MARINERS

Vol. 4

Changing Conditions

Contents

1.

National Interests

Early March 2078

"I'm surprised you invited me to meet with you so soon," said Helmut Langlais, as he entered the office of Chief Minister Jacqueline Collins.

"You've been back a few sols, right? Aerobraking was last Monsol." Jacquie extended her hand to Helmut and they shook. They eyed each other a moment; he was 55, she 45.

"Yes, aerobraking was Monsol, but we were on Phobos three sols. We landed here at Aurorae yestersol morning."

"Yestersol! I'm so sorry, I had no idea. Come sit with me." Jacquie pointed to two comfortable chairs. They sat. "But how's Oskar? He's in the hospital, right?"

"Yes, we got him there right away. The landing was pretty rough; they kept the gee force down to 1 gee, but that was almost too much for him. He's resting and starts the special genetic-based chemotherapy morrowsol. The doctors are pretty optimistic."

"Oh, that's good; leukemia?"

Helmut nodded grimly. "And it has resisted everything we threw at it, on Ceres."

"I'm so sorry to have made the appointment so soon, then! You must have barely had time to see your father and brother, let alone get settled in your new place and get Oskar settled in Mariner Hospital. I wish you had said something."

"No, that's alright. I spent the morning with everyone and dad's resting now. He's 85 years old; the oldest resident on Mars! We're all going to see Oskar later this afternoon because the doctors are evaluating him now. So I have some time."

"That's good. I was going to offer you some Marabica; I understand you don't have any on Ceres. But then I had another idea, if you have an hour or so."

"Yes, sure."

"Alright, good." Jacquie rose. "I want to show you Australia."

"The enclosure? I thought it was closed?"

"It is and isn't. Come on. Miki, can you call for a private car for us?"

"Done," replied her automated assistant.

Jacquie led them to the door, down the hall, down the stairs, and into Andalus Enclosure. "I'm not sure we've ever met before," said Helmut. "When did you arrive on Mars?"

"2065; a year before you left for Ceres the second time. I think I saw you once or twice because I knew who you were, but we never met. I was here briefly, then moved to Dawes to help with outpost administration."

"That explains it. It's hard to believe how much this place has changed. I've followed the details, of course, but it's different to actually see the place. Andalus was pretty new; the last enclosure was Liberty, and it was still bare. Now I walk through the enclosures and barely recognize them! I still have a clear image of Catalina and Yalta in my mind from when I first arrived here, and I can't get those images out of my mind when I walk through them. The trees all grew up, and half have been cut down, but I still see it the way it was!"

"It's like a time machine."

"Yes, sort of."

They descended a stair marked "Transpo" to the public transportation system and found their private car--it resembled a golf cart--waiting in the station. They climbed in and it took off

to the east, down the one-way transportation tunnel. At one point it narrowed and Helmut smiled. "I remember, when I arrived here in 2048—I was 26 and fresh out of grad school—the Conestoga brought us to Joseph Hall and who should insist on giving me a tour of the outpost than an eight year old named Marshall Elliott! We walked through this tunnel."

Jacquie laughed. "Marshall! That was a long time ago."

"It sure was," said Helmut. Jacquie nodded, a bit irritated that Helmut had, in effect, emphasized his seniority.

The tunnel bent to the left and then continued east past another station. She pointed. "Martech 1; it's so large, it now has two stations. It employs three thousand people and has 150,000 square meters of pressurized space. Huge."

"Impressive."

"More than that; hard to manage, and it's losing its edge. The hundred original employees are now in high positions and no longer push new research. The young arrivals want to do new stuff and often are frustrated."

"It must be hard to keep focus. When you have just a few hundred employees, you can give them three or four big projects and everything else has to fit into those priorities. But with 3,000 employees, it's easy for the research to become diffuse."

"Exactly. We're doing everything from artificial intelligence to fusion propulsion to photonics. It's mostly cutting edge research; we get a lot of awards and lots of patents. But a lot of the patents have nothing to do with Mars."

"But is that so bad?"

"Yes and no. We need to focus our resources on developing Mars and expanding into the solar system. More and more of the research does not support those goals."

"I see," said Helmut, pondering.

The car slowed and pulled into a station marked "Australia." The tunnel continued eastward, but was dark and closed to further traffic. They got out. The car turned off and headed for the westbound tunnel.

Jacquie led Helmut up a spiral ramp to the exit, which was closed; but as she approached they heard a click and the door opened, so they passed through. A moment later they entered Australia.

Helmut was startled. "Wow!" He turned to the right and looked to the end, three hundred meters away; then turned to the left and squinted at the dust being kicked up by a regolith processor.

"How big—"

"Twelve hundred meters long," replied Jacquie. "And 750 meters wide. This enclosure has 90 hectares of polder; nine tenths of a square kilometer."

"This is amazing! How high is the top?"

"Three hundred meters; a thousand feet of air overhead. That's 120 kilograms of air above every square meter, which is not bad radiation shielding."

"Not enough, but comforting."

"Exactly. The dome has sterile water bags 20 centimeters thick built into it that add another 200 kilos per square meter of radiation protection; that's getting pretty good for walks outdoors. The water can serve as a radiator to eliminate extra solar heating; the air temperature

against the dome can be as high as 40 Celsius during the day. It's tied into the fire suppression system, too." She pointed at the ground. "Work started two years ago when we covered the ground with black plastic and began to pump in Martian air so that it would flow down into the ground and warm it. The pile drivers and cables and dome segments followed. We started to oxygenate the air three months ago." She pointed at the machine. "That regolith processor is a 100-tonne, two hundred million redback, 5,000 kilowatt robot. We have two of them. It excavates down five meters, magnetically separates out the nickel-iron—which we currently throw away because we don't need it—sorts and washes everything to remove the salt, lays down a plastic sheet, then places the rocks, gravel, pebbles, sand, and finally the dust fraction on top. It installs pipes every twenty meters or so, allowing us to inject warm air or water to heat the under layer and add water, freezing an airtight ice table in place underneath all the vegetation. This enclosure will consume 250,000 tonnes of water to form an airtight seal underneath. You should see the robotic pile drivers that force nickel-steel pylons twenty-five meters into the ground, and the robotic cable layers, and the robotic dome installers . . . we now have three billion redbacks of equipment to make these enclosures, which require a crew of less than 100 to construct. It's actually a problem because it means Aurorae can expand cheaply. These machines are too big to haul to other outposts easily."

"I can imagine. Nine hundred thousand square meters; this can accommodate 4,500 people?"

"More, because there's buried housing outside the western edge." She turned to face south. "This whole area will be a new commercial center to replace Andalus and will open in two years. Immediately to the north of us will be our fair grounds—"

"Fair grounds?"

"Yes. This one hundred fifty meter long excavation is for the foundations and the emergency evacuation shelter for the grand stand. On the other side will be a soccer field; our soccer stadium is old and too small, so that dome will be converted to housing. The soccer field will also be used for concerts and nighttime theater. We'll move the town meetings and ethnic festivals here as well; it'll have much more space than Andalus and with the emergency shelter, it'll be safer for large events. The remaining northern three fourths of the enclosure will be agricultural, with 'suburban' housing along the eastern and western edges."

"Suburban?" Helmut laughed.

Jacquie nodded. "Buried houses with ample skylights along the sides and a lawn on the ceiling. There will be a narrow forest belt, then farmland."

"So . . . why are you showing all of this to me?"

"Because Mars has grown immensely, and Mars needs your talents now. We're becoming very sophisticated; the current wave of immigration will raise our population to 36,000. Aurorae will grow to 21,000 people. We can make anything we want or need, though we're importing twenty thousand tonnes of equipment over the next two years because we have the money and we need the equipment sooner than we can make them. Everything is robotic; we have the equivalent of a hundred thousand workers here. I don't think our capacity could have been imagined a decade or two ago. Our GDP has doubled in three years."

"It really is amazing. All the forces that are throwing a billion people out of work on Earth and causing terrible social disruption are moving us forward fast."

"We're surfing on the wave that may crash down on terrestrial society. The increase in GDP is all domestic, too, not from exports. It's causing an architectural problem; our houses don't have big enough closets to hold all the clothes people are buying. Mars has become one of the most materially prosperous societies in human history. And we need someone who understands that, and understands the vision that will move Mars forward. Someone to head Martech, because Vanessa's retiring from the position of Chancellor. She wants some time to do more research before she completely retires at age 70, 6 years from now."

"I see." Helmut looked northward along the long axis of Australia, then up at the sky, blue-tinted because of the dome. "That's not what I want, Jacquie. I thought we were here to talk about the Institute for Space Settlement."

"It's an excellent idea, Helmut, and needs to be done. It needs to be a priority, in fact. But Mars needs you to run Martech."

Helmut paused to think a moment, then shook his head. "Jacquie, I've never been in charge of anything with more than 350 people. You're talking about an institution ten times as large. I'm good with vision, with creativity, but I'm not a bean counter."

"We can hire bean counters."

"Not completely. You always end up dealing with a lot of details yourself. The Institute is what I want to do. It's a whole new creative phase of my life."

"And less stressful." Jacquie sounded disappointed. "I think an Institute for Space Settlement is the sort of institution Martech needs to coordinate and focus its efforts."

"Perhaps that's true."

"Then perhaps there's a synergy between your goals and mine, Helmut."

"How so?"

"A Chancellor to serve as bean counter and organizer, and a Director of an Institute for Space Settlement to provide overall direction and vision."

"How would that work? One person needs to handle both tasks. It's the only practical way to do it."

"Perhaps; perhaps not. Let me think about this more. Are you open to further discussion?"

"Sure, if we have an Institute for Space Settlement."

"You sure do. Let's think about this more and talk in another sol or two."

Helmut nodded. "Alright."

They turned and walked back to the transpo station. A westbound car was waiting for them, so they got in and it robotically zipped them to Andalus. From there, Helmut walked to his brother's flat in nearby Cathay Enclosure, where everyone was gathered. Even his father had returned from his nap, walking slowly with a cane to maintain his balance.

"So, what did she say?" Sebastian asked his son.

"We didn't talk about the Institute for Space Settlement, other than for her to say yes, we'll have it." He paused. "She wants to nominate me as Chancellor of Martech. Vanessa's planning to retire."

"She is?" said Sirikit, startled.

Helmut looked at his daughter in law, who tended to know all the public information and a surprising amount of private information as well. "I guess it's still confidential. I said no, I want to run the Institute."

"You said no?" exclaimed Sebastian. "That's an incredible opportunity, Helmut! Martech: It has emerged as a leading university, with incredible cutting edge research and more patents per employee than just about any school anywhere! It's got 3,000 employees and half are faculty, but less than a thousand students, and almost all of them are graduate students! It's an amazing place!"

"Easy to get lost in all the tunnels, too," added Kristoff. "It's a labyrinth."

"I'm sure the administration is a labyrinth as well," replied Helmut. "Look, I want to focus on research right now. And I don't mean geology; I haven't done any geology in so long, I'd practically have to go back to grad school to catch up. I've been in administration for twelve years. I have a lot of practical experience about planning and organization of settlements and I want to see our approach to settling the solar system systematized more. We're just starting to plan the Neptune settlement, so this is a good time."

"Are you interested in going to Neptune?" asked Sebastian, frowning.

"God, no! I want to stay here now. I wouldn't mind making a trip back to Earth some time, or going to Phobos or Deimos for a while, but we're here for Oskar now, and that's at least another five years. Right now, five years is my planning horizon." He turned to Charlie and Sirikit. "How's your new place?"

"Pretty good," said Charlie. "It's a pain being all the way out in Caspian; it's a long walk to get over here! And I'm still not used to the Transpo."

"It's *really* convenient," added Sirikit. "It comes whenever you need it and is fast."

"But the place is so big; a bedroom, two offices, living room, separate kitchen . . . I guess everyone is trying to get bigger places, now."

"Jacquie was telling me about the material prosperity," agreed Helmut. "Robotization has worked miracles, in terms of abundance and price."

"I spent an hour walking through Deseret and Silvio's and couldn't believe the choices," said Sirikit. "There's only one of everything, because if it sells, they order a replacement and have it a sol or two later! We've ordered just about all the furniture we need and it arrives morrowsol."

"We've used up just about all of our flight pay, though," said Charlie.

"But you have enough, right?" asked Sebastian. "Because I owned a quarter of the land they built Australia on and they paid me a pretty good price to buy it."

"Don't worry, we've got good stipends as grad students at Martech," replied Sirikit.

"When are you meeting with Dr. Park?" asked Irma, Kristoff's wife.

"Monsol. We're in touch by email almost daily anyway, so we don't need much of a formal meeting. We're having lunch. He wants to set my written and oral exams for December."

"Nine months," said Sebastian. "You can be ready. What about you, Charlie?"

"I'll talk to Jean-Paul next week, but I'll propose the same. I'm almost ready to write the dissertation, so I should get the exams out of the way! I could be finished by next June."

"I'll need a year, after December," said Sirikit. "There are plenty of theoretical issues to write about, where the economics of the Callisto settlement is concerned."

Just then the doorbell sounded and the house computer said, "Lunch has arrived." So they all rose from the living room's comfortable chairs and walked to the dining alcove, where the household robot had set the table for them. They sat and the food was placed on the table for them, so they dished it out. "The vote's morrowsol," Sebastian reminded them.

"We're so lucky to be back in time to vote," said Helmut. "I gather the polls are pretty clear."

"Eighty-five percent in favor," said Sirikit. "Everyone wants Marsian citizens who go off world to return some time and feel a part of the place, so of course they're in favor of giving them non-voting representation in the Mars Council, and a vote in the selection of the Chief Minister."

"This is causing a lot of unease with terrestrial nations, though," said Sebastian. "Not just the Chinese. I hear the plans to recruit a flight of settlers to Callisto from the U.S. and Europe has run into a problem: the settlers want to go to Mars first and depart from there, so they can receive citizenship!"

"I've heard the same concern about a flight to Ceres, which is ironic, because Ceres is a borough and therefore a resident automatically is a Marsian citizen," said Helmut.

"There's an easy solution," said Sirikit. "Let all mariners apply for Marsian citizenship from their outpost."

"But that would anger the Chinese even more," said Sebastian. "How much do Chinese Callistans understand about Mars, Sirikit?"

"They understand pretty well. The governing system is the same, so they know how our government works. There are fifty Marsian citizens of Chinese background there, too, so they explain it. All mariners read *Mars This Sol,* so they're familiar with the developments here."

"I see," said Sebastian.

"Look, it's just about time to go visit Oskar," noted Clara. "The chemo treatment should be finished now. I wish we wouldn't talk shop while we're together too. We're supposed to be having two weeks' vacation so we can 're-bond' as a family, remember."

"Yeah, I even scheduled my corn crops so I wouldn't have any work to do now," added Kristoff.

"Alright," said Helmut. "But you have to admit, it's hard for us to 're-bond' and *not* talk about Mars. This place is in our blood. Dad was commander of Columbus 2, I was executive of Ceres . . . it's not like Mars is a minor concern for us!"

"That's true," agreed Irma. "I guess I'm just a farmer's wife and a nurse, but this place is pretty important to me, too."

"Anyway, let's go see Oskar," said Clara.

They all went to see Oskar. He was not well at all, so the visit had to be brief and the doctors encouraged them not to come together, as it was too much excitement for him. Clara stayed with her son all afternoon, but the others left after a short while and divided up the next day so that everyone wouldn't be there at once, but someone would be with him most of the time.

Sirikit went to see her brother in law the next morning after all, just before lunch. "Are you feeling any better this sol?" she asked, as she stepped.

He shook his head. Oskar looked limp and exhausted; the leukemia had spread quite seriously and had debilitated him severely. "The doctors are optimistic, though," said Sirikit. "The genetic tailoring seems to be working."

"I hope so, because I feel like death warmed over." He paused. "I'm so tired of being too small for my age, too young looking for my age, too . . . babyish for my age. It's . . . just not worth it. What do you Bahá'ís believe about the afterlife, Siri?"

"The afterlife." She hesitated to respond; she didn't want to encourage the subject. "We believe that this life bears the same relationship to the next as the womb world bears to this world. In the womb, you grow arms and legs and eyes and ears; things you don't need in the womb. But you need them here. Similarly, in this world we grow our spiritual eyes and limbs for the next world; our ability to love, to be compassionate, to be fair, to serve others, to be trustworthy, to be honest, to be generous, to be wise. This world is the spiritual womb for the next world. This is something all of us accomplish here to one extent or another, and the more we achieve it here, the more this world is a heaven for us, and the more the next world will be a heaven for us as well. If we fail to develop these capacities, this world and the next are hellish instead."

"But how fair is it for someone to be confined to bed? How can they develop these capacities, stuck in a diseased body and trapped in a hospital room?"

"Well, you interact with other people here, so you can develop those qualities. You have been very cooperative with your doctors and nurses, from what I've seen; that's a good sign of love and compassion, Oskar. You are a really marvelous human being, and I am sure you will have a long life during which you can develop these capacities much further."

"And if I die young?"

"There are mysteries in our life expectancy, but there are also spiritual mercies and compensations. God is graceful and compassionate to us. I count on that every sol!"

"God." He contemplated the word. "I don't know whether I believe in a God."

"Some people do and some don't. This is all part of our personal development, too."

"But will non-Bahá'ís be punished for rejecting Bahá'u'lláh and God?"

"All of us will suffer from failing to develop our capacities to their utmost, and some non-Bahá'ís will do a much better job at that than some Bahá'ís. As for acceptance of the Manifestation of God, yes, that's important and God takes that into consideration, too, but none of us can say how He will weigh it."

"I see." Oskar looked up at the ceiling, either thinking about her reply or resting from the exertion of talking. "So, the voting is this sol," he finally said, changing the subject.

"Yes, it is. I stopped in the Martech cafeteria to get a latte and everyone was talking about it."

"What are they saying?"

"That it'll pass, and then everyone wonders what the Chinese will do, because they are by far the most opposed. The Americans and Europeans aren't too happy, but they respect democratic principles, and Chief Minister Jacquie has worked hard to minimize the damage."

"So, it'll pass . . . good. Any talk about dad being appointed to head a Center for Space Settlement?"

"No, the news will be released morrowsol or the next sol. Don't worry about these details, just get well!"

"No, I have to take my mind off being here! I'd rather see my friends and even try to do a little homework! I want a normal life!"

"I can understand that. You need some patience; it'll come." She smiled. "That's another of those spiritual capacities we need to develop in this world. I forgot to include it on my list!"

He smiled wanly. "I guess I'll try to work on that one, then."

"To what do I owe this reversal of protocol?" asked Ambassador Zhao Tao, as Chief Minister Jacquie Collins appeared in the doorway of his office.

"It's a gesture of reconciliation," Jacquie replied, stepping into his office. "The people of Mars have spoken pretty decisively and I wanted to assure you that there are no bad feelings."

"They have indeed. Come sit down, Chief Minister Jacquie, and share some refreshments with me." He pointed to his meeting table, which had a huge tray of pastries and a pot of hot tea. "This is a gesture to show that Chinese hospitality is equal to Marsian hospitality. No bad feelings."

"Thank you." She sat at the table. He sat opposite her and pointed at the tray of goodies, which no doubt had been ordered from Aurorae's best bakery fresh just an hour ago. She selected a little chocolate cup of berries with gelatin and whipped cream while he poured her a cup of tea.

"So; eighty-eight percent yes, twelve percent no. Only fifty-eight percent voted, but that's still more than half voting yes. No one will argue that those who didn't vote were opposed; they just didn't care enough to vote at all. Teaching Chinese at Martech, I know how the students there feel; they made it very clear to me. In my report to Beijing I explained that the Marsian public is pretty unified in favor of extending the legislative vote to all citizens, regardless of their residence. I suppose that means even the thousand or so who have returned to the Earth will have a vote."

"Correct; the Earth will constitute a single legislative district. Venus and Mercury, together, will be another. Jupiter, Saturn, and Uranus will have their own single districts as well. We're still not sure where to put the forty-five Marsians of Themis. The legislature has to finalize district borders."

"It's a big development, and China cannot oppose it." He paused. "We will accept the decision of the Marsian people and will not retaliate in any way; that will do us no good. We will cease the plans to move our nuclear engine work from Deimos to Callisto because our scientists and their families are opposed. Many of them have Marsian citizenship as well and we don't want to lose them. We're losing enough young people to your immigration policies."

