 could do that sol.

It took half an hour to enter all the commands into an uplink to the vehicle and run a simulation. Then he sent the commands and turned to the second of four C-500s exploring the asteroid. Programming them took much of the morning; analyzing the data in preliminary fashion, the afternoon. Two universities—Brown in the United States and Bangalore in India—were under contract from the Asteroid Belt Commission to analyze and publish the new data, but so far Helmut and a few graduate students at Martech had managed to get the jump on them.

Hearing footsteps entering the facility, Helmut looked up. It was Charles Vickers.

"Good sol. Where's all your help?"

“Wednesol mornings are bad, they all have classes, so I have to do the C-500s myself. I don’t mind; it helps me remember their capabilities.”

Charles looked at the map. Helmut projected the prospector’s route on it and he nodded. “You’re making pretty good time.”

“On a flat plain we can go one hundred meters per sol, but the sinkholes are both an obstacle to avoid and a window into the subsurface, so we’re photographing every single one of them as we go by. Basically, in a month we can do as much work as a professional geologist in a pressure suit would do in one sol. But we haven’t got any boots in the reg there, right now.”

“No, but that’s what I want to talk to you about. The launch date of the *Piazzi* to Vesta is now final; late 2048, or just over a year from now. Consequently we’re looking at the next big mission for the *Olbers,* and the logical destination is Ceres for three or four years. I think we can get funding for a deep drilling project to penetrate at least a hundred kilometers into the asteroid; that’s just about deep enough to hit liquid water. I suspect we can justify a carbonyl fractionator tower to extract nickel-iron and produce platinum group metals as a very lucrative byproduct; for that work we can get industry grants, because everyone wants to develop asteroid mining abilities. We’ll use the ‘waste’ nickel-iron for the deep driller.”

“When will the *Olbers* launch?”

“Probably mid 2051, opposition’s late November.”

“Oscar will be four and Charles twelve. . . that’s doable for the family, I think.”

“Are you sure you want to take the kids? Increasingly, I have my doubts about the wisdom of children on flights. Caitlin has various minor health problems that no one can figure out.”

“Yeah, Charlie does, too, but they’re different from Caitlin’s, and as we know, everyone’s health here is dissected so completely, some problem is found in everyone.”

“Yes, that’s true. This mission will be better for the kids than the last one; there will be less time en route and more time on the surface, where radiation shielding can be installed. Charlie would come of age in the asteroid belt, which is an interesting idea. He may have crew duties on the flight back. Helmut, I’m not just asking you whether you want to go. I’m asking whether you want to command.”

“Command? Wow; yes, I would like that!”

“I thought so. It’s easy for me to remember you as an enthusiastic twenty-six year old when you arrived here fourteen years ago, but now you’re forty! It’s time for a real command. You have incredible experience, and your ongoing love of Ceres needs no greater proof than this facility.” Charles Vickers scanned his hand around the large room.

“Thank you. I’m honored, Charles.”

“I’m sure you’ll do a great job. But it means you’ll have less time here; we’ll need a good assistant for you. I’ll need your time to attend meetings, make plans, negotiate details with people, etc.”

“Alright, when do I start?”

“How about tomorrow?”

“Great! I had better talk to Clara.”

“Definitely; she will have concerns. Let me know what she says.” Charles nodded and headed out the door to his office down the hall.

Helmut looked at the Prospector controls in front of him. The vehicles would have to wait. Clara was still home, so he headed out the door as well.

It was a few minutes walk from Riviera Biome, where the Asteroid Belt Commission had its facilities in the former Mars Commission headquarters, to their house in its buried bubble northeast of Andalus. Clara was feeding Oskar some cereal. The little boy was now almost nine months old and spent much of his time crawling around the house, but she had him strapped into his highchair. She was surprised to see him. “What brings you back here?”

“Charles just came to Ceres Central to talk to me. The Asteroid Belt Commission is initiating another Ceres mission, to be launched in 2051, and he asked me to be Commander.”

“Really?” She was surprised, pleased, and worried. “Wow, that would be great. So, what do we do?”

“He said the mission would fly straight to Ceres, stay—he didn’t say how long, I suppose three years—then fly straight back to Mars the next opposition. That’s less cosmic radiation exposure for the kids than on our first trip. We’d set up an outpost at the ataxite deposit, mine it for platinum group metals, and convert the nickel-iron into casings and other equipment for a deep drilling project; we’d aim to drill one hundred kilometers into the asteroid.”