"China produces some truly excellent graduates in science, technology, engineering, and math. One sixth of the current immigration wave is Chinese. But everyone is complaining to us that we're draining off some of their best young brains. People want to move here. It's a young, dynamic society with no crime or poverty and a stable, transparent governing system."

"With no military budget, a small health care and pension burden, and generous educational expenditures. Mars is riding quite a demographic wave."

"And the artificial intelligence wave. That's growing our economy faster than anything else," added Jacquie.

"Quite true." The ambassador paused to sip his tea and take a bite of his sweet. "But China, nevertheless, intends to pursue its own independent path in space exploration. We have our automation and artificial intelligence as well. The technology of caravels, galleons, and corvets is mostly public and the patents have expired. We're in the forefront of industrialization in low Earth orbit and the developments on the moon are staggering. We feel no need to create

international administrative monopolies anywhere in space: the jovian system, the Saturn system, anywhere. Keep that in mind. If we want to plant a settlement on Enceladus that can cooperate with Titan, why not? Why should the Titan settlement claim the entire Saturn system as its own?'

"This is a question for the Mariner League to work out," responded Jacquie, trying to keep disappointment from her voice.

"Exactly. And there's nothing that says every settlement in space needs to join the League. It doesn't embrace the national outposts on the moon, for example."

"It doesn't, but they don't have permanent residents."

"But with the rotating habitations they're now building, it's a matter of time," replied Zhao. "The moon will have its own population—its populations—very soon."

"I suspect you're right. We seem to be on the verge of a new space revolution. So; China no longer plans to cooperate with us?"

"On the contrary, we will cooperate where it benefits our national interest, and we will do our own thing when that benefits our national interest. We now have the resources to do many things on our own, and we will do so. Your banks will no longer have a problem with payments through our banking system. We have no plans to pressure you in crude ways like that. China and Mars have had a long history of good relations and we want to preserve that. But the sols when you could nearly automatically expect Chinese participation in a Marsian project have passed."

Jacquie nodded. "I think I understand your policy, then: call it cooperative competition."

"Or competitive cooperation. We'll see which pertains in practice."

"Alright." Jacquie downed the last sip of her tea. "I'm glad we had a chance to talk, Mr. Ambassador Zhao. I hope we have regular opportunities to explore our new relationship."

Zhao nodded. “I think that’s a good idea, Chief Minister Jacquie. Next time, you treat.”

“I’m so glad you could come see me,” said Chancellor Vanessa Smith, rising from behind her desk to greet Helmut. “How’s Oskar doing?”

“He’s a bit better, perhaps. It’s hard to tell, yet.”

“That must be very difficult.” Vanessa extended her hand; they shook. “In spite of the circumstances, welcome back to Mars.”

“Thank you.” Vanessa pointed to a seat; they sat opposite each other in two nice, comfortable chairs. “So, have you had a lot of media contacting you, since the announcement?”

“It hasn’t been too busy, but it’s been only two sols, and the announcement was barely noticed at first because it was made the sol after the vote. I’m just beginning to get emails from the terrestrial media.”

“They can take a few sols, and they’re still digesting the title ‘Institute for Space Settlement.’ We haven’t said much about what it’ll do, yet. And I think that you and I both want it to be central to the work of this institution.”

“Absolutely. Jacquie expressed a concern that Martech lacks a coherent focus. While I think it’s hard to expect a university to have a coherent focus—the word ‘university’ basically means it should teach anything and everything, and it’s hard to focus an institution like that—nevertheless, Mars’s ‘university’ does need to explore and help express the purpose of Mars. I think this Institute can serve as the source of Martech’s vision.”

“Well put. The vision I have tried to give Martech is that of a world-class educational and research institution, one with Nobel Laureates, the source of thousands of patents and scientific

breakthroughs, a center of the most sophisticated thinking in human civilization. I've been chancellor fifteen years and it's grown nearly tenfold. I think I've succeeded pretty well. We're lucky in that many, many qualified scientists and scholars want to move here."

"Yes, Mars has a legendary quality. I agree that you have done a great job, Vanessa. The expansion of Martech to Phobos, Ceres, Titan, Callisto, Urania, and Mercury has been a very important development in the last few years, too."

"We're the original mariners!"

Helmut chuckled. "Exactly."

"So the best way for the Institute to provide Martech its vision is for the Director to be Chancellor. There's no way around it; two people can't easily have one vision."

Helmut nodded. "I know, and I understand that point. I've been thinking a lot about it, in fact. As I said to Jacquie, my concern is that one can't be an active Director of the Institute if one is buried in all the details of administration."

"Helmut, that's what Vice Presidents are for. I have some pretty good ones, but I'm also pretty hands-on. My suggestion is that you appoint a Vice President for Operations who will handle the administrative details, or as many of them as you want. And I have an idea who to hire: our Chief Financial Officer. She's very good, detail oriented, and needs a promotion. She would do an excellent job."

Helmut considered the idea a moment. "That might work. On Ceres I had six departmental directors reporting to me, and that worked pretty well. I had some hands-on responsibility and I regard it as inevitable and an important part of one's responsibility, but I had

time to focus creatively on direction. That's what I want and need, if I'm going to be chancellor."

"I think that's possible. Let's talk to Jacquie again, and let's talk to Andrea. I think we can make it work for you."

Helmut nodded. "Alright, let's give it a try."

2.

“Coopetition”

Late March 2078

He appeared to be about the same height and age as Helmut: 55. He was also of European extraction, though he spoke with an American accent—Helmut had an accent that sounded a bit German and a bit Marsian—and had graying brown hair. The name, however, intrigued and puzzled Helmut: Zeke Swift. It was as if the famous space vehicle entrepreneur had arisen from the grave, unchanged from when he died in an automobile accident forty-four years earlier.

“I’m pleased to meet you, Mr. Swift,” said Helmut, who stood at the door of his new office to greet the visitor. “I apologize if I look surprised to meet you. I presume you are a grandson of the other Zeke Swift?”

“Correct.” They shook hands, then sat in chairs opposite each other. “I’m Zeke Swift II. My father, Asaph, was his son; Zeke was my grandfather. But he died when I was eleven.”

“He died when I was eleven, too. I remember the day very well. My father was very, very sad and worried. He had applied for Columbus 1 and had not been selected, but was very likely to be selected for Columbus 2. He was sure the bureaucrats would take over, push the price way up, and the entire project would collapse.”

“Your father—was he Sebastian Langlais? I had no idea. I’ll have to look him up some time, after I return to Earth.”

“You won’t find him there; he’s here in Aurorae now. The oldest man on Mars; he’s almost 85. He was born in 1992.”

"The last century. Maybe I can meet him here, then. I suppose he met my grandfather, and someday I want to commission a biography of him. His death was an incredible shock to my father, who suddenly had to run Swift Space. His problem, by the way, wasn't rising expenses because of bureaucrats; just the opposite, it was lawsuits from several countries and from several competitors, because the cost of developing the original transportation system was supposed to be divided equally between Project Columbus, transportation to the moon, and transportation of tourists to low Earth orbit. The lawsuits argued that if 8,000 tourists were being transported to LEO at the same time that a few dozen astronauts were being sent to Mars, the government payments to Project Columbus constituted an illegal subsidy of the tourist transport to LEO. That took ten years to resolve and my father mostly won, but it soured relations between Swift Space and the governments. After that, my father concentrated on tourist transport only and pulled down the price to LEO to 500 redbacks per kilo. At that point he sat on his laurels, competition took over much of Swift Space's market share, and Swift Space dwindled down to a minor player."

"It's a sad story. And since Swift Space owned the gryphon capsule and Thunderbird rocket and didn't put money into developing either, once the Swift shuttle became the main vehicle for tourist transportation, no one put money into updating their technology and they became obsolete. So Mars had to develop the caravel and its successor vehicles, and then the Prometheus."

"Which has shaken up the launch market again; my congratulations to you about that. Last year my father announced his intention to retire as Chief Executive Officer of Swift Space, and the stockholders have agreed to give me the job, once I return from this trip. Transportation

technology has improved so much in forty years! We left Earth just over two months ago; a galleon packed with 500 tourists and short term visitors with two gaseous core nuclear engines. It was the fastest passage ever, and our return to Earth will be just as fast. We're here 33 sols."

"A quick trip and a quick visit, but long enough to give you a feel for the place. So, are you here to acquire ideas for Swift Space's future direction?"

"Some, but I think I've already settled on a direction, so I'm searching for ideas and allies to implement it."

"So, is that why you asked to meet with me? I'm afraid the Institute for Space Settlement is just a week old, and we are searching for our direction as well."

"Good; maybe we can develop our visions together, then. I think Swift Space needs to go into the space settlement business. My grandfather's vision was to open Mars to settlement. He didn't mean government subsidized transportation of settlers; he wanted to throw open the door and let anyone who had the means to pay their own way. This is now possible for low Earth orbit, the moon, even Mars. Transportation to low Earth orbit costs 100 redbacks per kilo or 50,000 per person. A six-month galleon flight to Mars with chemical propulsion and a high density of passengers is 100,000 redbacks. I paid three times that much for the gaseous core nuke, the liquid hydrogen fuel, and the speed! A typical professional's house in any urban area around Earth costs at least 150,000 redbacks. There are literally billions of people who could afford to come to Mars on their own assets, and once here they could get a mortgage, a one year salary loan, and build a new life for themselves."

"That's true. But we have all sorts of screening requirements, to make sure we don't get terrorists or crazies, and we have been focusing on young, single professionals under age 30. They don't have the assets yet."

"Oh, some do. On Earth, the professionals are getting wealthier and those with trade educations are sinking into poverty as robots replace them. I'm talking about psychologists, writers, entertainers who use the web as their medium, researchers, software designers, engineers. . . many of these people are highly successful and affluent by the time they're in their mid forties, and they would have the money to move themselves, their spouse, and one or two children to space. Mars is the most expensive possibility. A settlement in a 600-kilometer equatorial orbit could be reached for 50,000 redbacks, maybe less in a few years as volume grows. Some people could afford to live there and commute to Earth once a year or so. A settlement on the moon would be a three-day trip from the Earth and a round trip ticket would be less than 100,000. The moon already is receiving several thousand tourists per year. And there are plenty of middle aged professionals who look at the orderly, peaceful, secure life here and would gladly immigrate."

"So, where does Swift Space fit?"

"I'm still not sure." Zeke paused to consider. "I think I'd like to invest in all three eventually. The carrier design that Ceres and Phobos have settled on is the key, because it can be a cheap transport to move ten thousand to Mars at once or can serve as a permanent settlement in low Earth orbit for a thousand workers; and think what a thousand permanent residents could do in low Earth orbit! I've already had conversations with people at Marcraft about investing in the carrier project and acquiring a license to manufacture carriers in LEO. They're hesitant, of

course; they don't want their own facility to have competition. I don't blame them there. But with the enormous expansion of automation over the last decade and the huge reduction on transportation costs, Mars's isolation has been greatly reduced. It's as if you've been moved to low Earth orbit! People still don't understand that they are in danger of going from one of the biggest players in space, to one of the smallest."

Helmut leaned forward, eager to hear more. "I've sensed that, over the last year or two. We used to have companies wanting to come to Ceres, and Ceres didn't have the capacity to accommodate them. We acquired the capacity and the companies no longer were so enthusiastic, because they no longer needed Ceres as much."

"Exactly. The synergies between the moon and low Earth orbit are developing very, very fast. Parenago brought a huge expansion in the transportation system fifteen years ago, Prometheus expanded it even more six years ago, and the mass driver will be the third revolution when it goes on line in five or so years. At that point, there will be the economic base for a lunar city. That's my other project. There's a rille in the Marius area with a lava tube five hundred meters in diameter and 200 meters high. I plan to visit it this summer, after I return from Mars. If we put rotating housing and a big dome in the tube, the inhabitants would have a marvelous, zero-radiation, multiple-gee residence that could be expanded to accommodate hundreds of thousands of people. A metal road to Peary and Shackleton with methane and oxygen pipelines and power cables could supply volatiles and power from the cold traps and perpetual solar panels at the poles."

"So. . . is this the ultimate gated community, an economic base for developing the moon, or both?"

"Both! People who want to live in peace and quiet, without worrying about terrorism, can buy their condo there, but the people running the mass driver can be there, the people doing robotic mining and refining also, and the medical and other support facilities they need can be there as well. Peary still has a rather small hospital. This place could have a Martech branch of its own!"

"Certainly, all the work we've done on Mars for the last forty-three years have made possible everything you describe. Rotating housing is a mature technology, domes is a mature technology, and carriers will soon be."

"Exactly. The more important issue, Helmut, is the social structure. What you've done up here is a breakthrough in human organization. It's as important as American democracy was to late eighteenth century Earth. It was the wave of the future. Settlements in LEO or on the moon need to have your organizational structure: professional, scientific, transparent. Because, as you know, in a decade or two carriers with a thousand people on board may be cruising anywhere in the solar system that their gigawatt reactors and electric propulsion systems can take them. There may be professional writers and artists on board who make their living over the web, too; not everyone has to be crew. You Marsians have to get past the idea that everyone has to have a preplanned, professional niche. If I could buy a carrier to transport ten thousand here every columbiad, I'd do it, and as long as the people passed the psychological tests, they'd be welcome to pay their own way."

"I bet we'd accept and accommodate that, too," said Helmut. "We've had to accept bigger changes than that in the past."

"If you want to remain a big player, you'll have to throw open the doors to immigration."

"I suspect you are right about that. Our policies made sense in a different era, but that may be changing."

"No, things *are* changing. What will Mars do if, at the turn of century—twenty-two years from now—100,000 people live in low Earth orbit."

"But there's no economic basis for that."

"Imprecisely phrased: there's no economic basis *yet.* But the foundation is there. It was laid when the Prometheus lowered the cost to orbit to 100 redbacks per kilo. Private investors are a conservative lot; they don't want to take chances. The terrestrial economy has been riding a rollercoaster for thirty years. That may or may not change. What does change is the availability of entrepreneurs with vision. I'm not just referring to myself; there's a whole generation of them looking up to the sky."

"I see. That's something I didn't know."

"Well, you're here, not there. That's why I've come to Mars. I want to know what's happening here, because something my fellow entrepreneurs on Earth don't know."

Helmut smiled. "I can help you with that. I should invite you to dinner. You'll meet my father, the venerable astronaut; my brother, owner of Mars's largest farm; and my daughter in law, Sirikit Thanarat-Langlais, who may be Mars's smartest young economist."

"Oh?" Zeke nodded. "I'd appreciate that."

"We're so surprised to hear that you're in town!" exclaimed Sirikit to Giovanni and Holly DePonte.

"I'm glad you guys were available for lunch," replied Gianni to Sirikit and Charlie. "We're here for two weeks."

"Staying at your parents?" asked Charlie.

Gianni nodded. "It's a good chance for them to get to know me better," said Holly. "We've been homesteading in Elliott borough for 3 ½ years, now. His dad came to visit us once, but that's it."

"So, have you struck it rich?" asked Charlie.

"Hardly." Gianni shook his head. "We do have a nice, comfortable place, now, with good radiation shielding, and we plan to move our conestoga out of the Quonset and get airtight end caps installed so the Quonset itself can be pressurized. That'll give us a lot more space. The Conestoga can be used for transportation and emergency accommodation, after that. So we like our place and our land, but we've barely earned enough to cover our expenses. We still owe a lot of money to my parents, too."

"Who want to give it to us; they aren't pressuring us to pay them back or anything," added Holly. "But we want to be independent."

"We want to make some real money! Elliott borough now has 127 residents, but that doesn't include the eleven that gave up and left. We've now got a hamlet at Erstad Crater of a dozen people who hire themselves out to help run equipment, buy and sell equipment, and watch your place while you're away—I can now set my equipment to work robotically and can control it from here, but someone needs to fix things if something breaks."

"Has anyone made a lot of money?" asked Sirikit.

Gianni smiled. “Three months ago one woman hit a mother lode and earned five million redbacks. There’s gold to be dug. Our land has had a few rich pockets and it might have a big strike. We’ll see.”

“I think it all sounds very exciting,” said Charlie. “Your own land, your own equipment, earning money the hard way . . . it’s the way mariners should be.”

“Rather than enjoying the malls?” said Gianni, smiling.

“Hey, I like coming here to shop!” replied Holly. “Or window shop, at least, since we can’t buy much, yet.”

“So, is this a window shopping vacation?” asked Sirikit. “I’m glad you can get away from your homestead.”

“We can; like I said, I can run the equipment remotely and there’s a service to drive over and fix anything that breaks,” said Gianni. “It’s partly vacation. We’re also here for an in vitro.”

“Oh? Time for a family?’ asked Charlie.

Holly nodded. “There’s no reason to wait any longer; we’re established, we have neighbors, Elliott has a nurse and is now serviced by an ambulance, we’ll have a pretty big place, there are other children planned . . . this is the time.”

“Why in vitro? Radiation issues?”

“I haven’t been so careful and have had a pretty high radiation load,” said Gianni. “We’re better off with in vitro, to make sure the sperm used isn’t damaged.”

“We’ll try for twins and get the entire family effort completed at once,” added Holly. “My radiation exposure’s not too bad, since I’ve been up here only a few years and I’ve mostly stayed indoors. You guys must be worried, especially with Oskar’s condition.”

"We do worry," said Sirikit. "I should be fine; I wasn't one of those kids who put on a pressure suit every weekend to go explore. On Callisto I was in an enclosure under several meters of ice, and the caravel had magnetic radiation shielding out and back."

"But my radiation burden's higher," said Charlie. "My brother's leukemia was radiation induced; the genetics of the disease make that clear."

"How many kids up here get childhood cancers?" asked Gianni.

"Our rates are double the rates in industrialized countries," replied Sirikit. "But lower than in some impoverished areas where there are carcinogens in the environment. Leukemia is particularly high. But with advanced medications, our death rates are lower."

"Anywhere you go, there are risks," said Gianni.

"We're planning to start a family, too," said Charlie. "Early next year, after both of us have completed our doctoral exams."

"That's a good time," said Gianni. "I wish you'd come visit us some time! You'd enjoy the geology, Charlie. I think the nature of the place will intrigue you, Sirikit. It's a different economic model, you might say."

She nodded. "Yes, I agree; it would be interesting. I hope we can get out."

"Maybe early summer," suggested Charlie. "School will be over and our schedules will be more flexible."

Gianni smiled. "That'd be great. We'll be there; you're welcome any time."

"I'm glad you were able to squeeze me in," Zeke Swift said to Alexandra Lescov and Jamshid "Jimmy" Khan. "I'm particularly pleased to meet you, Dr. Lescov. Your design sense is famous."

Alexandra smiled slightly. “Thank you, Mr. Swift. I’m afraid I don’t do too much designing anymore; I’ll be 77 soon! But I was pleased by the designs for the aerostat and the Peregrine shuttle.”

“And the Prometheus shuttle before that, and the caravel-galleon-corvet family of vehicles,” added Zeke.

“And don’t forget the carrier. I am supposedly the chief designer for it, but she contributed heavily to it as well,” said Jimmy.

“It was your project, Jimmy,” replied Alexandra. “And it’s a great design.”

“Which gets to the reason I wanted to visit, before heading to Valles Marineris and the North Pole for a week,” said Zeke. “Swift Space wants to partner with Marcraft. We already have an investment in the Prometheus, as you know, and the Commonwealth invested in Swift Space to get us back up after the war. We’ve had a reciprocal relationship for six years and it has worked well. We want to go into the space settlements business. Picture a 200-meter carrier in low Earth equatorial orbit with one or two thousand researchers, engineers, construction specialists, and other professionals on board to build powersats, or a carrier cruising the outer solar system to do mining and research. Swift Space thinks that the time has come to establish space settlements that people will choose to go live in, using their own financial resources, and they will help leverage the construction of space settlements that will serve economically valuable purposes. To do this, we want to invest in the carrier project and further expand our partnership with Mars.”

Jimmy looked at Zeke, surprised. “You want to meet with us to invest? I apologize; I misunderstood your message. I thought you wanted to hear about what we have been doing and plan to do in the future. That’s why I invited Alexandra to come.”

It was Zeke’s turn to be surprised. “I apologize my message was unclear,” he said tensely, feeling it was perfectly clear. “The reason I have come to Mars is threefold: tourism, gathering new information and understandings, and pursuing potential investment opportunities. Marcraft is the largest investment opportunity in the solar system, in my opinion. You have almost no terrestrial investments, I understand.”

“Correct,” replied Alexandra. “You have to understand our history, Mr. Swift. When we designed and built the caravel and galleon, Marcraft was property of the Mars Commission and thus was a public company. The patents belonged to governments and were thus public also; we actually did not own our innovations. That’s why Shantung Space and Boeing’s Spacecraft Division are both going into the business of making caravels; or modified ones, because they are updating the technology somewhat. Even the corvet is only partially protected by Marsian patents because some of its basic technology goes back to the caravel. So with the carrier we are starting from scratch, patenting everything, and we want to protect our patents.”

“Because the carrier means Marsian jobs,” added Jimmy. “We don’t want them manufactured in LEO.”

“I see. I understand your concern, but I think you may not be fully aware of the situation on Earth. Private investment in space doubled compared to last year, which was almost double over the year before. It took a few years to overcome economic uncertainty and start to take

advantage of the price drop that the Prometheus has brought about, but now things have started to move. Private investment in space will soon outstrip your resources."

"You may be right about that," said Jimmy. "But we're telling you Marcraft policy. We exist to support the development of Mars; the technology Mars needs, the equipment it needs, the jobs it needs. If we enter into partnerships and share our technology, it'll be used elsewhere and we'll lose our lead."

"What I'm telling you is that you'll lose your lead if you don't share your technology because other firms have deeper pockets and can innovate more. Swift Space is worth 8.8 billion redbacks and has several billion in lines of credit. That may be a bit less than what you have now, but we're one of a dozen players, and more are joining all the time. You used to have to worry about national space programs devoting 30 billion redbacks a year to space, which was roughly equal to Mars's GDP. There was a tiny commercial space sector, right after the war. But pretty soon, commercial investment will be 100 billion per year. What will you do then?"

Jimmy stared at Zeke uncomfortably, uncertain what to say. Alexandra finally filled the silence. "Mars has alternated between self-funding, funding by other governments, and private investment. At one point we had a large investment from an American chemical company, but then the war came and that arrangement collapsed. One reason we have been avoiding the commercial sector is because it has been repeatedly hit by economic and political uncertainty. They have not been reliable long-term partners to us."

"That may be, but I submit you are in a different situation now. You are victims of your own success because your Prometheus has brought about the huge price drop to LEO and has stimulated the commercial space sector. In the next few years, Boeing's new shuttle and the new

Swift shuttle will come out and they'll equal your achievement. Shantung Space's shuttle will be the first commercial space vehicle produced in China and it promises to be of high quality as well. Add to that the mass driver on the moon that will start to operate in four or five years and you face a wave of expansion."

"Have you invested in the mass driver?" asked Jimmy.

Zeke shook his head. "My father is still CEO for a few more months, and he didn't favor it. Swift Space has no investments in the moon at all, right now. We lost much of them when Peary Resources went bankrupt."

"That's the problem," said Jimmy.

"No," replied Zeke, wagging his finger. "When you're an entrepreneur, you have to take chances. Some investments work out; some don't. But if you don't take chances, you'll never get anywhere." He shrugged. "It was good to meet both of you. Keep my offer in mind."

Vanessa Smith looked at the gallery full of contemporary art. "The Mariner Institute of Technology joins the Aurorae Center for the Arts in celebrating the output of Mars's visual artists," she began. "While we are rightly celebrated for our science and technology, we also have incredible artistic talents, and we are becoming better known for our art all the time. Martech is pleased to have a developing relationship with the Center for the Arts and looks forward to increasing its support for all this world's artists. Thank you so much for inviting me. I look forward to walking through this gallery and being insured by the work."

Vanessa stepped away from the microphone and Liz Elliott, Director of the Center for the Arts, returned to the podium. "Thank you, Madame Chancellor Vanessa. The Center for the Arts

is delighted to be developing a stronger relationship with Martech, which will be opening a Department of Art and Theatre in the next few months. Many of the artists here today will have faculty status at Martech, which will enable them to develop their skills to new levels and share them with a new generation of students. We're delighted to see Dr. Helmut Langlais, the future Chancellor of the university, here this sol, and greet him as well." Liz pointed to Helmut and he nodded politely.

"I look forward to moving forward the Department of Arts and Theatre," he said. He had not realized such a department was being created until earlier that sol.

"Thank you," said Liz. "Without further adieu, I want to thank all of you for coming to this opening of our exhibit and encourage you to spend time to look at the works and talk to the artists. They are eager to tell us about their work, what they seek to express, and why their efforts are significant. We are a world that does not understand art. I suppose the people of Earth don't, either, but we are an educated population and we need to have a competency in the arts as well! So avail yourselves of this opportunity. Remind your friends to come; this exhibit will be open until the end of the semester."

Liz stepped away from the podium to strong applause. Helmut looked around the room, impressed. He walked over to Will Elliott, standing nearby. "There's a lot of interest in the arts! I had no idea; I've been away a long time."

"It's a good sign of the maturity of our culture and society." Will smiled. "So, the new Chancellor! Congratulations, Helmut!"

"Thanks, Will." It was the first time he had called the "Father of Mars" Will. They shook hands. "I thought maybe I'd end up the Director of the Institute for Space Settlement, and now this!"

"Martech needs some new direction. It's gotten so big, it needs a new *raison d'etre*. I don't think it needs a single focus. It needs a sense of mission, perhaps."

"I sense all of Mars is feeling the need for a sense of mission."

Will considered that, then nodded. "Yes, that's true, too. We're no longer a little village on the edge of civilization. We're now a civilization of our own; a small one, admittedly, but a separate society and civilization and culture. In the last four years, with a doubling of our population, the vast increase in automated production . . . we're a different place. We're affluent like we never could have been before and our priorities are more diverse than ever before."

"When I arrived in 2048—30 years ago this October—Mars had barely 100 people! We were intensely focused on building infrastructure, trying to cover some of our expenses through gold mining, and we could not have imagined we'd be an independent nation 18 years later. Then we struggled to survive a cutoff of supplies from Earth, something we'd now handle without nearly any trouble at all. When this wave of immigration ends, we'll have 33,000 people."

"And the exponential growth isn't stopping; it's continuing," said Will. "We'll be over 100,000 in six years, if the carrier comes on line and we can figure out the financing of the immigration."

"Zeke Swift II thinks people will pay to live in space. I met him the other sol. He's planning a settlement in low Earth orbit and possibly a city on the moon, and some of the inhabitants would choose to move there using their own finances."

"Really? Why?"

"The ultimate gated community, on the ultimate frontier."

Will nodded. "I suppose transportation has come down enough for that to be possible. That's what his namesake dreamed of. We need to get some of those people here!"

"That's what I was thinking, too, after I talked to him. He's coming to dinner next week, after he returns from a tourist trip."

"I have to take one of them, some time!" said Will. "Good luck with your new form of service to Mars, Helmut. I am sure you'll do an excellent job."

"Thanks, I really appreciate the confidence." Helmut smiled and they shook hands again. Then Will Elliott turned to another guest who had walked up to him and Helmut walked to the wall to look at the pictures.

One caught his eye; a huge canvas that, as he got closer, he realized was really a screen. It was a dramatic scene of the escarpment from the top of a mesa—he wasn't sure which one—with a large crater in the foreground. As he watched, a cloud of dust swept up over the rim! He blinked, thinking he had been looking at a painting, but realizing the image was really three dimensional and alive.

"Do you like it?" asked a voice nearby. Helmut turned and saw Ernesto Alves standing there. Ernesto was four years older than Helmut and had arrived on Columbus 5, four years earlier than he. Helmut smiled to see an old acquaintance.

"Ernesto, good sol! I haven't seen you in ages!"

"Well, you haven't been here in ages! It's good to see you again." They shook hands warmly. "So, you're back! And Oskar's in the hospital! How's he doing?"

"It's touch and go right now. The doctors are optimistic, but the new treatment hasn't done much, yet. We're spending a lot of time with him."

"Oh, I'm sure. He's what? Fourteen? What a terrible age to have a serious illness."

"It is, and it's pretty hard on him. How are you doing? How are your kids?"

"All grown up now, one's in Martech and one has gone back to Earth, I hope just for a few years, but we'll see. He's really enjoying Brazil right now and has a girlfriend, and she's not keen on flying to Mars! But I'm hopeful."

"I see you've continued with your art."

"More than continued; I make a living off it, now." He pointed to the piece Helmut had been looking at. "Three-d digital paintings, programmed to change based on the movement of the sun and factors such as wind speed. The software took a year and I got a lot of help from some friends in Martech's Artificial Intelligence Department. But now I can create a scene, determine the parameters, and set it going." He pointed. "I've sold 50,000 copies of this one on Earth through my website; 52 redbacks each."

"Wow. You've done well, then."

Ernesto nodded slightly. "Not bad. My other paintings are available as prints and they've been selling reasonably well, too." He pointed to a picture nearby. "You see that bunch of lilies? That's Angela Lake's masterpiece. Really beautiful; it looks like something painted by Monet. But it's three dimensional and animated. Right now, four of the lilies are open, but it starts out as a bunch of six buds and over a two week period, they all open. Then you can rerun the program, of course."

Helmut smiled. “I’ve heard of these new types of digital art. Really amazing. I have a scene of the planum on Ceres near Central Outpost. The sun rises and sets every nine hours, just like on Ceres. We have that in our new living room.”

“But that’s made from photographs. These are computer generated by the artists. There’s an absolutely enormous market on Earth for three-d animated art now; tens of billions of redbacks per year. Everyone is replacing their wallpaper or painted walls with screens and can change the décor of their rooms at will. There are a half dozen of us up here making our living off that market.”

“Really? You sent paintings to Earth once, too.”

Ernesto nodded. “Yes, we had a big exhibit of Marsian paintings about fifteen years ago, but I didn’t make any money off that. The cost of shipping the paintings to Earth was too high. But digital art gets to Earth almost instantly for a fraction of a redback, and we have locking software that prevents people from copying it.”

“Perfect.” Helmut looked at the images on the gallery’s walls, alive to a whole new set of possibilities. “Thanks, Ernesto, you’ve taught me something very important.”

“Thank you for inviting my over for dinner,” Zeke Swift said to Helmut. “When we last met, I had no idea you were going to be Chancellor of Martech!”

Helmut shook Zeke’s hand and escorted him into his house. “Thank you, and thank you for coming. That was two weeks ago; nothing was official. But a few sols later, the Martech Board of Trustees met and First Minister Jacquie—who is a member of the Board—nominated me, and Vanessa Smith, who has been Chancellor for fifteen years, seconded it immediately. The

rest of the Board read my statement and reviewed my c.v. and approved. I replace Vanessa on August 1st; fifteen weeks from now. That gives me some time to get the Institute for Space Settlement up and running. It'll still be the primary focus of my efforts. The idea is that the Institute will help provide Martech with a sense of mission."

"Ah, I see, so you will do both. That's a good way to look at Martech, then."

"Exactly."

"And I gather you're also a representative for Ceres in the Mars Council?"

"Correct. I was when I was Executive on Ceres, but I was unable to attend and my votes were virtually ignored by the Council. By the time my vote arrived and was added to the total, the Chamber would move on to other business! Now I'll actually need to attend and be involved, I'm afraid!" Helmut stepped away from the door. "Anyway, please come in. My father will be here in a little while, as will Charlie and Helmut and my brother Kristoff and his wife, Irma. Their kids—twins—are seventeen and utterly uninterested in our conversations! Come in and let me introduce my wife, Clara." They walked into the living room. "Clara, this is Zeke Swift."

She rose and shook his hand. "Very pleased to meet you, Mr. Swift."

"Thank you, I'm pleased to meet you. I understand you're quite an explorer!"

Clara smiled. "I suppose I am; I took both kids out on many geological expeditions with Helmut. My job was communications, logistics, and software. I did those tasks on both expeditions to Ceres as well."

"So, you were on the first Ceres expedition as well? How interesting!"

"I was; Charlie was just a little boy then. Oskar came along later and was actually exposed to much less radiation than Charlie, but he's the one with the leukemia."

"How's he doing?"

"A bit better this sol. I was just with him this morning. I'll go back this afternoon."

Zeke looked around. "This is a beautiful place. Is it new?"

"Yes," replied Helmut. "Shenandoah and its twin, Huron, were the fifth and sixth enclosures completed here. The first four—Yalta, Catalina, Riviera, and Shikuku—have been declared a historic district and are being preserved as they were set up originally. But Shenandoah has been completely renovated. Old units have been merged in some cases to make large condos, too. This is a pretty expensive, rather exclusive district as a result."

"Are housing values generally increasing on Mars?"

Helmut frowned. "I don't think so. Not much, at least. Inflation has been almost nonexistent. The technology for making housing has been steadily improving, so larger and larger units are possible for the same production cost. The government has been buying up old units and converting enclosures to other uses, or to new housing."

"But that's only true of the pre-Andalus enclosures," said Clara. "The later enclosures are larger and the building techniques were more mature, so the prices have held up better. This is a pretty good sized place; 160 square meters. It has a master bedroom, two smaller bedrooms, two small offices, this good sized living room and dining room, and a fairly nice kitchen."

"It's beautiful," said Zeke, looking out the window at the trees in the middle of the enclosure. "And very close to your new office."

"Yes, a three minute walk," said Helmut.

Zeke pointed at an image of Mars on the wall. “I love that one. I have it in my house, too. I love the way it changes with the daylight. I have it set on a 24-hour day in synch with the house’s time zone, too.”

“That was created by an old colleague and friend of mine,” agreed Helmut.

Just then the door opened and in walked Charlie and Sirikit. Zeke stood; Helmut introduced his son and daughter in law. “Very pleased to meet both of you,” said Zeke. “I hear you are both about to take your written and oral exams for your doctorates.”

“Correct,” said Charlie. “Toward the end of this year.”

“It’ll be grueling,” added Sirikit.

“And I have read some of your columns in *Mars This Sol*,” noted Zeke to Sirikit. “Very impressive.”

“Thank you, but I’ve had some good collaboration on them.”

“Sometimes with Will Elliott,” added Helmut.

“Really? I’d like to meet Dr. Elliott. I gather he knew my grandfather as well.”

“Email him; he will be glad to meet you,” said Sirikit. They all sat on the couch and the easy chairs in the living room. “I was looking up some of your recent interviews on the web. I’m excited to hear about the idea of a thousand-person settlement in low earth orbit, and I gather you were talking about a lunar settlement as well. It’s high time for these developments. I’ve been wondering why private industry has been so slow to respond to the new economic reality that the Prometheus has made possible.”

“Some it was economic uncertainty and some of it had to do with who was in charge of what,” replied Zeke. “Entrepreneurs have to take risks. You can’t make money any other way. In

the last decade, and especially in the last five years, the center of economic activity on earth has been automation of just about all industrial production. That has cost trillions and it has created many uncertainties; it has been very disruptive of prices and supplies of things. Automated processes designed to work on Earth would have to be completely redesigned for zero-gee. The settlement I propose will avoid that problem because it'll have centripetal gravity. It'll be low enough to reach easily and to be within the Earth's radiation shielding, so it won't need much protection. The big problem is to get the technology, though. I met with Jimmy Khan ten sols ago, before I left for Tithonium and North Pole Station. He was completely uninterested in any kind of partnership, though."

"We haven't been doing partnerships with terrestrial firms because in the past we've had problems with patents and profit sharing," replied Helmut.

"So I understand, but it's short-sighted in this new environment. Private investment in space is about to take off. It already has been climbing sharply, but the lunar mass driver will completely change the situation, and it is inevitable that a large population will settle in Earth orbit, where it will be highly productive. You can't isolate yourselves from these changes. Marcraft could be left in the dust. So could Phobos and Ceres. You see, Mars simply doesn't have the resources to keep up, if private investment really gets rolling along."

Sirikit nodded. "We need to lead the private investment, not react to it. What's the estimate this year? I think I saw 16.8 billion redbacks."

Zeke shook his head. "No, that's an old estimate for 2077. It's only early April 2078, so there is no estimate for the entire year yet, obviously. But from what I am hearing, I think it'll be

about 25 billion, and I wouldn't be surprised if in 2079 it's over 40 billion. That's what I'm trying to say; investment is climbing fast. What was it in 2076?"

Sirikit frowned. "I think ten billion."

"You see; it's growing very fast, and with automated production, that money goes a long way."

"The Prometheus manufacturing line is pretty busy," said Sirikit. "I think there are twelve of them operating now, and each one is able to launch 5,000 tonnes or 15,000 passengers per year into low Earth orbit."

"That sounds right," said Zeke. "And three new shuttle designs are coming in the next year. One is our new Swift 600, which should be cheaper than the Prometheus."

"I've heard it's good," agreed Sirikit. "So, what are you suggesting to Marcraft? Investment?"

"Exactly, we'd like to invest in the carrier project and even build a carrier production facility in low Earth orbit. The Chinese are already planning to produce a vehicle similar to the caravel, but larger, with some of the production in low Earth orbit. I need carriers to build my space settlement. If I build it without Marcraft's assistance, Marcraft will have a competitor anyway. If I build it in partnership with Marcraft, we can share technological innovation and the Carrier-2 and Carrier-3 will be better. If not me, it'll be someone else."

"The basic carrier design is not very innovative," said Helmut. "We're building one on Ceres to provide a large gravitied environment."

"Exactly, but as everyone knows, the final design will be quite innovative, because that's what engineers do. As they create something, they encounter new problems, and they develop

unique solutions. I've looked at the proposals for housing on Ceres and they went through drastic changes as the plans matured. What I want for low Earth orbit is basically the same; 200 meters in diameter and initially 100 meters long, to which separate 100-meter modules can be added as the population grows. If each has just three stories of construction, you can easily feed and house a thousand people, and the central hollow is your 'outdoor' park."

"Nearly the same configuration can fly 10,000 people to Mars, too," said Sirikit.

"Exactly!" exclaimed Zeke. "With ten thousand tonnes of consumables, ten thousand tonnes of liquid hydrogen, and at least three gaseous core nuclear engines. The transit would last four months; not bad. Mars is going to need more and more carriers, Phobos and Deimos will need them for housing as their populations grow, Venus needs them to become a viable permanent settlement, Ceres will need them to retain its central role in the asteroid belt, and they're going to get bigger and bigger over time. Who knows how large they'll be in fifty years, but one can imagine a vehicle able to transport 100,000 to Mars, and do so cheaply; 100,000 redbacks per passenger. But that'll happen faster if Marcraft partners with someone on Earth to share the development and production costs."

"If investment keeps growing as fast as you say it will, your strategy is essential," agreed Sirikit.

Zeke sighed. "I'll tell you, Mars could make a lot more money with its innovations. Right now, the Martech engineering department develops something, the Unique Fabrication Team produced one and tests it out, then Martech leases production to someone; usually MarFab, which seems to manufacture almost everything Mars needs. That works fine here, but on Earth, you should partner with someone to profit share with you and be involved in further

improvement of the product. Not Swift Space; we're not into manufacturing many of the items you create. But someone. The larger market on Earth will guarantee a larger cash flow in order to continue innovation and improve efficiency."

"We'll also have access to other people's patents through the partnership," said Helmut, nodding. "So we won't have to reinvent the wheel and purchase access to technology someone else has patented."

"Exactly," said Zeke.

The doorbell rang, then opened and Sebastian stepped in, leaning on his cane a bit for stability. "Good sol, everyone," he said. "I hope I'm not late."

"No, dad, we've just been talking," said Helmut. "You're just in time. Zeke Swift, allow me to introduce Sebastian Langlais, Commander of the Northstar 3 mission to the moon and Columbus 2 to Mars."

"I'm so pleased to meet you, Commander Langlais," said Zeke, rising and walking over to shake Sebastian's hand.

"Don't forget he was Commander of all of Mars, 2038-39," added Helmut. "Some people think Will Elliott was in charge from the very beginning, but in actual fact it wasn't until 2039 that he was put in charge, and it was a temporary command until 2040 when it was made official."

"I remember," said Zeke. "I was a teenager when you landed and I followed the mission very closely. The Columbus 2 crew were heroes to me."

"Well, we didn't do anything heroic. We were trained well."

"So, you knew my grandfather?"

"I met him several times, especially in the year before he died. I was in Houston, driving TROVs here and in Hellas, studying Martian geology, and familiarizing myself with the equipment, because I applied for Columbus 1. He was intense, very creative, and not one to stand on formality. I can see him in you, in your eyes."

Zeke smiled. "Thank you. Several people have said I resemble him."

"I think so," replied Sebastian. "But more important than physical resemblance is the skills and talents. I gather, from your reputation at least, that you have a bit of his spirit as well."