“So, we’d be gone about four or four and a half years. And on Ceres, we’d all be pretty heavily shielded.”

“We’d be sure of it. There would be at least two abort-to-Earth windows in that period, also.”

“Every fifteen months. What would I do? Will we have a teacher for the kids?”

“I don’t know who the crew will be. We’ll have to recruit. We’ll need some pretty capable engineers to keep the driller going. Considering your experience on the first mission and your position as number three in Mars control, I think you should be chief systems engineer, and I doubt anyone would disagree with me.”

“That would normally make me second in command.”

“Yes, it would. That might be controversial, but the decision who’s second in command is up to Charles and not me.”

“Hum. Intriguing. We’d have to have a child education specialist on the flight.”

“I agree.”

“When does he want you to start?”

“Tomorrow. There’s a lot to do; we have to select the crew and start training, plan all the supplies, plan imports from Earth, complete a far more extensive survey of the region with the ataxite in order to settle on a site for the outpost, there will be a huge amount of research to plan the driller and test it out in Phobos. . . we have a lot to do.”

“Well, let’s get started.”

Sarah Pannakar was a beautiful bride in a bright red sari, the traditional color for Indian weddings. Ramesh was dashing in his tuxedo with a tall hat on his head. As they walked down the aisle to the tune of the wedding recessional, Will turned to see Ethel had tears in her eyes.

“It was so beautiful.”

“It was nice. I’m still surprised Father Greg agreed to officiate. I doubt Ramesh will ever be Catholic.”

“Especially since they had a Hindu ceremony as well. I bet that startled Father Karol.”

“Yes, he must have been displeased. But then, he may also be displeased by the bride’s condition.”

“Shush, I think they aren’t saying anything about that. She’s only three or four months along.”

“You can’t tell she’s pregnant yet.” Will looked around the church. “Not bad, for a few months’ work. The cathedral will be quite attractive, with stained glass in the windows and art on the walls. They’re a bit plain now.”

“They’re talking about reproducing the entire ceiling of the Sistine Chapel up there. It’ll be spectacular.” Ethel gestured and Will stood; it was the turn of their pew to process out. They headed out of the church.

“And the pietà up front,” agreed Will. “Of course, some would say that Marsian churches should have Marsian designs and art, and not just be copies of Earth.”

“Eventually, my dear. Right now they want to use all the old symbols of elegance and spiritual power.”

They approached Father Greg, shook his hand, and thanked him for the service. Sara and Ramesh were part way across the square and waiting for the others to assemble behind them. Once everyone was out of the church, they set off for the reception in

Punjab Dome, led by a bagpiper and followed by the entire wedding party. The two hundred of them were a colorful pageant.

They didn't take the shortest route. When the party reached Liberty Dome—by leaving all the airlocks open so they could process continually—they detoured across the square. It was not completely finished. The Mormon Temple at one end was complete on the outside, gleaming white, with a statue of Moroni on top, almost grazing the dome. To its right and facing it were nearly completed commercial and residential properties; to its left was a hole where the future Aurorae Marriott Hotel would be built. Will found it hard to believe that a commercial hotel would be viable on Mars. The plan was to rent out most of the rooms as residences between tourist flights from Earth and to capture a large share of the domestic tourist market; at any particular time, Aurorae had between twenty and fifty visitors from the other outposts.

One restaurant had opened on Liberty Square, the Texas Steak House, and it was deserted except for two diners who were eating at a table in the open air: Brian Stark and Violette Cardin, one of New Hanford's younger and more attractive nuclear engineers. As Will passed them, he waved.

"Who's getting married to Ramesh?" exclaimed Brian.

"Sarah Pannakar; she's a nurse at the hospital. A good match."

"I wish her luck. Did Ramesh have a Catholic ceremony?"

"And a Hindu ceremony." Will diverted over to the table for a quick conversation. "So, you're going back to Earth, too?"

"For a month of talks, then I'll be back here. Maybe we can get some negotiations complete."

“How does the gas core funding look?”