"Perhaps. At any rate, he wanted to come to Mars and was prevented by his automobile accident. My trip here is to fulfill his dream, partly."

Sebastian smiled. "That's a fitting tribute to him."

"So, you already have big ideas?" said Jacquie Collins, as Helmut entered her office. She pointed to a seat and they sat.

"I'm sorry to bother you now, with the first wave of immigrants hitting, but this may require action in the next three sols. That's when the tourists depart."

"That's a tight timeline, but fortunately the two galleons with the families arrived quite safely this morning and will dock at Phobos in three hours, so all is well. What do you have?"

"Yestersol, I invited Zeke Swift II to my home for lunch. He takes over Swift Space in a few months. When he does, he has two large projects: a space settlement in low Earth orbit, initially for a thousand people, and a settlement on the moon of similar size. He plans to allow immigration to both by people who can pay their own way; there are a lot of people on Earth who could do their work from earth orbit or from the moon, and they can help bulk up a working

population who can refine lunar materials, manufacture zero-gee objects, etc. Very ambitious efforts."

"Sound like he'll create a strong competitor for Phobos. Does he plan to buy a carrier from us and build copies?"

"No, he wants to partner with us, invest in the carrier technology, help develop the design and the manufacturing process, and manufacture them in low Earth orbit."

"That's a tough one." Jacquie leaned back in her chair. "Has he talked to Jimmy?"

"Yes, and Jimmy rejected all partnership or investment."

"We've had problems with patent violations and unfair contracts, and right after the war when no one on Earth was investing, we got used to doing everything ourselves."

"But the situation is now changing fast. Private investment in space has been growing fifty to sixty percent per year for the last three years and it appears the increase this year will be seventy percent more than last. Private investment now exceeds our GDP and will soon be two or three times as much. The only way we can compete is to cooperate."

"Are you sure of these numbers?"

"Sirikit checked them and we talked to Dr. Park. He did some further research and verified them. The economic uncertainty caused by the war, currency problems, and robotization of industry have settled down and the reduction of launch costs caused by the Prometheus is now having an effect. Three other cheap shuttles come on line in the next year or two, also. We are facing a wave of economic expansion in space. The solution is 'coopetition': partnerships with as many people as possible, sharing technological development costs and breakthroughs, leveraging our resources with others, and shaping the wave to our advantage."

"While we still can." Jacquie pondered the situation a moment. "I need more information about this. Did you talk to Vanessa about Jimmy's rejection of the offer?"

"I did. She said I should talk to you, because this is a big change in direction."

"It is, and she's right. Alright, here's what we'll do. I want all the information you have and I'll talk to Dr. Park. If everything you say appears to be right, you and Vanessa and I will talk to Jimmy tomorrow afternoon. I don't know whether Swift is the right choice, but it sounds like we have to rethink our policies."

3

Jurisdiction

May 2078

"I love your new office," said Will Elliott, as he entered Helmut's new office as Director of the Institute for Space Settlements. Behind his desk was a huge, three-dimensional view of Central Outpost, Ceres, from a nearby crater rim.

"Thank you, and thank you for coming." Helmut shook Elliott's hand and escorted him a meeting table at one end of the office. "The Institute is getting all of Oregon Enclosure eventually, but for now we're getting this building. We've already hired three faculty and two support personnel. Our first personnel meeting is Frisol."

"I'm glad to hear you're moving fast. What you're doing is very important. That's why, when you suggested that we meet, I said I'd come to you, rather than having you come to me."

"I can always come to the Mariner League offices another time. Allow me to offer you some cookies. Would you like Marabica?"

"Sure; thank you."

Helmut handed Will a plate of cookies while a robot poured him a cup of coffee and brought it over. Helmut took a cup of Marjeeling. "I wanted to brainstorm with you a bit about space settlements," said Helmut. "As you have probably heard, Zeke Swift is planning to set up a settlement with an initial population of a thousand in low Earth orbit. He wants to create a settlement of similar size on the Moon. It sounds like, in a decade or two, there may be more people in low Earth orbit or on the moon than anywhere else off Earth, except possibly on Mars. The economic forces give both big advantages. My questions are two-fold; could and should

they join the Mariner League, and should we be working to be sure their social and political character reflects mariner values?"

"You ask very important and difficult questions. I've been thinking about them for the last few weeks, too, because Zeke Swift had lunch with me, the sol before he left."

"Oh, he did? He had said to me he wanted to meet you."

"We reminisced about his grandfather a while and I promised to write him a long email with my memories, which I did. Then we talked about his plans for a settlement in orbit and one on the moon, attracting middle class buyers as well as workers pursuing important jobs in those locations. He was very pleased that Marcraft had come around and was seriously exploring a partnership with Swift Space."

"Yes, we had to meet with Jimmy and impress on him the importance of allowing investment. I'm afraid I have antagonized Jimmy. I need to meet with him and bring about some reconciliation."

"He's a brilliant engineer, and he can't be fooled into agreeing that a five billion redback investment in technology X is necessary to complete a project. But he isn't an economist or a businessman. That side of Marcraft needs to be handled by someone else."

"Martech needs an office to handle investments, and I assure you it will have one soon. But back to all these settlements; should they join the League, and how will they assimilate mariner values?"

"I think they should join the League because the League is strengthened by the numbers. If they grow to outnumber the rest of us, it may change the League, but that's farther into the future. We're still not completely sure what mariner values are, so it's not clear what they should

assimilate to. Mars, Phobos, Ceres, Titan, and Urania are the closest, culturally. Venus and Mercury have their own history and are different. Callisto and Themis are different as well, for their own reasons."

"True. By 'mariner values' I refer primarily to our elections. Every member of the League follows our system, though I suppose there are some variations. We also have a remarkable uniformity, where class is concerned; the rich are not that rich and there are no poor."

"That may be a function of our size and recent founding. Mars has been getting less equal. The more we encourage entrepreneurship—which we have to encourage, in order to diversify our economy and stimulate growth—the more we will create a rich class. It's the same way with terrestrial investment; we have to open up to more of it. Before independence, we welcomed it warmly. We encouraged investors to come here as tourists and make deals while they were here. The Commission also had an Office of Investment on Earth to serve as a midwife for deals. We lost some of our profits, but we gained investment, and we wouldn't have the Muller Campus of Martech at Cassini if Muller hadn't invested and then given a big portion of his profit back to Mars as a gift to the university! Rich people are not necessarily a problem. No one knows what the ideal division of wealth in society is."

"Good point. I suppose I've spent too much time on Ceres, where there were few of us and we were all on salary."

"The Commonwealth employs only a quarter of all Marsians. Two thirds are employed by non-profits like Mariner Hospital or Martech or public-private corporations like Marcraft or Marcomm. A bit less than ten percent are employed by small private businesses, and that's

actually a problem. Construction and agriculture could be privatized a lot more. When we tried to encourage homesteading, there were all sorts of problems."

"Still, we have a certain distinctive culture. I suppose new settlements will pick up some of it through imitation and through the media. We could also encourage some of our people to move to the new settlements."

"That would help, but encouraging emigration will be very controversial!"

"It will. But I think we need to privatize immigration anyway. Let entrepreneurs like Swift haul a thousand people here at a time and let the people pay their own way. As long as they pass the psychological tests, let them come."

"That's also controversial, as you know. Immigration always is. It changes us."

"And if we let prosperous people pay their own way, that will change the class structure here. It'll be controversial that way. One problem we have is that our population grows by a third over a six month period, with all the chaos that produces, then we have twenty months of relative peace and quiet to assimilate the arrivals, then it all happens again. But with the mature technology of gaseous core engines and the availability of cheap hydrogen in orbit, and the availability of larger interplanetary craft, we can now fly immigrants here via a variety of trajectories and stretch out the arrivals a lot more."

"This columbiad is the first one that does that," agreed Will. "The arrivals are coming over a seven-month period, with a three-month period a year later for a secondary arrival via Mercury. Arrivals via Venus are possible every three or four years. We've been using those trajectories for two decades, but not extensively because of the costs."

"They've come down quite a lot."

"They have." Will sighed. "Sounds like you have a lot of controversial ideas. Good! We need to do things differently, sometimes."

"Actually, you've forced me to think about 'mariner values' and Marsian culture in some very different ways, Will. I've been worrying about preserving the status quo, but now I see we have been changing in some profound ways all along. The Institute for Space Settlements needs to think more broadly, let the culture evolve, let it diversify, and not just try to be sure the Marsian way of life will be preserved as is and extended to the rest of the solar system."

Will nodded. "We do have a lot to preserve and propagate, but our way of life will change, and we need to be prepared for that. There are ways we can shape the change, but we have to be open to unexpected developments as well. Let space settlements develop in low Earth orbit and cities grow on the moon. Let them compete. Let our people go there to settle and their people come here to reside. Common technology will give us a lot of commonalities, and our organizational system—our Marsian democracy—is attractive to the others, so I wouldn't worry about it. The Institute for Space Settlements needs to organize all sorts of conferences and blue ribbon panels to explore various issues. Organize some of them on Earth! Get creative dialogue going! I think you'll see that some interesting and useful results will emerge."

Helmut nodded. "Thanks. I think you're right. We'll need to tackle technology, investment, economics, society, culture, politics, art, religion . . . everything. And we will include everything off Earth. That's an important addition to my thinking."

"And I'll try to get them into the League as well. The Mariner League and the Institute for Space Settlement can collaborate in all sorts of ways, Helmut."

"And I'm looking forward to it, Will."

Just then, Will Elliott's communicator beeped urgently. He pulled it out of his pocket to take a look while Helmut's communicator began to beep urgently as well. They both stopped to read the messages.

"The Chinese?" asked Will.

Helmut nodded. "They're rejecting the current standard definition of legal jurisdiction of a settlement."

"That's what my message said, too. Looks like I'd better go; we both have some emergency tasks to complete."

"To resist this change!"

"Definitely."

"I think you've all heard of the Chinese statement," said John Anand Tian to the Urania science team, twelve hours later. "But two hours ago we received a communication from the Chinese national space agency, directed specifically at us. They will again grant us access to the Chinese rover on Titania and the communications channels of their mother ship in Uranian orbit. But first we have to acknowledge their statement that settlements cannot claim jurisdiction over a planet's entire gravitational sphere of influence—the Hill sphere—unless the settlement is located on the mother planet itself. And since we can't settle on the planet Uranus, only on one of its moons, we would not be able to claim jurisdiction over the entire Uranian system."

There was silence in the room while the fifty cryogeologists, meteorologists, atmospheric chemists, seismologists, and geophysicists looked each other. "The bastards," said Tad Lind a moment later, expressing in his brash youth a thought many had.

"It's blackmail," said Anand, nodding at Tad. "The Council hasn't met to deliberate about the demand, but it is safe to say that it will want to reject their demands. The science team is affected the most, so we want your input."

"What if we accepted their terms, used their equipment, the repudiated the statement after we arrived?" asked Tad. "It'd take them how long to send someone after us? Five Years? And what would they do? Refuse to buy our Helium 3?"

"No, we certainly can't do that," replied Anand.

"Well, maybe we should consider that option, with a twist," said Jasmine Smits. "We could always agree to the statement with the caveat that we won't sell Helium-3 to any nation that doesn't recognize our jurisdiction over the planet Uranus."

"What would we do, if a Chinese mission showed up in Uranus orbit to harvest Helium-3?" asked Tahirih Morales. "Surely we'd agree to provide rescue capability, if they had trouble. And I assume we wouldn't seize their equipment, either."

"You make a good point," said Anand. "We probably don't have to fear that they'll use force against us, but they probably don't have to worry about us using force against them, either. There's too much at stake in either case. Too many people could be killed."

"Especially if they sent a settlement that included children," said Dr. Jane Hudes, who was in charge of surface geology.

"We need to reach a peaceful solution," urged Gandhimohan Ramanujan, the settlement's health officer, who was also on the Council. "Anything else will produce uncertainty, and that weakens our settlement in all sorts of ways: economically, in terms of morale, in terms of social cohesion, etc."

"Certainly, we could use access to the Chinese equipment," said Jane. "Without their communications channels, the data we can get back from the European and Indian equipment is greatly reduced. We still have very little of the orbital photography we need from Miranda, for example."

'That's true," said Tahirih, who had been focusing her research on that moon.

"Our satellites and rovers arrive in twenty months," said Tad. "We'll get plenty of data then."

"That's true," agreed Jane. "But we need data now, too."

"Especially to finalize our settlement location," added Jasmine. "It's that much harder to decide where we'll settle when we don't have all the data we need."

"That's true," said Anand. "But we won't be settling for thirty-one months, anyway, so we really don't need to make a decision now."

"How much data do we have on the Uranus system, and how much more do we need?" asked Gandhimohan.

"A funny way to phrase it, but I understand the question," replied Jasmine. "There have been orbiters in the Uranian system for forty years and there's very detailed photography and mapping of all the inner moons and the five major moons, though not of the small, outer retrograde moons. Those of us studying Uranus itself also have very detailed data; terabytes of data. Of course, we need *more* data for our ongoing research projects."

"Of course; science always needs more data," said Anand. "But can we manage with the data we have, and the trickle we can continue to get for the next two years?"

"Even with the Chinese equipment, we can't get all the data we need," commented Pierre Wilson, one of their cryogeologists. "Even the surface geologists can't get everything we want; we need ground truth. The seismologists and meteorologists and geophysicists can't get practically anything from the existing equipment. We have to be there."

"That's true," said Tad. "We need to say no to them and just wait. Their statement basically strips us of our identity; it says we can't call ourselves 'Urania' anymore! We'll get to Uranus soon enough and get all the data we need."

"Yes," agreed Jane. "We can probably manage to rearrange our research projects to use the data we already have or can get."

"We can't give in to them," said Tad.

"I agree," said Tahirih. "We can keep ourselves busy."

"Is that what you all think?" asked Anand, looking around the room. People looked at each other and nodded or said "yes."

"It'll be a pain, but we can manage," added Pierre.

"But we probably do have enough data to choose a settlement location," said Tad. 'Maybe we should focus on that."

"I don't know," said Jasmine. "The big problem isn't a lack of choices; it's too many choices and too many lobbyists. Every moon has its party."

"I'm not tackling that one now," said Anand. "The Chinese are the issue right now. Thank you, everyone, for your input. Gandhi and I will talk to the Council. If nothing else, we can make a counter-offer to sell them Helium-3 if they recognize our jurisdiction."

The Saturn Council's new offices were in an elegant building three-story of blue steel and transparent glass on Cathedral Square, with the soaring, hundred-fifty-meter arch of artificial sky overhead and a view across the two-hundred width and along the hundred meter length of Titan's largest enclosure. Marshall stood at the window looking out at the square itself and the growing trees, flowers, and crops that turned Cathedral Enclosure verdant while he awaited the other council members. One by one, they came to him and joined him at the window.

"You never tire of it, do you?" said Anne Hollingworth.

"I don't," agreed Marshall. "It seems so unbelievable that we have built something this big underground on a cryogenic world." He pointed. "And in a few months the far wall will be removed and the enclosure will double in length. Imagine how many billions of people could live here, if we built enclosures like this under just five percent of the moon's surface."

"We'll never do that."

"No, we never will," agreed Marshall, somewhat reluctantly. "The estimate is that one percent is the max we could heat, using wind and geothermal energy, but with fusion we could probably heat as much space as we could ever want or need. Like Mars, we are essentially resource unlimited; so unlike crowded Earth. But never mind. Let's sit and discuss the Chinese statement." He turned to the big, round table, so the other six members of the Council followed him. They all had their own seats, so they sat in them. Shiyoko, who was the Council's recording secretary, projected the Chinese statement onto the wall.

For several minutes there was silence as they went around the table and everyone read one paragraph out loud. There were seven paragraphs; one for each of them, ironically enough. "Lots of legalese," said Kurt.

"But it all says the same thing," concluded Marshall. "We're the Titan Council, not the Saturn Council; the only Hill Sphere we can claim is Titan's!"

"They say 'settlement,'" noted Tomas Racan. "That term usually refers to a non-sovereign entity; they wouldn't call Mars a 'settlement.' We have de facto sovereignty here; there are no other humans within a billion kilometers. So perhaps we should declare sovereignty and rightfully assert something we already have anyway."

There was silence as everyone considered the idea. "Interesting," said Shiyoko.

"That strikes me as an old-Earth response, though," said Marshall. "There's no reason to claim something that no one can take away or reasonably dispute anyway, and there may be advantages of not claiming it. We are not economically independent, and at times it is useful to emphasize our financial dependence to our supporters."

"Any idea what Callisto thinks of this?" asked Anne.

"I emailed Cai Xiaopeng," replied Marshall. "Do you realize that with the newly arrived vehicle from China, Callisto has 600 people, and we only have 700? They'll pass us in a few years. But he said they aren't particularly worried about the Chinese statement, for several reasons; no one can exploit Jupiter's Helium-3; China's not going to set up a separate station on Callisto; and there is no other good spot in the jovian system for a station."

"I don't know about that," said Kurt. "The leading hemisphere of Ganymede doesn't have that bad of a radiation environment, and with active shielding, a crew can manage there reasonably well."

"That would be difficult," said Marshall. "The inner moons are all in the radiation belts, except Callisto, and the outer retrograde moons are small, distant rocks. But never mind. Our

situation is radically different. We have seven decent-sized moons and a dozen small ones that can be explored or settled, and we have Helium-3."

"Uranus is in the same situation as us," added Sydney. "Have you asked them what they plan to do?"

"I videomailed Anand, but haven't heard yet."

"We should coordinate our response with theirs, since we're in almost exactly the same situation," suggested Sydney.

"Do you think someone will send a Helium-3 mission here, though?" said Anne, frowning. "Mars has invested over ten billion redbacks in the aerostat and the Peregrine nuclear shuttle. Who's going to do that? And if they do, we'll have years of warning."

"True," said Marshall. "So, do you think we should ignore the statement?"

"Ignore it? I don't know."

Marshall raised his eyebrows; Anne was not one to admit uncertainty. She saw his surprise. "Secretary-General Elliott of the Mariner League released a very clear statement asking what the statement really meant and what its implications were. He implied we should ignore it. We don't have diplomatic relations with China, anyway, since we're not sovereign. So why not ignore it?"

"Perhaps," replied Marshall. "But the Saturn Council is not in the same position as the Mariner League. We have real territory."

"We have a Hill sphere," added Sydney Kilgore. "Though which Hill Sphere is disputed."

"You know what would make us a Saturn Council," said Marshall. "A second borough. We've been talking about a settlement on Enceladus, for example. How big was Cassini when it became a borough? A dozen?"

"I believe Aurorae became a borough when you were born," said Anne.

"Correct; and including me, it had twelve. We have two caravels and they've been going from moon to moon, commanded by Kurt, who is a Council member. If they went together to a moon for six months at a time and set up a semi-permanent facility, why not call it a borough?"

"Especially Enceladus," said Sydney. "The biological precursors we're getting out of the geysers beg for thorough, extensive, and careful study. The mission that leaves next month is our third expedition there, and it's planning to stay four to six months. It's even expanding the moon's infrastructure."

"And Mimas gets a semi-permanently manned facility late next year, the latter for supporting Helium-3," noted Kurt. "Both Hyperion and Rhea are slated to get permanent robotic facilities and housing in 2080. We have plenty of personnel to support four boroughs off Titan, and three hundred more residents are arriving in 2081 and in 2083."

"Our response, then, is clear," said Marshall. "We're already a Saturn Council of one borough, but a second borough is coming in a matter of months—we'll move up the establishment of the Enceladus settlement—and three more are scheduled in the next two or three years. That's a lot of Hill Spheres."

"It'd give us a pretty solid claim on the entire system," said Anne, nodding. "Once the Titan-1 rotating housing facility is finished, we can move our three galleons to the other moons too, which will give them robust facilities."

"We'll need to plan some changes to the Basic Law," noted Ryoko.

"We may need to rethink our claim to sovereignty pretty soon, too," exclaimed Marshall. "In two years we'll have 3 boroughs, more than a thousand people, and Helium-3 mining. That's a pretty solid basis for independence."

"I don't know about that," said Anne.

"Well, let's think about it, at least." Marshall glanced at the clock on the wall. "That's everything I had. Shiyoko, how's construction?"

"Going well. Cathedral 2 will open in another two or three months. The foundation for Titan 1 is complete in its cavern and we're finally managing to maintain its temperature at a mere 40 below Celsius, even though it's draining off half our heat production. This is the disadvantage of building right at the surface. Additional insulation will be installed overhead next month and that will greatly reduce heat loss. The electromagnets will be installed shortly thereafter. At that point we'll be able to enclose the shell and start it rotating. We should be able to start construction of housing and work spaces in about a year."

"A bit late," said Anne, referring to the arrival of Saturn-4 in 13 months.

"We'll have plenty of space for them by the time the galleons have to leave for Mars," replied Shiyoko. "By December 2079 or January 2080, we'll be able to move about half our population into Titan-1, which means one of our three galleons will be able to move to Enceladus or Mimas at that point."

"With Titan-1 and the enlarged Cathedral Enclosure, this place is going to be absolutely amazing. Thanks, everyone, let's go have supper." Marshall grabbed his tablet and rose, as did everyone else. They all headed down the hall to the ramp well that would take them down to the

cafeteria, but at the last minute Marshall waved and turned into his office. There, he sat and quickly recorded a videomail to Anand. Clearly, Saturn and Uranus needed to coordinate their responses.

"Daddy, where were you?" asked Willie when he finally showed up. The family's supper was half over.

"He had work," said Amy, some irritation in her voice.

"I did; the Chinese statement." He didn't have to say anything more to her, but Willie said, "What Chinese statement?"

"The Chinese government has declared Saturn to belong to everyone, not just us," replied Marshall. "But we're here and they aren't."

"Of course it's ours!" said Willie, who was 8 ½. "Saturn belongs to Saturnians."

Marshall smiled. "That's right." He took a few bites of his soy-cheese ravioli and thought about the comment. Until a year or two ago, they had referred to themselves occasionally as Titanians, but when Marshall had become Chief Executive he had called for the Titan Council to be called the Saturn Council, and people had begun to use the adjective "Saturnian." Still, he had never heard Willie use the term. "So, should we declare ourselves a nation, some time?" he asked Amy.

She thought about it. "We have stage 3 self-determination."

"Yes, the League has defined three stages, and we're on top. But I have to wonder whether there's a stage 4. Mars has stage 4."

"Independence?" She contemplated the idea. "I think we are independent."

"So, are we acting independent sometimes, then pretending to be dependent when we need more money and help?"

Amy smiled. "I suppose; you tell me, you're the one communicating on our behalf!"

Marshall chuckled. "Good point. But I'm referring to all of us. To our identity."

"I'd say our identity is still that of a small, struggling, remote human community; *de facto* independent, but uncertain and anxious about our future."

"I think you're right about that." Marshall took another bite and thought about their identity as a people further. He couldn't help but wonder what the Urania community was thinking, with 2/3 the population of Titan and immense construction capacity.

As he wondered about them, the Uranian community was ending its sol as well and sitting to dinner in the cafeterias of its three galleons. "The gall of them," said Wicahpi-Luta, picking at his vegi-sausage stuffed ravioli. "We're the ones going three billion kilometers, not them. They didn't even contribute to Project Uranus, and I haven't heard anything about them contributing to Project Neptune either! "

"They're busy packing Callisto with their own people," replied Esther.

"Well, then they can figure out a way to get Helium-3 from the jovian atmosphere," replied Wicahpi-Luta. Then he quickly added, as the expert in rocket propulsion, "of course, with current technology that's impossible. Serves them right."

"I'm sure Anand will use that fact to our advantage," said Tahirih. "I do hope he can shake loose some time on the Chinese satellites. I need some close-up imaging of Elsinor Corona to complete the convective model of its southern portion."

"But you don't favor that if they insist we give up any claim to the entire system, do you?" asked Esther.

"No, our claim must be maintained. I could see that the Chinese have a point where Venus is concerned; all humanity has there is two galleons permanently stationed in orbit. But everywhere else, we're talking about human communities settled on a piece of land, with access to natural resources."

"Actually, they have that in Venus orbit, too," said Esther. "Their second asteroid has been diverted into a Venus orbit and will join up with Magellan Station and the first asteroid in a matter of months. Venus now has a moon; actually two, but they will merge. Two more will arrive in the next three years. So they have 'land' too."

"And who would send a second station to Venus orbit?" said Wicahpi-Luta, shaking his head. "There's already infrastructure there and it cost billions of redbacks, thanks to the Europeans and Indians, and again *not* the Chinese. The nations who have invested there, and the people who are resident there, make the decisions about the place."

The exception seems to be the moon, and Earth orbit," said Vahid. "There are a multitude of stations in both places."

"But that's inside Earth's Hill sphere, and no one nation can control that," said Wicahpi-Luta. "They're the exception that proves the rule, you might say."

Just then, Anand walked by. "The same debate here as everywhere else," he said to the four of them. "Is anyone here in favor of our accepting the Chinese demand?"

"No!" replied Wicahpi-Luta. "Is there anyone in favor?"

Anand shook his head. "Not that I've seen."

“So, what do we do?” asked Wicahpi-Luta.

“We go claim Uranus for the Urania community and sell our Helium-3 to anyone who recognizes our claim. I suspect by the time we arrive, this will blow over. So now the question is how to get access to the Chinese equipment in orbit.” He looked at Tahirih. “I’m working on it.”

“Good, thank you.”

Anand smiled and nodded. “I’ll see what I can do.” He looked at her and Vahid. “I guess, marriage suits you both?”

Vahid smiled and nodded. “It’s great.”

“Congratulations again. It was a beautiful Bahá'í marriage; the first one I’ve attended. We’re building a good, solid community up here, we’re on course, we’ll pass Jupiter in a few months and head for Saturn, then we’ll be alone in the sphere of the ice giants. No one will be coming along to bother us or compete with us, so we will spread our wings, be fruitful and multiply, and settle Urania. Humanity will look over our shoulder and applaud.” Anand smiled and moved on.

He felt good. At every table, people were quietly united against capitulation. Anand had never seen such unanimity on the flight, and as he went from table to table his confidence grew that they were in the right. When he went back to his office he heard Marshall’s summary of the Saturn Council’s deliberations, to which he immediately replied.

“I’m so glad you called, Marshall! The Chinese didn’t write you; they just issued a statement. But they actually emailed us, or I should say their Space Agency emailed us, and told us that if we didn’t accept their statement, we’d have no access to their Uranus satellite and the

Titania rover. But no one here wants to capitulate. I think we will say no, politely but pointedly, to the Space Agency.

"But I think we need to say more to China than that. Uranus and Saturn need to work together about this because together we will control Helium-3 sales. I think we need, together, to tell China that if they don't accept our sovereignty, they don't get any of our Helium-3. And since neither of our settlements has diplomatic relations with China, I think the Secretary-General of the Mariner League needs to speak to the Chinese ambassador on our behalf. That's the appropriate channel, right? No question that your father will do a good job, too. What do you think? Let me know. Ciao." Anand closed the recording and sent it back to Titan.

The videomail winged its way to Titan at the speed of light and arrived there an hour and a quarter later, when Marshall was finished with dinner and back home. He listened to Anand's message twice, contemplating it, then he began to craft an email. *I like your idea very much, Anand. I'll craft a joint statement and email it to you morrowsol morning. I suggest we finalize the wording and run it past both Councils, so it has the approval of them as well, then forward it to the Secretary-General.*

"I take it from your brief email, Mr. Secretary-General, that this meeting is highly irregular," said Ambassador Zhao Tao, as Will Elliott entered his office.

"I don't know; there's not much of a standard procedure for communications between China and semi-sovereign entities. It is certainly more polite for this joint resolution of the

Saturn and Urania Councils to be conveyed in writing to an ambassador than for it to be published on the web for all to see, China included."

"And there's no guarantee our reply won't simply appear on the web as well."

"That is China's prerogative, but I would appreciate a courtesy copy in any case."

"I probably can arrange that. Sit down and tell me what they say."

"Thank you." Will sat in his usual chair, opened his carrying case, and pulled out a neatly printed three-page statement with the logos and addresses of both Councils on top. "This is the official paper copy, but I'll provide you an electronic copy as well. The Councils drafted a joint statement and both passed it unanimously; they worked quite diligently for over a week on it. To summarize: the resources of the Saturn and Uranus systems, like those of Mars, are the common heritage of all humanity, but their stewardship rests in the hands of the inhabitants of each respective system. By 'system' they continue to use the natural definition available to any physicist, the 'Hill Sphere' or region where that planet's gravity dominates, and orbits about that planet are possible. They cite existing space law quite extensively in the appendix to back up their claim. Any sales of natural resources from the Saturn and Uranian systems, such as Helium-3, will be made only to nations that recognize their claim."

"I see." The ambassador took the three pages and read through it very slowly and carefully, forcing Will to wait. "They have expressed their understanding of space law very clearly, and we have expressed ours very clearly as well," he finally said, putting the paper down on a coffee table nearby. "They had the assistance of some very capable space law attorneys."

"They have access to the best here and on Earth."

"I'm sure they do, and I'm sure the Mariner League Secretariat played a role."

"We provide services to our members, of course; health, educational, legal, and now diplomatic. But we had no input on the statement itself. As I am sure you can imagine, the Chinese statement angered the vast majority of residents on Titan and Urania."

"Yes, I can imagine. If there is any response forthcoming, Secretary-General Will, I'll be sure to inform you. I don't think my government anticipated a diplomatic response to their statement."

"It may take some time to adjust to the idea that 500 or 750 people with advanced technology, a billion kilometers from another human settlement, intend to make up their own mind about things," replied Will Elliott.

4.

Settlements

Aug-Sept. 2078

Callisto was a big, battered, gray-white ball, a mass of craters overlapping craters, with bright spots of frost and dark splotches of stony or organic material. Anand sat in his chair in the bridge, stared at the images coming back from their flyby, and contemplated the presence of another human community.

"Greetings, Urania!" exclaimed Chief Executive Cai Xiaopeng. His voice preceded his image, which suddenly popped onto the view screen, replacing the image of Callisto. "Welcome to the jovian system! It's a shame you can't stop for a visit. We have a beautiful outpost here; in fact, our U-100 cylinders were designed for your use and we got to try them out first. We will follow your voyage with great interest and wish you the best."

"Thank you, Executive Xiaopeng," replied Anand. "We had to hunker down for our passage through the radiation belts, but that was fairly quick and we're now beyond them. Jupiter is a beautiful mother world for you, and your Galilean sister worlds are colorful and variegated. We regret not being able to stop and double your population briefly. I'm sure there is much we could all learn from each other. We look forward to the Outer Planets Science session we will be holding with you this afternoon. The morning session proved quite fascinating."

"There are a lot of parallels between the jovian and uranian moons, and the differences are illuminating as well. I was fascinated as well. We envy your access to Helium-3!"

"Who knows, it may be possible to extract it from Jupiter's atmosphere, some day. And we all can look forward to the time when Callisto has large supplies of liquid hydrogen, so that

visits are possible. Perhaps 12 years from now, when the planets align again, there will be a Uranian expedition that can stop."

"I hope so," replied Xiaopeng. "With Chinese and Marsian commitments to grow this place, Callisto should have two or three thousand residents in a dozen years. And with no economic resources to distract us, our purpose will be overwhelming scientific; Callisto's working population will always be one third to one half researchers. We hope to become a center for engineering and technological research as well."

"Excellent. Thank you for the call, Chief Executive Xiaopeng."

"Delighted, Anand. Say, I'm told that the time delay in our conversation is two seconds less than expected. It's really quite good; noticeably better than the session this morning!"

Anand was careful to keep a straight face and not look surprised or awkward. "You probably had access to old flight data. Our trajectory has been updated several times since we left Mars. We're flying closer to Callisto than planned because our arrival to Jupiter was delayed almost a sol from the original."

"Oh, I see. That explains it. It's a great, fast connection! I'm looking forward to the afternoon session and will offer a wrap-up afterward. Thank you for your warm opening remarks this morning."

"Delighted, I'm so glad we planned this mini-conference. Talk to you again this evening."

"Good, Ciao."

"Ciao." The link closed; Callisto returned to the screen. Anand turned to Gandhimohan and Adla Ndung'u, numbers 2 and 3 respectively in Urania's command structure. "I suppose he won't say anything to the Chinese. He's Chinese-Marsian, after all."

"But others may notice and wonder," said Gandhimohan.

"The new trajectory was spot on," said Adla. "We'll reach Saturn fifteen sols sooner than originally planned, and Uranus thirty-three days sooner: December 10, 2080."

"Not that the difference will be all that important. The Chinese aren't going to try to beat us there."

"No, but the sooner we arrive, the sooner we can start our research and make up for the lack of access currently," said Anand. "I'm glad the engineering team said the Kevlar armoring is sufficient for any collisions that are higher energy, as a result of our greater velocity."

"Overall, we are in excellent shape," agreed Adla. "Ecological management is operating more efficiently than anticipated, we've been able to convert more of our water into hydrogen and oxygen than planned, food stores are excellent, and reserves are proving quite aequate."

"And morale is excellent," added Gandhimohan. "The mini-conference has given us a sense of contact with others; of 'shore leave' almost."

"Especially the 'pair up with a stranger' program; that was a stroke of genius," said Anand. "We'll have to make even more ambitious plans for the Saturn flyby."

"Definitely, and we have time; eight months to plan," said Gandhimohan. "I've already started conversations with my friends there. It'll be a great flyby, I assure you."

Helmut tapped the three-d visor in front of his eyes to remind himself that what he was seeing wasn't really in front of him. Virtual reality was now so good, it was hard to believe.

"This is amazing," he said to himself. He couldn't actually walk around Ceres-1, but he could stand and look at the borough's large new space. It was a cylinder 200 meters in diameter and 100 meters high, prompting the nickname "the tuna can." It was already rotating fast enough to generate a fifth of a terrestrial gravity, six times as much as Ceres's pull, so the round band on which he appeared to be standing was down. He could see people walking around almost overhead—presumably the virtual reality file he was sampling had been made by someone's stereoscopic helmet camera—and they seemed to struggle a bit, because Ceres's pull was at right angles to the more powerful centrifugal pull generated by rotation. The two "sides" of the tuna can—which were really the top and bottom in Ceres's gravity—were connected along the enclosure's axis by a large transparent tube filled with lights, wires, and pipes. It supplied Ceres 1's light and renewed its air. Someone with wings strapped to her arms was flying along the outside of the axial tube, where centrifugal gravity was virtually nonexistent and Ceres's minimalist pull could easily be countered by periodical flaps.

Carter Levine, the borough's Chief Executive, had just sent him the file, attached to a video mail. Helmut savored the view and tried to imaging the buildings that were about to rise in the enclosure, tall ones along end caps with spiral ramps that extended all the way to the axis and progressively shorter ones toward the middle, where there would be a circular ring of park with a pond, a small brook, and patches of tropical woods. In a year, Ceres-1 would be set up to house all 500 inhabitants; it would later expand to house a thousand and potentially could house and feed several thousand.

Satisfied, he pushed an icon to end the projection and pulled off the three-d glasses. “Play Carter’s videomail, please,” he said.

A fraction of a second passed and Carter Levine appeared on the wall screen. He was young—just 34—and full of ideas. “Good sol, Helmut. I thought you’d like to see the 3-D of Ceres-1. This was shot just yestersol; we just opened the place to the public. I’m sorry you can’t come and walk around inside! Phase 1 was delayed by almost six weeks, but I’ll get to that in a minute.

“I sent the file to Zeke Swift II this morning and he immediately replied, saying ‘are you sure you can’t make us a 200-meter carrier instead? I am amazed by the spaciousness.’ I’m tempted to reply and tell him to go to hell, but of course I won’t do that. I apologized it was impossible with our current work schedule.

“And that’s the issue, Helmut. I need your help to coordinate matters at the Mars end because we can’t easily and usefully participate in a conference about allocation of resources. We simply can’t handle anything else; not any little addition, not a shift of a delivery to a speeder date, not anything at all. We’re overwhelmed.

“A lot has happened since you left and I took over. We had a lot of possibilities for growth and I wanted to pursue as many of them as possible, especially with 300 more settlers arriving this spring. I know you’ve been receiving detailed reports and I suppose you’ve been reading them, but I had better summarize. Last fall we were looking at a water transport 20 meters in diameter and 100 meters long and able to hold 30,000 tonnes of water. We had a contract to supply Phobos 120,000 tonnes of water and Earth orbit 120,000 tonnes of water by early 2080. Phobos wanted the 400 tonnes of nickel-steel anyway; we were pretty sure we could

sell 400 tonnes of it in earth orbit as well. The Prometheus engines are just the right size to launch tanks of that size into Ceres orbit. Marcraft has designed a very nice 500-kilowatt arcjet propulsion system with liquid oxygen afterburners, so that we can use the water as a highly effective propellant and deliver almost two thirds of the water from Ceres orbit to Earth orbit or three quarters of the water to Phobos.

"But then people asked for changes. Phobos wanted the tankage to be the proper thickness for reuse in carrier manufacture, which doubled the mass of the vehicle itself. Not a huge problem, but it required Martech supercomputer time and a lot of redesigning. The need to supply Uranus and Neptune with metal required a lot of redesign of the power and propulsion systems; the systems needed several 500-kilowatt arcjets and huge mirrors to focus diffuse sunlight onto thousands of square meters of solar panels. These were expensive modifications, but we gained some important experience for other applications.

"Then in January the Venus Authority made a very specific request for a 100 meter class carrier for Magellan Station. They wanted the thicker tankage; more, they wanted a double hull with a 10-centimeter space between them divided into compartments to accommodate water for radiation shielding. They wanted nitrogen pressure so that the tank can easily be converted to housing; that's a lot of nitrogen for us to provide, but we can do it. Launching it into Cererian orbit is tricky; the mass isn't the problem but the diameter requires a lot of supercomputer time to design the software to run the propulsion system. The Prometheus engines have to be attached along the outer edge of the carrier, each with their own pumps.

"Then along comes Swift, and Phobos—which would like to go into carrier production, but is too busy manufacturing corvets, galleons, and caravels—passed him on to us, so we are

carrying out Marcraft's carrier contracts! And they aren't putting any limits on them. Swift wants what Venus wants, but more. He wants us to fill the carrier-100 with water for sale in earth orbit. A great idea, if it were possible; the carrier would hold 780,000 tonnes of water. We'd have to lift it to Ceres orbit 30,000 tonnes at a time, and we can't put enough arc jets on the vehicle to get to Earth in less than about 15 years! He also wants several thousand tonnes of metal and plastic so that a crew can move right in and start to build, assuming he can move the water into something else, of course! We can probably come up with a partial solution if we can get Marcraft and Martech to focus research and development resources on the problem, but we don't have the resources here to solve these problems. Just completing Ceres-1 and launching our first 30,000 tonne water carrier to Phobos and launching a cargo of metal to Uranus via Jupiter has kept us so busy we've had to stop building the metal roadway around Ceres and have had to cut back on PGM production. We don't have enough people to run everything. Morale is good, at least, but people are getting frustrated. If we can increase our capacities to build carriers and use them to transport larger quantities of water and raw materials, Ceres will be able to compete economically with the lunar mass driver. So as painful as this has been, it has a positive side.

"We need Martech's help to design larger systems and Marcraft's appreciation of our limitations. It would also help if Uzboi could launch more metal to Phobos and if Phobos could produce more water itself, or produce more from Deimos. That would lighten our commitments. Those are the four parties that need to help us, if at all possible. I hope you can help. Ciao."

Helmut sat thinking about the videomail for a minute. He had indeed been reading all the reports sent him and had been digesting articles in *Ceres This Sol* and *Mars This Sol,* the two principle online multimedia sources. He had been very worried about exactly the problem of

over commitment that Carter was now complaining about. If he had remained in charge, he would have been more prudent in making commitments; Phobos would not have been getting water and metal from Ceres, in spite of its strategic importance to Mars's ability to compete with low Earth orbit and the moon. Venus would have had to wait at least a year longer.

And Swift's plans for a carrier would have been routed through Phobos only. But now that he knew Swift, Helmut knew how important it was to work with him; Swift was the kind of guy who would take a basic carrier blueprint, haul metal to low Earth orbit from the Earth or moon, and start building his own carrier. Even though the contract with him was just two months old, his technicians—a group of smart young engineers—had already proposed to Marcraft some very clever innovations. So Helmut was glad the partnership between Marcraft and Swift had been established.