Brian shook his head. “Project Odyssey has been trashed in every single congressional committee looking at the 2048 budget, and it isn’t clear the White House will threaten to veto a bill lacking the funds. It’s looking grim.”

“Of course, space funding looks impossible about half the time, and it gets approved anyway.”

“That’s what we’re hoping. And all our equipment has left Earth orbit and is on the way; if they cut funding now, they’re cutting the money to buy the stuff we get in 2050.”

“So you could have equipment and no salaries.”

“And people on Mars to do the work, with no money to send them home!” Brian shook his head in disgust. “You can’t do space exploration without one or two simple, clear goals; otherwise everyone tacks on their pet multibillion dollar projects and the whole thing is in danger of collapse. But I think a partnership with Mars to go to Saturn is the best bet, now.”

“The Chinese say they’ll establish a Jupiter Commission.”

“Yes, but the U.S. will never join.”

“They should swallow their pride. Otherwise, it’d be hard for them to send a mission to Callisto; they’d be landing on a moon under international jurisdiction.”

“But they wouldn’t have recognized the treaty.” Brian shrugged. “The United States can’t always get its way.”

That’s the lesson the last fifty years have been trying to teach it. Maybe eventually it’ll get it. I’ve got to get back to the wedding procession, Brian. Ciao.”

“Ciao; did you hear Skip Carson’s coming back?”

“Yes, we’ve been in touch. Ciao.”

Will hurried to catch up with the wedding party, which had begun to enter the tunnel to Zanzibar Dome. By the time they entered Zanzibar, he had caught up with Ethel. The party crossed Zanzibar, passed through the tunnel to Punjab, then walked into the big room they had rented for the reception, a room that was also serving as the meeting place for Aurorae’s Hindu community.

The bride and groom disappeared for a while, then reappeared and received a formal welcome. They all went through a reception line. “Two beautiful ceremonies,” said Will. “And now I can see a lifetime of happiness ahead.”

“Thank you, Will,” said Ramesh. He smiled and shook Ethel’s hand quickly.

“May you have many children,” added Paul Nuri, who was also at the wedding and followed in the line behind Ethel.

“Thank you; six or seven,” replied Ramesh.

“Six or seven?” replied Sarah, alarmed. “How about one, and we can open negotiations again later?”

“I plan to negotiate with you on the matter regularly, my dear,” he replied.

Jacaranda shook hands with Ramesh and kissed her good friend Sarah, then the four of them headed for their table. “This is going to be an interesting marriage,” said Jacaranda. “She’s absolutely crazy about him, and I think he takes advantage of that.”

“Yeah, a bunch of us had dinner with them last night and the question of housing came up. Ramesh said he wanted to build a house for them in Little Colorado Canyon.

Sarah was rather shocked and said ‘how will I ever get to town?’ He said there are busses about every hour, and more often on request. So she seemed to accept the idea.”

“A house in the canyon?” asked Ethel. “It’s romantic, but impractical.”

“And against zoning,” added Will.

“Ramesh said he’d apply to get the zoning changed, and I bet he could arrange that,” said Paul. “The technology is so much better and cheaper, now.”

“Yes, it wouldn’t be hard to set up a prefab in the canyon, especially two years from now when the silane pipeline is installed,” agreed Will. “It’ll carry almost everything someone would need.”

“He does really good work,” said Ethel. “I rode the Uzboi Highway two weeks ago. The graveled, widened, and graded sections just can’t be compared to the original dirt trace.”

“And we wouldn’t have the technology without someone like him to put together and manage the team,” agreed Will.

Suddenly, he felt his communicator beep. He reached down and looked; it was an urgent message from Rostam Khan in Mars Control. He activated the video only, knowing the audio would go to his earpiece anyway. “Hi, Rostam, what’s up?”

“There’s an emergency on the *Tienan.* We’re doing some routine auditing of their systems, so we get some of their data. Apparently there’s been a small explosion on their second shuttle. Right after it happened, all data from the shuttle abruptly stopped.”

“Anyone on board?”

“Negative. It’s about two kilometers from the *Tienan* itself.”

“Okay, I’m on my way.” Will turned to the others. “If this is nothing, I’ll be back in a half hour or so.”

“What is it?” asked Ethel.

“I’ll tell you later.” Will rose and walked out of the room briskly. Once outside, he began to run to Andalus two domes away.