Carter Levine had said something else new and very important also: that the larger propulsion systems that carriers and the transport of greater quantities of water required would make it possible for Ceres to compete against a lunar mass driver. The construction and operational costs of the electromagnetic mass driver were settling down. More importantly, it could only launch materials from one point on the lunar surface to L4; materials had to be transported by automated truck to the mass driver and had to be captured at L4 and hauled to the place where it would be used, usually in low Earth orbit. Ceres's low gravity meant that it could use fairly standard rockets to launch huge payloads into Cererian orbit—which only required a delta-v of 300 meters per second—and very cheap, slow, mass produced propulsions systems could move the cargo anywhere it was needed cheaply. Ceres required several years to get items to Earth, but large quantities of water could go the slow route easily. Ceres had more water than

all the Earth's lakes and rivers, and cheap mass produced solar arrays could provide all the electrical power the outpost there could use. Competing with the moon was a very important achievement.

Helmut hit the reply icon. "Thanks, Carter, for the virtual reality file. I took a look and was very impressed by the size of the space. I'm glad to hear Swift was impressed as well because he's very clever, innovative, and demanding. We want him as an ally, not as a competitor. Send me some of his latest requests and I'll sit down with Jimmy. We'll figure out what to say to him to keep him happy without promising the stars. And send me the cost calculations of the larger transport systems. I'll have the folks here take a look and see whether they can be improved on. Being able to compete with the lunar mass driver is crucial for the survival of Ceres, so it needs to be a priority. It won't go into operation for five years, so we need to have a solution in place in two or three, so that our cheaper stuff reaches Earth orbit the same time as the moon's. Once we have a plan, then everyone can sit down and figure out how to get there without breaking anyone's back. I'll do my best, but I'm inaugurated as Chancellor in less than a month, then the fall session of the Mars Assembly begins and that will take up a lot of my time as well. Between the two, I hope to have more leverage for Ceres than ever."

He hit send and turned to other messages. But it was now 11:30; time to go get Oskar out of Mariner Hospital, because they were releasing him that sol.

Mariner was a five minute walk; a deeply buried facility to eliminate all cosmic radiation and reduce other risks as much as possible, with four dozen functioning beds but space for two hundred more in case of emergency. Oskar had changed out of his hospital robes and was dressed and ready to go. "How do you feel this sol?' Helmut asked, as he entered his son's room.

Oskar shrugged. “A bit better. Boy, am I glad to be getting out of here.”

“I’m sure. Let’s go.” Oskar rose and they walked to the nurse’s statin to say good bye, then headed down the hallway to the exit.

“I hope I don’t have to come back here again, but I suppose I will.”

“The doctors say if you keep taking your medication, the leukemia should stay under control.”

“But all my life, dad? That sucks!”

“They may be able to craft a genetic solution. The research on Earth is quite far advanced, and we have access to just about anything they can do. We have to be patient.”

“I don’t want to be patient, I want to be normal!”

“Well, take the pill every sol and you should be normal. That’s what they say.”

“Ninety percent chance. There’s a ten percent chance the leukemia will escape again. I wish I knew why this is happening to me.”

“It was a stray cosmic ray strike; it could have happened almost anywhere, even in a well shielded place. Random. Nothing we can do about it.”

“I guess. Sirikit believes everything has a purpose.”

“We can make everything have a purpose, Oskar, or we can cry tears and be helpless.”

“But I don’t know dad. I don’t know I *can* have a purpose.”

“Again, be patient with yourself. For me, you and Charlie and mom are my purpose. So is Mars, and Ceres.”

“Yeah, I know.” That didn’t seem to be enough for him. “Can we walk through the Emporium on our way to grandpa’s?”

"Sure. It's totally changed; glittering and prosperous like you wouldn't believe."

"I want to see it. You guys have, but I've been stuck in the hospital three months."

They walked—slowly, because Oskar was still weak—across the Outpost to Andalus Enclosure and strolled through both Silvio's and Deseret, all three floors of displays. Oskar was exhausted and feeling a little sick when they headed for Sebastian's place for lunch.

"I was happy to see the Emporium, at least," he said to the family as they gathered around him. "The stores were so small and plain, when we left."

"We can make just about anything up here, now," said Sirikit. "If you think Silvio's was plain when you left for Ceres, you should have seen it when I was a kid. It would have fit in this apartment!"

Oskar smiled at that. "I was amazed to see the pet store! I think there was just one dog here when we left, a husky. Now there's a pet store with a dozen breeds of dogs, several kinds of cats, plus birds, fish, rabbits, and lizards!"

"Do you want something, son?" asked Helmut suddenly. Oskar had shown some interest in the pet store, but suddenly there seemed to be more.

"You know, I think I would like a dog," said Oskar suddenly. "What was that little, bright-eyed one?"

"A terrier," said Helmut.

"A dog in our house?" said Clara, trying not to sound alarmed.

"Yes, a dog," said Helmut. "I think that would be perfect for Oskar, right now. You'll have to take it out and walk it, you know."

"I bet it would love Uncle Kristoff's farm," added Charlie. "There's that long dirt road along the edge. It could run free there."

"Ukraine enclosure's pretty big, and it's all his," agreed Helmut. "What do you say, Oskar? Shall we get you that terrier, after lunch?"

"Yes, sure!" said Oskar, with an excitement in his voice and a sparkle in his eyes that no one had seen in months. "I'd enjoy walking it in Ukraine."

"Kristoff will have to authorize your entry, but I'm sure he will," said Sebastian. "He'll be here shortly. Let's sit down and dish out the lunch before it gets cold. The house keeping robot will be here in 90 minutes and I want to be sure the dishes are all ready for it to wash and we're all pout of here so it can clean then!" Sebastian pointed to his big dining table, which was set for eight, since Kristoff's wife, Irma, was coming as well, though the twins weren't.

They all turned to the table and sat in their places, then Sebastian passed the roast veggie turkey, mashed potatoes, mixed vegetables, gravy, and corn bread around. Kristoff and Irma arrived just as the food reached their places, embraced their nephew, and expressed relief that he was well enough to be home again. "I just want to resume a normal life!" exclaimed Oskar, exasperated.

Helmut nodded. "I'm sure the dog will help. Oskar and I are going to the pet store this afternoon to buy him a terrier."

"Oh, that sounds like fun! You can walk him in Ukraine any time," said Kristoff.

"I was hoping you'd say that, Uncle Kristoff! Thanks!"

Helmut turned to his father and cast an eye on Kristoff at the same time. "Remember the African violets?" he said, referring to a time when Sebastian was on Mars and Kristoff, as a

young teenager, was back on Earth and missing his father terribly, and the two of them had been able to collaborate in the study of an African violet found accidentally growing in a tree pot in one of Mars's enclosures/

Sebastian smiled warmly. "Oh, yes, I do!"

"I think a dog will be more fun, though," said Kristoff, and they all laughed.

The dinner table grew quiet for a minute, while everyone chewed. Then Helmut said, "So, Sirikit, what's going on down on Earth now?"

She smiled. "A big controversy. The new central Bank for the world dollar is supposed to keep inflation under control; the published goal is no more than 3 percent per year. But it is hardly a secret that the governments are all willing to accept 7% per year. But no one is happy that it appears this year's inflation will run 15% per year! That's too much."

"Why does it matter?" asked Oskar.

"Fifteen percent inflation means that in five years, your money will lose half its value and prices will double," explained Sirikit. "In normal times, the goal used to be just 1 or 2% inflation per year. A slight, slow increase in prices encourages people to buy things, because prices will be higher if you wait. But high inflation causes all sorts of problems. If a bank loans someone 100,000 redbacks to buy a house over 20 years, by the time they pay off the loan, they'll have paid less money in real terms than they borrowed! That's bad for the banks. The reason everyone was willing to accept 7% inflation—which halves the value of money in about 10 years—is because the war and the depression forced governments to borrow more money than they can now pay back. The inflation cuts down the amount of real value they have to pay back. The loaners take a haircut, but at least they get back something; otherwise, some governments would

default entirely and they'd get nothing. Also, by retiring the massive government debt faster, the world economy can start to grow again. But no one wants 15%; that hurts everyone."

"They built the world dollar on the plan that its value would drop, right?" said Kristoff. "That's why there are only 500 world dollars per ounce of gold, whereas there are about 1,000 redbacks."

"Yes, and 1,000 redbacks per ounce is itself an indication of the strength of our currency," she said. "In US dollars, year 2000—which is a benchmark many economists use—gold would be worth $2,000 per ounce. The US dollar currently is so deflated, gold costs over $100,000 per ounce. That's a reason it's being phased out in favor of the world dollar. A lot of people have been denominating prices in redbacks, because it is relatively stable! I suspect the world dollar will come down in value to equal the redback in a few years, and they'll try to keep it there."

"How will the high inflation affect our partnerships with Swift Space and other places?" asked Helmut.

"The value of their assets—property, equipment—will adjust upward as the world dollar drops, so that shouldn't be an issue. The main thing to watch for is a stock market bubble, because money can't go into government bonds; their value won't keep up with inflation. Investments are going into stocks and real estate instead."

"Interesting. Sounds like our partnerships should be alright, then. It looks like Ceres will play a big role in them. We're also working on ways Ceres can compete with the lunar mass driver."

"That's very important," agreed Sirikit.

“So, do we have a breakthrough?” asked Jacquie Collins.

“I wouldn’t call that,” replied Jane Addison, the Director of Nuclear Propulsion. “Thank you again for coming to the Nuclear Propulsion Lab, Madame First Minister Jacquie. We’re quite excited by our progress. It hasn’t been a breakthrough as much as steady progress. As you know, gaseous core propulsion is now a decade and a half old. Our first engine had a specific impulse of 2,000 seconds—double solid core nuclear engines—and cost a half billion redbacks. Pretty steep, but that was the breakthrough. We can be thankful to NASA and Los Alamos Laboratories for all their investment in the project. Our second engine had a specific impulse of 3,500 seconds and with the investment in a production line here at Aurorae, the cost was 150 million redbacks each. Quite an improvement. We can repurpose the production line pretty cheaply, because this new engine represents the latest in a progressive improvement, which saw the specific impulse rise to 4,000 seconds and the production costs drop twenty percent. The new engine will have a specific impulse of 5,000 seconds—probably the max we can achieve with this technology—and if we manufacture fifty of them over a five year period, the cost will be down to 100 million each.”

“That’s impressive. Five thousand seconds; that’s an exhaust velocity of about 175,000 kilometers per hour!”

“Exactly,” said Jimmy Khan. “It means that we can now dock four galleons or corvets together in a stack with two gaseous core engines—for redundancy—and fly them here in 60 to 75 sols. A galleon is rated for 800 people on a flight of 75 days or less; a corvet is rated for 1,500. That doesn’t include the zero-gee gyms and other facilities we can include in between the vehicles. That means we can fly 3,200 or 6,000 people here at once—depending on the vehicles

deployed—using about a tonne of liquid hydrogen per person. These complexes will mass about 2.3 tonnes per person at launch and 2 tonnes per person at arrival, so they will provide robust radiation protection. The gaseous core engines and the uranium 235 fuel they burn up will add ten to twenty thousand redbacks to each ticket. We can then fly the vehicles back to Earth on a fast trajectory, refuel them, and fly them back here via Mercury or Venus. Those are generally eight-month flights; a four-galleon complex is rated at 500 per vehicle and the corvets at 1,100 per vehicle for that duration. The second wave would arrive about a year after the first and would be 2/3 as large. The vehicles could then be flown back to the earth nearly empty at a very fast pace so they are in place for the next opposition."

"We were planning to use a 4-vehicle galleon complex and a 4-vehicle corvet complex for the first time next columbiad," said Jacquie. "With the goal of flying 12,000 people here. But you are now saying that with these new gaseous core engines—assuming we can have 4 of them ready in time—we can fly 9,200 here in the first wave and 6,400 in the second wave, for a total of 15,600."

"Exactly," said Jimmy. "That doesn't include anyone added to the commercial flights, either. United Space Alliance and Lufthansa are planning a joint two-galleon complex and they want permission to use our technology to build a three or four galleon complex. That gives them the added redundancy to pack more people in, and more gaps between the vehicles for inflatable zero-gee gyms and open space. If we give them permission, that's another 1,500 people at least, 3,000 if they build a four-vehicle complex. They'll fly people here using chemical propulsion on a 6-month trajectory and the vehicles will separate to aerobrake on arrival. But you can be sure they'd buy gaseous core engines as well, if we agreed to sell them."

"The higher exhaust velocity makes a propulsive arrival burn quite feasible, and reduces the risk that aerobraking brings," agreed Jane.

"We could sell them the gaseous core engines, too," said Jacquie. "The bigger issue I have is the huge increase in immigration this produces. The logistics are massive. Getting 6,000 people into low Earth orbit in a two or three month period is hard, but you're now talking about 12,000! And at this end that's housing, work space, and 200 square meters of polder per person. Then there's the controversy that increased immigration causes."

"You'll have to resolve the politics, I admit," said Jimmy. "We're providing you a way, basically, to complete the goal of the 2084 immigration in 2080. Because 2082 was supposed to see 15,000 arrivals and 2084, 18,500. Now it appears we can transport the 2082 goal in 2080 all by ourselves, and the 2084 goal is achievable if we let the commercial carriers do what they want to do. A Prometheus passenger vehicle can carry 150 to low Earth orbit every 48 hours, or 1050 in two weeks. In two months it can transport 4,200, so three of them can transport 12,000, and Earth already has five such vehicles, each flying tourists to orbit once a week. So there's huge capacity. A ticket to low Earth orbit is now 75,000 redbacks and when we fly large numbers up the volume reduces it to 50,000. We can get them to Mars for another 150,000 with this system. When Zeke Swift was here, he repeatedly said we should throw open the doors and let people come who want to pay their own way, assuming they pass the physical and psychological tests, which just about everyone can. Why not?"

"Jimmy, simple housing, basic work space, and polder for them at this end costs 200,000 redbacks. We have a budget to build for 12,000, but we don't have a budget for 18,000! The

difference between those two numbers is *1.2 billion redbacks*." She emphasized the number. "That doesn't even include any equipment they might need to have imported!"

"Let the private sector here expand! A quarter of that cost is enclosing the polder they need for food and materials. We can now manufacture pile drivers, the dome materials, regolith sorters, and other equipment faster and more cheaply than ever. I suspect this is not as difficult as we think. We just need to plan."

"And we need people to be able to compete," added June. "That's something else Swift made clear. We need to double, triple, quadruple our GDP, and as quickly as possible."

"Importing a bunch of 40 year old dreamers with skills we might not be able to use is not that helpful to our GDP."

"Jacquie, they'll open all sorts of businesses, or they'll export intellectual property," replied Jimmy. "Let writers come and sell their manuscripts to Earth. Let artists come and sell their digital art. Let builders and restauranteurs and farmers and hair dressers and florists come. We still have a huge shortage of small and medium businesses because the people who come here are scientists and engineers. We need the dreamers who can liquidate their terrestrial assets, use half to fly their family here, and use the other half to get established here."

"The cost of living here has become comparable to that on Earth because the price of land on Earth has been driven up," said Jane. "Here, we can just enclose more of it, so the price is fairly stable. The banks here have enough credit to support loans to more arrivals, too."

"We'd need input from the economists about that." Jacquie sighed. "So, what does this do to expansion into the rest of the solar system?"

“The new engine is very good for Venus because the flight there is already pretty fast and the delta-v is low; now fuel consumption will be much less,” replied Jane.” Fuel consumption to reach Mercury will become a minor cost, so they can expand their population as fast as they can build housing and enclose land. That still costs them several times more per person than it costs us because they’re smaller and the enclosure techniques are more complex, but they’re coming along.

“The engine means flights to Ceres from Earth or Mars can be completed in six months, flights to Jupiter in six months, flights to Saturn in 12 months. Uranus can be reached easily in a bit less than 2 years and Neptune in three. Eventually, even Neptune can be reached in 2 years. That means Pluto will be a two-year flight as well and inner Kuiper belt objects in three to four.”

“Neptune in three years.” Jacquie considered that. “With the Chinese legal aggressions lately, we may want to move up our Neptune mission.”

“Why not?” agreed Jane. ‘The big issue so far has been propulsion.”

“It also means if we want to transport two thousand tonnes of cargo to Mars, we can do it for less than a half tonne of liquid hydrogen per tonne of cargo,” said Jimmy. “That’s still more than the price via a solar sailer, but we may have a way to lower the price sharply. I’ve been talking to Helmut Langlais, and with Carter Levine on Ceres. We can produce large quantities of liquid hydrogen on Ceres, launch it with chemical propulsion into low Ceres orbit, and use a gaseous core nuke to send it to earth orbit or to Phobos. The nuke is probably cheaper than chemical propulsion because it can transport larger quantities. The transportation price should be about 10,000 redbacks per tonne and transport would take 6 to 8 months rather than several years.”

“The lunar mass driver can’t launch hydrogen,” noted Jacquie. “The Prometheus cost is 50,000 redbacks to launch hydrogen to low Earth orbit from the moon and 100,000 redbacks per tonne from the Earth’s surface. So that’s a potential breakthrough for us, since we consume more liquid hydrogen in LEO than anyone else.”

“It means we can transport other cargos from Ceres fairly cheaply,” said Jimmy. “We can get them cheaply and quickly to Phobos also, so that it will no longer have to get some of its raw materials from the Martian surface at a cost of 25,000 redbacks per tonne.”

“We’re only beginning to consider all the implications,” said Jane. “The engine manufacturing line will need 500 million redbacks in upgrades. If we start right away, we’ll be able to use the engines in two years.”

Jacquie nodded. “I want a written report submitted to the budget office right away, and the economics department needs to review the numbers and explore the economic options further. I assume this engine design will be stable for five years?”

Jane nodded hesitantly. “I am sure there will be minor improvements. But we can’t get much higher performance; the uranium plasma in the engine core operates at 20,000 degrees Kelvin!”

“Wow. And fusion propulsion is still 10 years away?”

“At least. We might have a working engine by then, but it will be massive and expensive; suitable for use in the outer solar system, but not for transport in the inner solar system.”

“Alright, let’s get the paperwork going to do this,” concluded Jacquie.

4

Adjustments

September 2078

Helmut Langlais nodded briefly to the audience as he stepped away from the podium to a rousing applause. He scratched his arm; the doctoral robes of the Mariner Institute of Technology were itchy, and it seemed to him their design was part way between that of a medieval monk's robes and a 21st century pressure suit; a rather strange combination. He sat at his seat on the platform between Vanessa Smith, Martech's outgoing Chancellor, and Chief Minister Jacquie Collins. He glanced at the audience; Clara was seated in the front row and was beaming with pride, as was Sebastian, Kristoff, Irma, and all the kids.

"Well done," whispered Jacquie, as the Aurorae philharmonic struck up their closing piece.

"Martech is in good hands," agreed Vanessa.

"I hadn't expected a speech about civilization," said Jacquie. "And I very much appreciate the emphasis. You are right: Martech is our principal instrument for defining Marsian and mariner civilization."

"We always have been, thanks to the diversification that Vanessa oversaw. Our economics department has an international reputation, our sociology and political science departments have been doing important cutting edge work, the effort to develop the arts aspect is important, and we can now turn to developing literature and history. They'll never approach the size of our STEM facilities, which theoretically could count 2/3 of our adult population as

adjunct faculty. No university in the world has 10,000 faculty! But we could, if we want to go that way."

"We should," agreed Vanessa. "Especially if we can market online courses by many of them. They'd pay for themselves, enhance the university's reputation, and bring in additional revenue from Earth."

"I agree," said Helmut. "Thank you for all you've done, Vanessa."

"Thanks, Helmut," she replied. He nodded to her and turned back to the music. In some ways, the change of leadership occurred at an awkward time; from April to the end of August, Mars had received 9,000 immigrants, raising its population to 33,000. A thousand of them worked full time for Martech, raising its work force from 3,000 to 4,000. There were still misallocated offices, missing furniture, and poorly timed equipment set-up schedules to straighten out.

The philharmonic finished and everyone applauded. It switched to a recessional and the hundred or so on the stage rose and processed out of the auditorium, heading for the open-air reception outside. Helmut pulled off his robe with some relief and put it on a chair.

"Good speech." Helmut turned and saw Johnny Lind approach him. "I was very surprised by the emphasis on civilization. It seems to me that a scientist such as yourself understands the centrality of science and technology to our future."

"I do, of course, Johnny, but 'civilization' doesn't take away from science. It balances it, rounds us out."

Johnny shrugged. "I supposed. I've never understood the arts, and I'd leave the humanities to Earth. It has never contributed materially to GDP, for example."

"I'm not so sure. A population with a well-rounded education makes better political and social choices."

"Could be. At any rate, I'd favor another scientist with a Nobel Prize or a very strong research c.v. as head of Martech."

Helmut was startled by that. "Perhaps next time." He turned away from Lind, who was known to be socially inept or rude at times. Johnny, as the commander of missions that landed on six moons of Saturn for the first time, probably had the sort of c.v he preferred.

Jacquie came into the room at that moment, having deposited her academic robe in an office somewhere. She made a beeline for him. "You look startled."

"Johnny Lind just said he would have preferred a chancellor with a stronger research record!"

She shook her head. "Vanessa was solid that way, but it didn't make her a better Chancellor. You have the experience of running an outpost doing important research *and* engineering, and one focused on exports and economic growth. In short, you are perfect for Martech. Ignore Johnny." She sighed. "He's giving me trouble, too. In a private meeting yestersol, he said he'd oppose aspects of my fall legislative agenda."

"Really? Why?"

"He wasn't very clear. But Johnny is sometimes . . . strategic in his thinking. He'll oppose something to make a name for himself, I think, rather than because it's the best thing for Mars."

"Just what we need."

"Revolutionary fervor is fading somewhat." Jacquie shrugged. "We've been independent thirteen years. Only a quarter of our population was here at the time; the rest has arrived since."

"In some ways, one of the best ways to retain revolutionary fervor is to import the young and idealistic!"

"That's true. I plan to present Jimmy Khan's plan to expand immigration. But I feel ambivalent about it. We're talking about a bit more than a fifty percent expansion, next columbiad. That'll be quite a strain culturally as well as economically."

"The people who arrive are already assimilated to our culture; that's what I've seen in the last month, talking to people in the Emporium and in restaurants. They want to be Marsians. They felt Marsian even when they were on Earth. We won't be able to expand at fifty percent per columbiad forever; I don't know how we'd raise immigration over several tens of thousands. So I say, expand now and plateau later."

Jacquie nodded. "You may be right about that."

Live images from Enceladus covered the wall of Saturn Mission Control. Marshall turned from one to the other, watching the slow progress. Both caravels had landed on the moon half an hour earlier and had slowly moved closer to the U-75 enclosure that had been completed several years earlier, but hadn't been used much. On the ridge 200 meters away were two solar dish concentrators fifty meters in diameter that tracked the sun and produced 10 kilowatts of power. A hundred meters from the enclosure, at the base of the ridge, an automated vehicle with a 20,000 kilowatt nuclear reactor had landed the sol before.

The crew had been coming out of the two vehicles in groups of four for the last half hour. They had been slowly hopping around the landing site, adjusting to Enceladus's 1% gravity, and looking at the geology, even though it had been thoroughly explored. As the last group came out, Kurt Hollingworth said "Mission Control, permission to enter the U-75."

Marshall leaned toward the microphone. "Permission granted," he replied. "Since the robotic connection to the reactor was completed, the interior temperature has gone up almost 100 Celsius, but it's still about 20 below zero in the main area. The lab, however, is at room temp."

"Thanks. I've been watching the temperature sensors." Kurt turned to the common frequency. "Let's go inside!"

The fifty crew that had arrived on the two caravels headed for the U-75's airlock. Kurt went in first, with four others. Once inside, they removed their helmets.

"Terrestrial standard pressure," Kurt said, nodding happily. "But rather cold."

"Even so, let's see the enclosed area," urged Sydney Kilgore.

"Alright." Kurt pointed to a hallway that led them past the prefabricated metal building filling the end of the cylinder. He led the first group down the hall to the other side.

"I guess once upon a time this was big, to us, but now . . ." said Sydney. The cylinder was 75 meters long and 37.5 meters high with a curved, semicircular floor. Titan had much larger enclosures, but once upon a time the enclosure was a standard size.

"It's big enough," said Kurt. "Three floors in here, and there will be plenty of space to grow all the food for 100 people, and we have plenty of power from the nuke until we install geothermal power."

"But we do need to expand the lab." Sydney bounced a bit on her feet. "This low gee will take some getting used to, especially as we alternate between the artificial gravity in the caravels and this place."

"We've got plenty of time. We need to have the spaceport ready for Helium-3 support in two years. The geology and biology labs won't take much time; this space was already set up for them once."

"Let's go into the lab where it's warm!" said Sydney.

Kurt nodded and led them back down the hallway and into the main entrance area of the building that had been erected inside the U-75 several years back. It still had old couches and chairs, though they were hard to use in the low gravity, which was even one third as much as Ceres's. But at least the room was warm; people took off their helmets and gathered. Neither caravel yet had a space where all fifty of them could easily assemble; once some of the lab equipment was moved out, that would change as well.

As the majority of the Enceladus crew assembled, Marshall walked back to the Saturn Council's meeting chamber, where the rest of the Council was gathering as well. They had an entire ceremony planned out. Once everyone was off the two caravels—except a skeleton crew left on each—Marshall nodded to a video technician to start the live broadcast over *Saturn This Sol,* their multimedia website.

"Greetings to the residents of Enceladus," Marshal began. "Congratulations on your safe transit and landing on Saturn's second closest major moon, and the second most important moon in the Saturnian system. With its warm ocean, its bionts, its active geology, its geysers, and its geothermal power, Enceladus is the second most important world in the Saturnian system. It was

actually the first place humans landed; Titan was second, and it was many months before both galleons moved from Enceladus to Titan. More expeditions have returned to Enceladus than to any other Saturnian moon. Enceladus has more automated infrastructure than any other world, except Titan. Biological research on Enceladus is of ongoing significance to our understanding of the origin and evolution of life in this solar system. Because of its proximity to Saturn itself and its low gravity, Enceladus is a logical base of operations for our Helium-3 extraction effort.

"For all these reasons, several months ago our plans for a return expedition to Enceladus underwent significant revision. Rather than a six-month visit for biological research, the expedition became a one-year visit with three crucial objectives: to renew and expand biological research, to set up a spaceport from which Helium 3 operations could be run, and to refurbish the U-75 so that it can provide food, recycle wastes, and provide work space for up to 100 people. With the continued expansion of the population of the Saturnian system, which now exceeds 700, the Saturn Council felt it was time to set up Enceladus as a permanent borough with its own government. With the refurbishment of the U-75, it will be necessary to retain only one caravel on the surface to provide gravitied housing for a population of fifty.

"In order to establish an Enceladus Borough, the Saturn Council has made several changes to our implementation of the Basic Law that governs our community. The Saturn Council has, to this date, consisted of seven members elected by the entire population of the Saturnian system. The Council has approved a new system so that the Council will now consist of seven members elected from among the population of Titan and one elected from among the population of Enceladus. We call on the residents of Enceladus to choose their representative in the next few weeks.

”At the next regular election, next year, the Council will grow to nine. Each borough, including Titan, will elect one member automatically, with seven seats on the Council distributed proportionally. This means that at our next regular election, the Council will consist of eight from Titan and 1 from Enceladus. When a borough is established on Iapetus—which is likely to be next, in five years or so—it will elect one member as well.

“The Saturn Council has asked me to ask the residents of Enceladus this question: are you ready and prepared to declare yourselves a borough and elect a borough council and a representative of the Saturn Council, based on the stipulations of the basic law?”

Marshall paused. Kurt Hollingsworth turned to the residents gathered in the room and said “Are we ready to declare ourselves a borough and elect a borough council and a representative to the Saturn Council?”

“I so move,” exclaimed someone.

“Second.”

“Objections?” Kurt looked around the room. “All those in favor of the resolution please assent by saying ‘aye.’”

“Aye!” thundered everyone.

“Opposed?” There was no response. “Mr. Chief Minister Marshall, the residents of Enceladus have declared themselves a borough.” Kurt had intentionally used the title ‘Chief Minister’ and this had been planned in advance as well. The Basic Law did not specify unambiguously a title for the chief executive and they had customarily used ‘chief executive’ just like the boroughs on Mars. But now, Saturn was a multi-borough community, so the title had to change.

"Thank you, Commander," replied Marshall. "All of us here are thrilled by this development and look forward to hearing the results of your election. The Commonwealth of Saturn has undergone a historic step this sol."

"'Commonwealth'? 'Chief Minister'? It's absolutely outrageous!" exclaimed Ambassador Arthur Danforth.

"Not really, Ambassador Arthur," replied Helmut. "You have to appreciate the isolation they feel. No one can invade them or rescue them; they're on their own. It was the same way with Ceres, but at least we're just a few months from Mars, and imbedded in the solar system's largest 'archipelago,' as it were. We need Marsian help. Saturn has Helium-3 and profound isolation."

"And note, they did not declare independence," added Will Elliott, who happened to be standing nearby. "They do not plan to establish diplomatic relations with anyone, either. They plan to continue working through the Mariner League. Nothing has changed."

Arthur turned to Zhao Tao. "The Chinese have forced their hand. If your government hadn't declared everything off Titan to be free territory, they wouldn't have done this."

Ambassador Zhao nodded slightly. "That may be true, but I see no evidence my government will recognize this claim, either. They are a Council of two boroughs on two moons, so they control two Hill Spheres. There are still significant Hill Spheres for Tethys, Mimas, Rhea, Hyperion, and Iapetus, not to mention nearly a hundred smaller moons and the planet itself. They can call themselves the Saturn Council, but that doesn't mean we have to recognize their claim."

"On the other hand, if they and Uranus refuse to sell Helium-3 to governments who don't recognize their jurisdictions over their respective planets, a few Chinese fusion reactors will not get the fuel they need," noted Will.

Zhao nodded. "My government has not yet said what they will do about that, either."

"We'd better sit; the program is about to start," said Arthur. The others nodded and the group dispersed, Arthur and Zhao to the VIP area in the Mars Council, and Will and Helmut to their seats as representatives. It felt funny for Helmut to sit in a real chair in the Council, because he had been a video member for several years and had watched the deliberations on a screen with a time delay of 10 to 37 minutes each way. Now he was there in person, still as a representative of Ceres but also as Chancellor of Martech, a job he still found it hard to believe that he had.

"All rise for the Chief Minister!" announced the Speaker of the Council, Johnny Lind. Everyone rose and Jacquie Collins entered the chamber to applause. She stopped to shake hands with a few people or say hello, then walked to the podium, where her speech was already projected onto the teleprompter.

"Mr. Speaker, members of the Council, justices of the Supreme Court, ambassadors, distinguished guests, good morning," she began. "Thank you for your interest in this special session of the Mars Legislative Council, called at an important turning point in our history to review our progress and to look forward to greater accomplishments and successes. We have just completed the largest immigration wave in our history, with 9,137 new people successfully launched into low Earth orbit, transferred to a dozen interplanetary vehicles, flown between the planets and braked into Martian orbit, brought safely to their destination borough, and settled into their new home and work place. The Marsian Commonwealth now embraces 36,346 people.

Aurorae alone has grown to 21,000 people. Notably, Phobos has grown to 1,500 and in four years may become our second largest borough. Even distant Ceres now exceeds 700.

"Tying together our boroughs is a network of hyperloop-compatible metal highways that now connect Aurorae to Uzboi, Aram, Thymiamata, Kalgoorlie, Elliott, and Meridiani. Metal also connects Cassini to Dawes. In less than two years the Aurorae to Tithonium and Meridiani to Dawes links will be completed, and 95% of the surface population will be within quick, cheap surface transportation of each other. Embedded in the metal road are methane and oxygen pipelines, which means energy can be transferred among our boroughs and ten thousand kilometers of surface will be opened to fairly easy settlement. A revolution started almost ten years ago, will be complete."

She paused for strong applause, and she deserved it; the metal highways were a very important development, worth the billions that they were costing. "A similar transportation revolution is imminent in the interplanetary realm, thanks to the diligent work of our nuclear propulsion laboratory and their terrestrial partners. Gaseous core nuclear engines sustain a nuclear reaction in a uranium plasma ball surrounded by hydrogen, which is heated to temperatures approaching the surface of the sun and blasts from the exhaust bell at velocities of 175,000 kilometers per hour. We can now mass produce these engines for 100 million redbacks each and they are good for five transits between Earth and Mars before they have to be expended. Two of them—an extra for redundancy—can be attached to a 'stack' of four corvets and can power them between the planets in as little as 60 sols, allowing the stack to transport 6,000 people comfortably. Because of its speed, the stack can make two round trips per columbiad, though the second trip will take much longer and will transport a little over 4,000

people. In short, a single stack, with these more powerful engines, can transport more people than our entire immigration wave this columbiad. The amount of hydrogen propellant needed is less; the amount of consumables per person, less; the amount of use per vehicle in its lifetime, more. The implications are staggering.

"First, next columbiad we can transport 18,000 people instead of the intended 12,000, because of the greater use of pre-existing vehicles. We had a very smooth arrival process this time; doubling it is not out of reach, but will require reallocation of resources, which my new budget calls for. We have wanted to procure a second set of state of the art enclosure equipment that can move via metal road among Cassini, Dawes, and Meridiani, and that's in the budget. So is stimulation of the construction industry to expand their output of housing and work space. The result will be a larger, richer, more capable Mars.

"Related to this goal is a new way to look at immigration. Heretofore we have selected immigrants from among a pool of applicants, paid their way, and set them up here. We will continue to do this, but we will now also allow people to pay their own way, if they satisfy certain criteria, such as physical and mental health, sufficient assets, and skills appropriate for earning a living here. There is a chance that the cost of immigration in our budget, next columbiad, will be smaller than it was this columbiad, even though the cohort will be twice as large. Revision of immigration procedures is also in the legislative package.

"The new propulsion system has implications for the rest of the solar system as well. Some of our immigration flights will pass Mercury and Venus and allow larger, less expensive, flights to both. Six-month trajectories to Jupiter are possible. Saturn will be reachable in one year. Higher speeds and larger volumes of hydrogen will allow flights to Uranus in 18 months

and Neptune in 2 years. Because all these worlds will soon be able to build their own carrier-style rotating accommodation, the vehicles going back and forth will not be needed to accommodate additional residents and can be dedicated to passenger transport, which makes settlement of the outer solar system cheaper. The robotic probe to Neptune we plan to launch next year can reach that world before the settlement flight departs in 2083, allowing Neptunia to start its exploration earlier. Probes to Pluto and Kuiper Belt objects that include landers and rovers are now feasible in a reasonable time frame and have been added to the budget I am submitting to you. Helium-3 shipments can be sent to their customers more quickly, speeding up the return on investment.

"Finally, our new budget anticipates important changes on Ceres. The completion of their rotating housing means that they can now accommodate a much larger population. Because they have access to vast quantities of ice that can be cheaply purified and launched into space, Ceres will become our main supplier of liquid hydrogen, in Earth orbit as well as Mars orbit. Because Ceres processes hundreds of thousands of tonnes of nickel-iron every year to extract their PGMs, it will become the chief supplier of metals to Phobos. It has sufficient access to carbon and nitrogen in the form of methane and ammonia dissolved in subsurface water to become a bulk supplier of plastics. Gaseous core nuclear engines will allow the more rapid movement of bulk supplies to the inner solar system and shrink the flight times that our development plans must accommodate. Therefore, my budget includes major expansion of Ceres to a population of 1,000 and expansion of its production and transport facilities. Ceres will be able to complete with the moon, even after the completion of the latter's mass driver, if we are smart. Its role in the Marsian economy as a crucial complement to Phobos is secure and important.

"In summary, my friends and colleagues, this budget represents an important adjustment for Mars: an adjustment to new technology here, to the lunar mass driver, and to the great increase in terrestrial investment in space. With it, we will be poised to remain central in the space economy and as the leaders in humanity's outward expansion. I look forward to your deliberations."

Jacquie stepped down from the podium to sustained applause. "A bold plan," said Will Elliott out loud, and Helmut nodded in agreement. Johnny Lind heard the comment and turned their way with a scowl. Once the applause had died down, he said, "Thank you, Chief Minister Jacquie. All of us have now received the legislation you have proposed and I am sure we will read it very carefully in the upcoming sols. Your speech and news conference yestersol answered many questions people had as well. You can be sure that we will give the bill very careful and respectful consideration. During your speech, several indicated they wished to speak, and I see even more representatives have signaled their request for the floor. We will start with comments by David Hamm."

Hamm, who was the new Chief Executive of Cassini, rose at his seat. "Thank you, Mr. Speaker. I think I speak for all the Central Highlands boroughs when I say we are delighted to hear that we will finally receive state of the art equipment for building large enclosures. The idea of providing us with only one, however, is problematic when we have three settlements that require the new, larger enclosures. We are at the point where Cassini, Dawes, and Meridiani—which now will get a spaceport of its own—can provide high quality schools for children and a diverse economy, so all three deserve the chance to grow. Aurorae remains by far our largest settlement, but ironically, it has no natural resources. It has to import its metals from

Uzboi. We are the economic bedrock for Mars and we can't get the resources to compete with Aurorae. So if there is to be a large immigration wave, send them to the Central Highlands, and give us the resources to accommodate them! In a way, they're already our resources, because our gold is Mars's largest export."

He sat to scattered applause from the representatives of the other Highlands boroughs, but Ramesh Prathan stood and said, "We're not without resources here, David. We're producing a billion redbacks of deuterium per year. At that rate, half the cost of each immigrant is covered by the profit made on the deuterium extracted from the water he needs."

"Ramesh, all of us have water. If Cassini received a lot of immigrants, we'll have big enclosures, we'll need a lot of water, and it'll be profitable for us to produce deuterium as well."

Johnny waved to cut off the informal debate. "Rodrigo Moreno," he said. The Chief Executive of Uzboi rose. Helmut scowled, wondering whether Johnny was favoring the people who were against parts of the bill.

"Uzboi naturally will be concerned about anything that undercuts its role in the Marsian economy, and it sounds like Ceres and the moon might do that. Thanks to the metal highway, our products can be moved to Aurorae spaceport very efficiently and inexpensively. So I would hope that launch costs will be examined again so that ways to reduce them can be found. All of us have to compete against the moon, once the mass driver goes into operation. Lower launch costs here will also mean lower launch costs from the surface of the Earth, which makes immigration and imports cheaper as well. The mass driver is going to cost several times more than the cost of developing the Prometheus. Surely, a few billion redbacks can lower launch costs again and maintain our competitive edge."

Rodrigo sat to applause. Helmut scowled at that comment because, no doubt, Swift Space and other launchers were considering exactly such investments. “Lyle Quincy,” called out Johnny.

Lyle was a teacher in the Aurorae system and a well-known curmudgeon. “We are always told that we need more immigration,” he began. “But no one has proposed doubling the numbers from one columbiad to the next! We’re talking about our population increasing over fifty percent in 2080-81! While we all like to see new faces and we all like the idea that more people mean a greater diversity of goods and services up here, let us remember that one quarter of our workforce—that’s over six thousand people—do nothing but make the enclosures, the housing and work space, and the stuff that the arrivals will need. It’s an incredible fraction of our population. If our population increases by half, doesn’t that mean we’ll need to devote more like a third of our workforce to provide them the space and materials they need? How will we do that, now that the entire immigration wave for 2078 has arrived? I find it very hard to believe that just because the last wave arrived smoothly, the next one can as well. That doesn’t follow logically.

“I think we need to be very careful about increasing immigration drastically. Robots are more productive than people and don’t require oxygen or a large store in the mall. We can use our resources wisely to expand our GDP and stay competitive. And we can do it in a way that we are more comfortable here as well. That increase in construction workers can be devoted to producing more consumer goods, and why not? Let’s be more competitive and live better at the same time.”

Lyle sat to strong applause. Immigration and consumption had been a controversial choice from almost the beginning. Johnny looked around the room. “I think it is clear there are

important issues for us to deliberate," he said. "We've had an immigration goal—a sort of quota—of thirty percent per columbiad for several decades, and it has worked well. Why should we increase it to fifty percent? And does that mean we'll increase the percentage to seventy percent in 2082? Where will it stop? What material sacrifices are necessary here, to make it possible? We have slowly and painstakingly increased the terraformed area per person from 100 square meters to 200 square meters, and even that's pretty small! Will we let that number slip back down to 100? What do we do if we have a depressurization emergency and lose some of our polder? These are very serious risks, and even if they are unlikely they have to be planned for.

"We haven't even gotten to the possible problems with the solar system side of the proposed legislation. Are we planning a bigger wave of settlement to the outer planets? To what end? Should we really be devoting so much money to the expansion of Ceres, and can we really make it economically viable, or will it be a constant drain on our resources? It sounds crazy to haul 10,000 tonnes of liquid hydrogen to Phobos or to Earth orbit at once, with perhaps a thousand tonnes of metals and plastics as cargo as well. These are huge issues to explore. Who wants to defend these ideas?"