Getting into the control area took an extra minute; Rostam had engaged the emergency security. Mars Control was tense, but no one was doing anything. “Status?”

“No data from any of the vehicles.” Rostam shook his head. “They encrypted it; we still detect radio transmissions, but the transmission is now garbage.”

“I’ll call the General.” Will walked to a videophone on a desk in the corner of the room and commanded it to call General Zhou Qisheng for him. The General didn’t respond. “Where is the ship, anyway?” Will asked Rostam.

“Central Asteroid Belt,” replied Rostam. “A long way away if they have to abort.”

“Could we send an automated rescue vehicle?”

“Not in any reasonable time frame. They can probably get to Callisto faster than back to Mars.”

“Someone crunch the numbers.” Will looked back at the videophone, which suddenly showed a connection after twenty rings.

“Hello, Commissioner Elliott,” exclaimed General Zhou. He was formal, using Will’s last name rather than the Marsian custom of using the first. Will could see a darkened control room behind the General.

“General, can we help in any way? We manufactured the caravel and we have an entire team who is expert at shuttle repair.”

“The repair team may be of help to us. Right now we’re trying to determine exactly what happened.”

“Let us help. We know there was an explosion on board shuttle number two.”

“Yes. We have a little additional data. No one has been injured.”

“Any idea of the cause?”

“Hydrogen tank number one suffered a rupture; the pressure level has dropped and still is dropping. There is no rupture of any of the oxygen tanks, fortunately.”

“Micrometeoroid?”

“Or a bad weld.”

“Can you retransmit data from that shuttle to us? We can assist in its analysis. I’ve got fifteen people in here right now.”

There was a pause. “I have no authorization to do that.”

“It’ll take half an hour to get such authorization because Earth’s a long way away. Meanwhile, my people are discrete and have your best interests in mind. We have friends on that flight and we want it to succeed.”

“Very well, Mr. Commissioner. . . . I’ll take you at your word and I assume there will be no leaks to the media.”

“There will be no discussion with the media at all, I assure you, General.”

“We’ll transmit the data from the shuttle to you immediately, then. Thank you for your offer.”

“Let’s leave this line open, then.” Will turned to the others, who scrambled to consoles, logged in, and began to pull up the data screens for the shuttle, even though the data had not started to arrive.

“If tank one is ruptured, they’re going to lose half their hydrogen,” said Rostam.

“And they won’t want to lose the shuttle. Can the tank be repaired?”

“Unlikely; it’s a hard alloy to weld in space, and patches can’t handle the temperature changes.”

“Someone call Louise Tremblay. We need to get the shuttle repair team involved. The Chinese have two modified Hermes-class shuttles, if I recall.”

Rostam nodded. “From the telemetry, it doesn’t look very modified, too. I see two options for them: send the shuttle deeper into Jupiter’s gravitational field where the orbital injection burn will require less fuel, or lighten the caravel and dock the shuttle to it, so that the nuclear engines can slow the shuttle.”

“Both are pretty risky. If they can get it into any kind of orbit at all, they could probably refuel it; they’ve got two cargo shuttles on Callisto and they should be refueled by now.”

“Ah, here’s the data,” said Rostam. He turned to his console and began to parse out different systems to different people around the room.

Will called Louise Tremblay and got her to come up with several repair experts. By the time they had arrived, some details were clear. “The main tank has a leak,” said Rostam. “From the acceleration vectors we can determine approximately where the hole is, but that analysis is incomplete.”

“How big is the hole?” asked Louise.

“About a square centimeter.”

“Plenty to drain a tank in no time.”

“Could they fix it?” asked Will.

"It's not impossible, but it'd be very difficult in zero gee. Even on Callisto it'd be difficult."

"It has never been done before," added one of the repair experts.

"Let's see whether it can be done, then," said Will. "The Chinese can hear this conversation. We've got plenty of folks in orbit and on Phobos, and plenty of equipment. There are more Hermes shuttles here than anywhere else. I'll negotiate with them about setting up a test facility. They won't reach Callisto for close to a year, so there's plenty of time."

"Costs?" asked Louise.

"We'll figure that out later. It's a good investment, if we want Mars to become the premier spacecraft repair center."

Since the accident occurred on a Satursol afternoon, the residents of Mars turned to their televisions. Sales in the stores plummeted, but the cafes with television screens did well, and the Gallerie was crowded. By Sunsol evening, things were calming down

"So, if the rupture had happened on the *Giovanni Piazzi*, what would it have done?" asked Kristoff to the family over dinner.

"The worst case scenario would be a rupture of oxidizer and fuel tanks and an explosion," noted Sebastian. "Our estimates indicate that three or four of the six airtight compartments of a typical caravel could be ruptured."

"If that didn't kill the crew, they'd die in space because they wouldn't have the fuel to return," said Kristoff.

“Not necessarily,” replied Sebastian. “The delta-v from the central asteroid belt back to Mars is less than 2.4 kilometers per second, and we always tried to have 3 kilometers per second of delta-v on board. If the crew could even get close to Mars, a rescue flight could intercept them.”

Helmut looked at Charlie; he was worried his son would be disturbed by the conversation. “We had five oxidizer tanks and five fuel tanks, so we would have lost twenty percent of our fuel.”

“Maybe less,” said Sebastian. “Because all the tanks are partially empty after a firing. Some fuel could be pumped out of the ruptured tank before all of it escapes.”

“The Chinese didn’t have that option because they launched with slush hydrogen,” said Helmut. “The shuttle’s tanks were three quarters full when the rupture occurred.”

“And the jetting fuel displaced the liquid away from the pump intakes,” added Sebastian. “The tank drained pretty fast.”

“They could change the combustion ratio,” noted Kristoff.

“Yes,” agreed Sebastian. “That could help. The shuttle would have been burning oxygen and hydrogen at a six to one ratio, but eight to one is the stoichiometric requirement. The specific impulse is ten or twenty percent lower, but your fuel supply is increased by thirty percent.”

“And they’ll have spare hydrogen on the other shuttle and the caravel,” noted Kristoff.

Sebastian shook his head. “Zero gee transfer of hydrogen’s tricky; they may not have the special equipment.”

“Overall, the situation doesn’t sound too dire, then,” concluded Clara.

“It isn’t life threatening. But I wouldn’t want to arrive at Callisto orbit with only one functioning shuttle. If it breaks, crew could be stranded on the surface somewhere, and refueling the caravel could be imperiled. The reactor and its tank farm stay in orbit; refueling the tanks requires about four or five shuttle flights.”

“The bigger implications are financial and psychological,” said Helmut. “If the hole is caused by a bad weld—which is much more likely than a micrometeor—every shuttle flying in space will have to be reinspected, at a cost of billions.”

“Would they shut down the fleet?” asked Irma.

Sebastian shook his head. “No, the shuttles have flown so many hours, their safety record is well established. This is the sort of accident that costs a lot, causes a lot of worries, and generates criticism of spaceflight. Charles will have to battle to keep the mission back to Ceres funded, for example.”

14.

Earthflight

Nov. 2047

Will looked out the porthole at the dark gray, sandy-dusty regolith of Deimos under the hopper. The vehicle was still rising from the surface after a brief burst of its engines. The rounded mound of dirt covering the Chinese station appeared in the corner of the window, followed a minute later by the circular metal landing pads of their spaceport.

"We are very grateful you were able to visit, Commissioner Will," said General Zhou Qisheng, who was sitting next to him and looking out the porthole as well.

"I felt very honored to be invited to tour your facility." Will had been the first non-Chinese to enter their station, which was basically a caravel minus its propulsion system and heat shield, buried for radiation protection.

"There is really very little to show anyone; it was manufactured at Aurorae. The classified equipment arrives next year, and we still don't have the hanger in which it will be placed."

"I'll remind Alexandra of your need," said Will, repeating a promise of earlier the sol when Qisheng had noted that delivery of the hanger was behind schedule. The Chinese needed the large airtight structure to assemble their gaseous core nuclear engine. Later they'd get another structure where robots could work on radioactive equipment in a dust-free environment. "She has assured me your second caravel-hab is on schedule and will be here next June."

“Excellent. Ironically, though, we probably don’t need it as badly as we need the hanger. Our staff on Mars will increase to 100 next fall, and we’ll have thirty almost continually on Deimos.”

“Deimos is getting busy! The Americans will be increasing their staff here as well, and the Commission will increase its support staff commensurately. I’ll have to encourage Silvio’s or Deseret to open a branch here.”

“Really? They could do that? I think we would welcome a store up here!”

“You and everyone else. Whenever a place has more than about seventy people, a store becomes very helpful.”

“I’m surprised the Americans can increase their staff, with the danger of funding cuts.”

“We’ll see. Funding cuts are common. I think it’s absurd, personally; you can’t fly two billion redbacks of equipment and a team of people here, then abandon the operation.”

“Politics. In China we have it as well.” The General sighed. “This welding system Ms. Tremblay has developed appears to have promise.”

“Yes, I’m looking forward to seeing how well it works. Repairing tanks is very tricky. But it turns out your mission is fairly well equipped.”

“It’s a five year mission that could easily stretch to six or seven if there’s any trouble, and the caravel’s en route sixteen months each way. No one has done that before. We were careful.” He paused and watched Deimos roll by. “If this mission succeeds, we will probably release our entire cargo roster, the equipment designs, the staff allocations;

everything. Or almost everything. That sort of generosity pays off in goodwill, respect, and support."

"Not to mention the feedback you'll get, which can only improve the plan."

"Exactly. Let the Indians, Europeans, Americans, and Latins fly their own missions; they'll join the Jupiter Commission, and its headquarters will be in Beijing."

"Why not?" agreed Will. "I was pleased to see you had a Brazilian on the mission."

Deimos Central Outpost began to appear in the porthole as the hopper began to descend. At forty kilometers per hour, it didn't take long to travel four kilometers to the Commission's facility. Deimos wasn't a very large place; equator to pole was only six kilometers. Will pointed to a shuttle with a large fuel tank docked to its nose. "There's the test facility, ready for launch into orbit."

"Ah, yes. The six of us are anxious to get started."

"Fortunately you have eight or nine months to get the welding right."

"I doubt it'll take that long. The crew on the *Tienan* wants to get this problem fixed and get things back to normal."

"I don't blame them. Enlai told me everyone was confident they could fix it somehow and move on."

"I hope so. The shuttle will still be short on fuel. We'll have to send it all the way down to the edge of Jupiter's atmosphere to inject itself into Jovian orbit, then fly it past Ganymede and Callisto to circularize its orbit, then inject it into Callisto orbit close to the moon's surface. It is possible, but it'll require some very precise flying."

"Nothing the crew can't do."

“Oh, quite right! They’re very capable. Have you started checking the welds on your shuttles?”

“No, we’re awaiting more data from the *Tienan*. This could be a freak accident.”

“You’re right. The shuttles have gotten so good, freak accidents cause many of the anomalies. So, you’re on your way to Earth in three sols?”

Will nodded. “With Ethel and Liz. It’s mostly a vacation because this will be the last trip back for Ethel and me. But I’ll spend four days in Washington and three days in Beijing, and of course I’ll visit a few other places as well.”

“You’ll have to deal with independence.”

“That’s the big issue, isn’t it? And they don’t understand.”

“No, they don’t. I’ve been trying to explain the environment and culture up here. I may have made some progress.”

“Well, I’m very appreciative of that. Please continue. There won’t be a violent revolution, obviously, but if the Marsian public called for a declaration of independence, the Commonwealth Authority would have to do it, and what could anyone do? Cutting off government subsidies won’t do any good.”

“Not as long as Mars produces so much platinum-group metals and their market value says up. I doubt anyone will advocate a blockade, either. Of course, right now independence is just a minor issue.”

Will nodded. “And with home rule, Mars effectively has independence, except for an official flag, passports, and an ambassador to the U.N. But independence will become an important domestic political issue; that’s guaranteed.”

“Yes, it’s inevitable.”

"Rather than worrying about these matters, Qisheng, I suggest that after I get back from Earth, that you and your wife come visit Ethel and me for the weekend. They can chat and shop, and you and I can cook. I want to learn how to make that chicken and rice dish you made for us, last time I was in Dawes."

Qisheng smiled. "Yes, and I was curious about the Persian rice dish you made with green beans, tomatoes, and chicken! Such a different kind of rice!"

"The secret's in the soaking. Let's definitely plan a weekend of cooking. The older I get, the more important cooking gets, and the less important politics seems!"

The rest of the sol was devoted to a joint meeting of the Chinese and Marsian shuttle repair teams and briefings about ways to repair the hole in the *Tienan's* shuttle. The next sol, when the teams began their rehearsals, Will took a hopper to the American nuclear facility on the northern side of Deimos for a tour of it with Brian Stark. They had a much more advanced facility to show him, and trusted him to see classified equipment.

The next sol, a shuttle departed Deimos for Embarcadero with Will and Brian. Columbus 14M was assembled at their interplanetary transit facility and nearly ready to depart. It was an extremely impressive sight. Embarcadero had grown over the years and now consisted of a two-hundred-five meter tube of inflatable cylinders, each of which was ten meters in diameter and twenty meters long. Providing backbone to the tube were two steel truss works that ran the length of the station. Connecting each cylinder to its neighbor was a metal docking unit, also ten meters in diameter but five meters wide, sporting four docking adaptors. Embarcadero had nine docking rings to which shuttles, caravels, power units, labs, or other cylinders could be attached, giving it a lot of

flexibility. The eight cylinders were laid out as zero-gravity housing, office space, storage, or recreation space, with one entire cylinder serving as a zero-gee gymnasium. Embarcadero had enough interior space to accommodate a crew of seventy, though it rarely had more than a dozen and occasionally was unstaffed. It was set up to accommodate the entire 125 to 150-person complement of a passenger caravel in an emergency.

The shuttle docked at one end, and Will's first problem was determining which of the five caravels docked to the station was the *Courageous*, on which he and his family were flying to Earth. He and Brian floated down the main corridor and stopped at the first caravel; it was the *Xi*, named for the fourteenth letter of the Greek alphabet because it was the fourteenth caravel they were working on. It was heading for Earth to become NASA's first caravel. It had limited life support equipment inside; on the flight to Earth some of the crew would be working on it, and it would be finished by NASA in earth orbit.

Sixty meters farther down they came to a pair of caravels, but they proved to be the *Prospect*, the Mars Commission's new passenger caravel, and the *Rho*, a mostly complete vehicle that would be finished during the hundred-sol trip and turned over to the Venus-Mercury Commission for use in flights to Venus. Finally, at the far end, they reached the *Intrepid* and the *Courageous*, the other two caravels heading for Earth; even then they guessed wrong and entered the wrong vehicle at first. It took Will an additional few minutes to find his quarters on the first or outermost level, where the centrifugal gravity was slightly less than Mars normal.

“You found us!” exclaimed Ethel, rising from her chair as he opened the door. “Your shuttle docked almost an hour ago. I was almost ready to send out a search party!”

“No, don’t do that, you might miss me in this labyrinth.” He put down his bag and gave her a kiss, then kissed Liz, who also stood up to hug her father.

“It’s not that bad, dad, once you explore a bit.”

“Oh, I’m sure. So, both of you are comfortable? How’s your room, Liz?”

“Fine; I’m next door. And dad, I found an empty passenger quarters on the second floor. The gravity up there is about the same as on the moon. So I emailed the commander to find out whether I could use it as a dance studio on the flight, and he said yes!”

“That’ll throw off your reflexes, though.”

“I’m planning to practice in my room as well. Dad, if I can get ready for lunar gravity, could I accompany you to Shackleton? I’d love to dance there. They have quite a dance program and I’d like to meet their people.”

“Well, you just spent about two million redbacks, you know! Why don’t you email Madhu and see whether she can arrange it. If you practice a lot, maybe by the time we arrive you’ll be able to do it.”

“So I could accompany you to the moon, then?”

“Sure. The financing actually may not be too difficult because you already have a ticket from high Earth orbit to Earth and back. Getting to Gateway is free. It’s the flight from there to the moon and back that’s tricky.”

“Thanks!”

Will turned to Ethel. “How was your flight up?”

She shrugged. “Routine. It was a mixture of exhilaration and fright for Liz, as first flights tend to be.”

“Wait till you’re launched from Earth,” said Will.

Liz rolled her eyes. “It really isn’t bad.”

“I’m amazed how many people are up here,” continued Ethel. “One hundred twenty-eight people are going back to Earth, and a lot of them are young.”

“Twenty are coming back on the return flight,” replied Will. “One hundred eight departures out of 800 who arrived two years ago is about average. Some are veteran astronauts who plan to serve on Mars, the moon, Mercury, and Venus during their careers.”

“Yes, I know some of them, but there are still a lot of younger ones. It’s a shame we’re losing them.”

A lot of them have been here almost four years,” added Will. “And we’re getting work out of all of them on the return flight, especially to complete the *Xi* and *Rho.”*

“One advantage of having so many people on board the five ships; there will be fewer duties for us to do,” noted Ethel. “I know you have a lot of plans, Will, but let’s have some quiet time together.”

“Okay, but I have a lot of meetings. Besides the geology courses Roger and I are coordinating, there’s all the planning for the time on Earth. I also have some ideas for restructuring the Commission and privatizing some operations—”

“I have planning to do, too; I’m meeting with investors in Mars Metals, with the Board, and I have some lectures. But you know what I mean, Will Elliott! It’s time to

slow down life a bit. We don't have an infinite number of sols left ahead of us! Let's be sure to savor life as well."

"Savor life; what a concept."

Ethel scowled at his mild sarcasm. "My Presbyterian grandmother would not be amused. Come on, promise."

He nodded. "Alright, I promise. Let's savor life on this flight." He leaned over and kissed her.

Sept. 16, 2045: Vernal Equinox

Nov. 1, 2046: Autumnal Equinox
Dec. 21, 2046: Dust Storm Season Begins
Sept 2, 2047: Vernal Equinox

EM 17 April 2046
EM 3 June 2048

Helmut becomes in charge of the continuation of Ceres exploration
He wants to return to Ceres, but the money isn't there yet (will depart in 2051). Clara wants to stay on Mars and have another baby and let it grow a bit first. They argue about that a bit.
Sebastian plans to retire in 2047 when he's 70
First wave: 300 arrivals, 3 April 2046
Will reappointed to third and last five-year term, 15 May 2046 (age 60)
After appointment, he meets with Érico and trusted others about transfer of as much to Authority as possible over five years
Early Sept. 2046: Corrie returns to Aurorae
Olberg launched to Vesta, 15 June 2046; Piazzi prepared for a mission to Pallas (out of ecliptic).
Chinese arrive from Earth, 25 Aug. 2046
Second wave: 450 arrivals, 1 Sept. 2046
New Hanford 50 mw goes on line, Dec. 2046; Chinese 50 mw is started
Helmut and Clara's baby born Jan. 2046
First gas-core test on Deimos (US) 28 February 2047
Chinese mission to Metis becomes one to Callisto, 3 March 2047
Sebastian retires June 2047
Vernal Equinox, Sept 2, 2047
C14E departs Earth, 23 November 2047
C14M departs Mars, 8 December 2047
C14M reaches Earth, 18 March 2048
C14E reaches Mars, 8 March 2048
C14E departs Mars, 15 April 2048
C14M departs Earth, 28 April 2048
Opposition, 3 June 2048
C14E returns to Earth, 1 August 2048
C14M returns to Mars, 28 October 2048

How big are the various outposts?
Mormons?
Shiites?
Sunni Wahhabis?
Green World Community?

Nigerians?
Zen monastery and Japanese community around it?
What does Father Greg do? John Hunter? Madhu and Roger?
Project to Jupiter?
New Hanford developments? Negotiate a big power reactor?
Plans to test megareactors (50 mw)?
Developments with Embarcadero?
Preparations for Vesta mission? *Heinrich Olbers* is launched in late 43 after Astrea is finished
Mercury growth?
What happens on the moon?
Plots, Volume 13:

Columbus 13B: leaves Mars for Earth: Nov. 15, 2046
Columbus 13A leaves Earth: Dec. 20, 2045
Columbus 13B leaves Earth for Mars: 1 Mar 2046
Columbus 13A arrives Mars: 3 April 2046
Earth-Mars Opposition: 17 April 2046
Columbus 13A leaves Mars for Earth: 3 May 2046
15 May 2046: Will Elliott given third five-year term
Columbus 13B reaches Mars 1 Sept. 2046 (and Chinese ship, with extra Chinese on board). Will threatened by the Board of Trustees if they fuel the Chinese ship
Columbus 13A reaches Earth: 18 Aug. 2046
3 Mar 2047: Chinese leave Mars for Jupiter

Started 15 December 2004; finished Feb. 14, 2005