Helmut's hand shot up; he was not pleased by the way things were going. Johnny saw his hand and hesitated, but Helmut stared at him intently and Johnny involuntarily nodded. "Helmut, our Ceres representative."

Helmut rose. "One of two Ceres reps, Johnny, and I should add that as Director of the Institute for Space Settlements and as Chancellor, I have some expertise on this subject.

"First, some technical quibbles: the next columbiad was scheduled to receive 12,000, so the jump to 18,000 is a 50% increase. It may be a doubling compared to 9,000, but a third of that was already planned. Most of the original 12,000 was scheduled to arrive in 2080; that number increases to maybe 14,000, so that's not a huge increase. The gaseous core engines allow us to spread out the arrival time some, also. The remaining 4,000 come in 2081 via Mercury and Venus, so there's extra time to prepare the additional enclosures and buildings for them. We already have 200 square meters for 36,000 people and we were already planning to add 200 square meters for 12,000 more, so even if we manage to enclose no additional polder, the number of square meters per person would only drop to 175. The additional state of the art enclosure equipment that the Central Highlands will get will allow additional polder to be created, too, so the drop should be short lived.

"More importantly, however, is the conception of our future that immigration represents. Can we build fifty percent more robots and increase our GDP fifty percent, with just a modest increase in immigration? Yes, we probably could. We need the increased GDP to compete. But Mars is more than a financial player in the exploration of space. Mars is a civilization. But we are a very small civilization, and we need people to remedy that, not robots. We need writers, artists, musicians, philosophers, public intellectuals; we need Nobel Peace Prizes. We need to keep our ideational edge because that's what attracts people to this place. They didn't come here to buy a house with large closets in order to fill the closets with clothes and shoes! We have a lot more clothes and shoes than we used to. In fact, many of us have closets that are now too small. So we are doing pretty well, materially. But we don't need to be as prosperous as our cousins on Earth because we are sacrificing to support a dream: the dream of building a new scientifically

and rationally based civilization, one that is inclusive, with no gross injustice or absurd racism or crippling poverty or debilitating drug abuse problems or frightening crime or anxiety-causing terrorism, a place where people can feel like they are serving a greater purpose for humanity while they are raising their families and living a life which is enjoyable as well as purposeful. That's Marsian civilization. It is attractive; it is an example; and it needs to grow. And we need to sacrifice some additional shoes and clothes to make it happen. Because at this point, we are so well established here, any troubles caused by an extra 6,000 immigrants over a year's time won't cause a collapse or gross hardship, just a decrease in the already abundant consumer goods.

"As for the solar system side of things, the Neptune settlement was probably going to launch in 2083; this just makes it official. We're already sending migrants outward and no additional commitments have been made, but the speech this sol just said that we can now get people there faster and probably cheaper. Every settlement off-Mars needs to aim, next, to hit the thousand mark, and they all will. That's an important critical mass for health, educational, and consumer services; the Institute for Space Settlement is studying exactly what benchmarks make sense, and you can be sure the time will come when they will grow to that point, because they aren't going to shrink.

"Competing with the lunar mass driver is a palpable concern for us, and should be, but so is competition and partnership with terrestrial commercial interests. You want to make launches to low Mars orbit cheaper? We can't do that ourselves, but there are a lot of companies now competing against the Prometheus. We need to work with some of them to make a combined system cheaper. Otherwise, terrestrial launch technology will get cheaper and we won't be able to adapt it Mars, so we be at an economic disadvantage. It is also clear, from Martech and

Marcraft studies in the last few months, that Ceres can indeed build and launch to orbit vehicles in the ten thousand to fifty thousand tonne class. The engines to get these behemoths into low Ceres orbit would be hydrogen-oxygen systems and clusters of Prometheus engines are sufficient. But getting those vehicles to Mars or Earth is best done with an advanced gaseous core engine, which ideally needs to push vehicles of 10,000 tonnes or more; otherwise, you waste a lot of uranium when you expel the uranium plasma ball. The uranium costs a million redbacks or so and the engine, which is good for at least five uses, costs 100 million, so if it pushes 50,000 tonnes in its lifetime, the cost is only 2,000 redbacks per tonne. The mass driver won't be that cheap! When you remember that a cylinder 100 meters in diameter and 100 meters long—in other words, the basic outer shell for a carrier—can hold 60,000 tonnes of liquid hydrogen, you begin to get some idea about the synergies that Ceres can offer. Build it on the surface, launch it into Ceres orbit, top it off with liquid hydrogen if you can't launch it full, add a few thousand tonnes of metal and plastic parts for internal construction, and send it anywhere in the solar system with a pair of gas core engines. If you don't need the hydrogen on arrival, fill it with hydrogen and oxygen propellant instead and use a chemical engine to do the same thing. Ceres can send half-built carriers to Venus orbit, complete with water for shielding, where they can be docked together and people can move into them one by one as a settlement for studying that fascinating world is expanded. Or they can move to any point in the earth-moon system to support industrialization there. Yes, it can compete with the mass driver if we plan and invest.

"So, that's the vision this bill represents. That's the promise it faithfully offers us. Let's not get hysterical about the worries or get immersed in our narrow interests. This is good for Mars." Helmut emphasized the last point and sat to applause. Johnny scowled at him angrily.

6.

Negativity

December 2078/January 2079

"What an amazing house!" said Ethel. She and Will stood at the edge of the property looking at the entrance area, which descended in beautifully landscaped terraces to the front of the home and its pillared main door.

"It must be the largest house on Mars," agreed Will. Then he quickly added, "That's publically owned, anyway. The houses around it may be bigger!"

"They put our house to shame. It was the largest house when it was built!"

"That was twenty years ago, and a different era. Well, let's go in."

Ethel nodded and they proceeded down the ramp through the garden. The house's roof was a tropical garden at the ground level, complete with palm trees; it was surrounded by a wall for privacy. The pillars extended up to the top if the privacy wall, making them two stories high and quite grand. The entire entrance areas, which faced the western sun, was glass, and the lowering sun poured into the public area of the house. Discretely hidden light wells took light down to the lower level where the private quarters were located, well buried for radiation protection.

The main door was open; the murmur of the party spilled out. The wall to ceiling windows were cover by sheer curtains and were impressive. Helmut saw them coming and hurried to the entrance. "Come in, Will and Ethel! Thank you so much for coming!"

"We wouldn't miss this for the world!" replied Ethel. "We've followed both Charlie and Sirikit since they were babies!"

"It's an honor to be invited," echoed Will. He looked around. "What an incredible place!"

"Vanessa wanted the Chancellor to have a proper residence for entertaining, but she didn't authorize it and spend the money until she decided she would resign; she didn't want to live in it! And it is a bit embarrassing to have such a house, but it's quite a privilege as well."

"Didn't you already have a house, too?"

"We had just bought it and moved in! Now it's Charlie and Sirikit's."

"The Chief Minister doesn't have anything like this," said Will. "I suppose that will have to be authorized now."

"Probably! I invited the diplomatic corps over last week; this place is designed for fund raising and networking. Zhao took one look and said, 'China needs to replace its embassy,' and Arthur overheard the remark and added 'the US, too'!"

"Andalus is going to be rebuilt quite a lot in the next decade. Well, let's go congratulate the star students."

Helmut gestured them in and they walked over to Charlie and Sirikit, who were talking to other guests. But they immediately stopped for the former Chief Minister and his wife. "Thank you for coming!" said Sirikit, jumping up.

"We wanted to share your joy and relief!" said Ethel to her.

"Written doctoral exams are a big hurtle," added Will. "I'm sure the dissertations will be much easier!"

"Mine's already outlined," replied Charlie, as he shook Will's hand. "The exam was long, but wasn't too bad."

"He was ready," added Firuz Moulin, Charlie's advisor, from a nearby chair.

"He's been finished almost two weeks," said Sirikit. "Mine was just five sols ago."

"And she got an 'outstanding'," said Hunjai Park, her principal advisor.

"I'm not surprised that both of you did so well," replied Will. "You're brilliant and focused. Congratulations to you both. Are you aiming to get the dissertations done by June?"

Charlie shook his head. "Six months isn't enough. More like September, for me. There's a lot of data analysis."

"I'll take a year," said Sirikit. "The solar system economy is a pretty dynamic subject; it keeps changing!"

"That's why we need you," said Will. "The role of Mars seems to be shifting. Gold and PGMs are still our biggest income sources, but deuterium is now growing and Martech is producing more and more patents that earn royalties to Mars."

"Two hundred million redbacks last year," confirmed Helmut. "And we should hit half a billion in a few years, thanks to its expansion. We're bringing the best and brightest."

"They want to come here," said Charlie. "I am amazed how much Martech has changed just since Siri and left for Callisto four years ago! You can get lost in all the new corridors!"

"It reminds me of MIT," said Ethel.

"We need to greet the others," noted Will. He turned to Hunjai and Firuz, shook hands with both of them, and thanked them for the solid work with the two ABDs, greeted Kristoff and Clara and the other children, then gave Sebastian a hug.

"You must be so proud," said Ethel.

Sebastian smiled. "You can't begin to imagine! I keep thinking back to 2025 when I joined the European Space Agency's Astronaut Corps—Helmut was just three years old and

Kristoff was a newborn!—humanity hadn't even returned to the moon yet, and here I am looking at a grandson who has gone to Callisto and contemplating the imminent possibility of great grandchildren!"

"Oh, are they expecting?" asked Ethel.

"No, not yet; they were waiting until they had the exams over." Sebastian shook his head. "Life has such unexpected twists, huh Will?"

"It really does, Sebastian. You're the 'old man of Mars' at 86."

"I know, who would have imagined that, either! Everyone says the radiation makes this place dangerous, but so far the oncologists have kept me one step ahead of the trouble!"

"And without major interventions, thanks to laparoscopic technics, nannites, and a zillion tests," said Will. "You've been much luckier than me! They're going to send the nannites into me next week to remove another pancreatic tumor."

"Will you have any down time?"

Will shook his head. "I'll have to take it a little easy for a sol or two."

"We've been blessed with families, too," said Ethel. "When I reflect on everything we now know about child bearing on Mars, I think our children were miracles!"

Will and Sebastian nodded. Just then, Helmut came over. "Will, I've been meaning to thank you for that breakfast you hosted in late October. It's been two months, but I haven't seen you since. I was very impressed by the spirit of hospitality, collegiality, and happiness you created. I think it helped to heal some of the differences that developed in the legislative session."

"I hope so. I worked really hard on the atmosphere; I was wiped out for two sols afterward, partly because of the stress I felt. The session was so unnecessarily negative. In the end, Jacquie's budget and plans received eighty percent of the votes, but it took an extra two weeks to get there."

"It was unnecessary; a big waste of time. I don't know why Johnny dragged things out."

"Johnny was trying to find a way to raise his status, so he was trying to block Jacquie's agenda in order to show his leadership to everyone. Lyle jumped on his bandwagon and Ramesh decided to oppose them for the same reason, or similar reasons. But the standard techniques of generating negativity and controversy on Earth don't work so well here. Our population is better educated, it is not automatically distrustful of government, and it is suspicious of selfishness. After all, we depend on each other to maintain our oxygen supply! Johnny was trying to find a way to use old techniques here to advance his own agenda. Eventually the effort exhausted itself and he ended up looking foolish. But—" Will paused for a moment. "We still could have ended the discussion sooner and more positively if everyone responding to Johnny and Lyle had done so with more consistent kindness. Ramesh made that impossible."

"Maybe I should have talked to him."

"Maybe I should have; he can perceive you as a rival, but not me. I appreciated your stress on creating a civilization and not just building robots to push up our GDP, Helmut. It's a positive response, it's ideologically attractive, and it creates a human ideal. But referring to 'hysterical' worries or immersion in self-interest: while that is true, pointing it out causes three problems. First, it is better to let the legislators figure that out themselves. Second, it alienates the negative ones. And third, it allowed them to accuse you of being negative."

"And they did!" said Helmut. "You are right, I probably shouldn't have used that language, but I was mad!"

"Of course you were mad! I was, too. But it kept a spiral going and provoked the speech by Lyle that more money should be spent on the education of children and less on Martech! I think your first speech made your points well and if you had dropped your last sentence, it would have been better. *Mars This Sol* picked up on the sentence, too, and repeated it, amplifying it. I spoke to the editor about that because I think it distorted your points, but that will happen. When I get mad about something, I try to figure out how to respond to it in positive language, because it will reduce the blowback."

"And that will shorten the debate." Helmut nodded. "Yes, I think you are right. On Ceres, we have always been careful to maintain and build trust, and it was a small community where egotism seemed rather obvious. Things are more complicated, here."

"And they'll get even more complicated as our society gets bigger. No sooner did we pass legislation allowing self-funded immigration, United Spaceways decided to launch a flight via Venus in a few months and bring us 600 people we never expected to receive before! Spare capacity is suddenly gone and we will have a taste of the complications that start in 2080."

"Yes, 2079 starts in a week and it will prove more complicated than we had ever expected. And the economic situation on Earth is sliding downward again."

"Who would have thought that an international strike could be called and pulled off in 70 countries about robot-generated unemployment! So now there's all sorts of legislation being considered and all sorts of economic uncertainty. But at least an international consciousness is emerging."

"Yes, that's a silver lining. At least the winter is normal; no more volcanic cooling."

"This is potentially quite serious," said Hun-jai, piping up from across the room. "Permanent unemployment may now be 15 or even 20%. No one knows what that will do to politics. It's generating lots of demagogy."

"Hun-jai, let's switch seats," suggested Ethel. "That way, you can participate in this conversation better."

"Thank you," replied Hun-jai. He rose and switched seats with Ethel, who overheard a bit of the conversation Sirikit was having with her mother, Kim, her sister in law, Irma, and her mother in law, Clara.

"Twins worked pretty well," said Irma. "It was really exhausting for two years; *really* exhausting. I couldn't work at all. Maybe it was the personalities too; Mark just wouldn't sleep and kept waking up Niki! But look at them now, all grown up and starting Martech!"

"I'd never take geminale," said Kim. "I suppose I shouldn't complain that it's unnatural; so much of our life up here is! But I prefer the natural arrangement."

"I think it'd be a lot of work, to raise twins," said Ethel. "That's what would worry me. "

"It depends on whether you want to go back to work after the maternity leave ends," said Clara. "I think twins may make that more difficult, depending on the personalities."

"Don't forget you get a year of maternity leave for twins!" said Irma. "And you can spread it out. That's very helpful."

"How often are kid hard to get to sleep?" asked Sirikit.

"Who really knows?" replied Kim. "A lot of it has to do with the parenting. You should take the 'parenting babies' class at the hospital."

"I plan to, now that the exam is over," replied Sirikit. "And there's all the crying."

"You can't sleep well at all for six months," said Irma.

"It depends. Marshall was no problem, but Liz was really difficult and colicky," said Ethel.

"No one seems to understand that very well, either," said Kim. "Just remember you've got two grandmothers who will help!"

"And probably two grandfathers as well, if we put a little pressure on them," added Clara with a smile, and Kim nodded.

"I know. Charlie and I have some talking to do about this," said Sirikit.

"Our burn is complete," reported Commander Christine Niehaus. "All is nominal with Saturn 4. Our projected arrival at Titan is now June 28, 2079."

"God speed, Saturn 4," replied Commander Arun Harris of Jupiter 6, just seconds later. "Thanks for accompanying us on this leg of your trip to the ringed planet. It was great to share the flight with you. Enjoy your view of our new home for a few more hours. We hope to see you again some day."

"Maybe Neptune?" asked Christine. "It was great to fly with you, Arun. And I loved beating you in handball every week!"

"It wasn't every week, Christine, but our striker team beat yours almost every week! I guess it's appropriate that we kept the striker court with us and you kept the handball court with you."

"Hard to reverse it, anyway. Best wishes to you and your crew, Arun. The Jupiter system is a big and fascinating place, and you guys have a lot to contribute. I look forward to reading all about it."

"Thanks, and keep in touch. Jupiter 6 out."

"We will. Saturn 4 out."

Marshall turned to the others in Titan Flight Control. "We hadn't planned to hear all that! It sounds like the two galleons had a really good flight together."

"We were listening in to the traffic every sol," confirmed Julia Lopes, who was in charge of flight control. "The two crews had a lot of friendly rivalry and that produced a lot of fun. Some of the Saturn 4 crew even studied Chinese. Christine and Arun challenged each other to all sorts of contests, some silly. They placed silly bets on contests between the crews, too. Saturn 4's glee club was best, but Jupiter 6's theatre troupe got better reviews than the Saturn 4 players."

Marshall laughed at that. "Glad to hear we have some good singers coming this way. I gather there were two recreational bubbles in the stack, and the one attached to Saturn 4 had the handball court."

"Yes, and the aerostat, and the Peregrine," said Julia. "The two bubbles were both sandwiched between the galleons, with a gas core nuke on the outside of each. Saturn 4 is now on the way here faster than any ship destined for Titan before."

"We can be proud of that." Marshall turned to Iris Geyer, who had also come to Flight Control to follow the progress of the burn. "So, you're on your way to Enceladus on Frisol?"

She nodded. "With the first contingent of engineers for the Helium-3 work. I wish we weren't devoting three months to setting up a geothermal power system, though!"

"I know, but someone has to do it, and the construction teams here can't spare anyone. Once we get the geothermal system in place, Enceladus will have access to 25 megawatts of free power and the nuke can be saved for later. Enceladus borough needs to manufacture a thousand tonnes of liquid hydrogen to send Saturn-4 back to Mars, and the turnaround time is pretty tight."

"I know, and the U-75 is mostly set up for the final work on the aerostat and the Peregrine. Enceladus probably is a better place to base them; closer to Saturn, less delta-v to get there, and no problem getting in and out of Titan's atmosphere. I just hope we can get the *von Braun* there by June, when Saturn 4 arrives. We can't fit everyone into two caravels at that point."

"Don't worry, we'll have the *von Braun* outfitted for flight by then. It's delaying the work on Titan-1 somewhat, but we'll manage. Titan-1 will be rotating a month before Saturn 4 arrives, so it'll provide plenty of space for exercise, and that's the main thing we need to maintain health. We have plenty of housing in Titanian gravity for the arrivals. The kids will be going to school in the *Cassini* anyway, so they'll be exposed to plenty of gee every day, and the 'Hotel Korolev' should provide everyone the chance to hang out, eat, and sleep in gee at least once a week."

"I suppose I'm worrying because I use the exercise center on the *von Braun* every sol!"

"Maybe. I use it, too, but I also jog up the spiral ramp from the bottom of the bioarchive three times a week, and I wear fifty kilos when I do it. That's exhausting! But it's good for my bones."

"A lot of people do that, and jog around the *Cassini* after school's out. It'll be good to have the *von Braun* on Enceladus, because it sounds like it'll be our permanent headquarters."

"We'll see whether the Helium-3 team needs to be based there permanently. Certainly, the Peregrine maintenance crew will have to be there whenever the Peregrine flies down to Saturn to recover helium-3. Once the aerostat is deployed in the atmosphere, the crew to monitor and run it can be anywhere. And once Titan-1 has sufficient housing and work space, all three of the galleons can depart. We may send one back to Mars and keep two here for permanent deployment on Enceladus or another moon, like Iapetus."

"Remember, everyone would rather be here. Enceladus will never be as large or as comfortable. It's fine for a temporary assignment to set up or repair equipment, but not to raise a family."

"I know, and I agree. Enceladus will be our interplanetary transportation hub because its gravity is low and it lacks an atmosphere. Titan's atmosphere is an impediment to making Titan spaceport our hub, until we can build some large nuclear powered spaceplanes based on the Peregrine. Once we can manufacture and store large quantities of hydrogen and oxygen propellant on Enceladus, it'll be the best location for flights down to Saturn or back to Earth and Mars. But the spaceport crew and the scientific crew there can rotate back here periodically. I doubt it'll need to have more than fifty, so the *von Braun* will be the perfect size for them."

"And we're working with Marcraft on a larger version of the Peregrine for use here," said Iris. "It'll work much better in our atmosphere than the caravels. I still think we should set up a propellant storage facility in Titanian orbit and do away with Enceladus."

Marshall shrugged. "I'm not so sure. A little bit of gravity is very helpful. Tanks anchored to the surface of Enceladus don't need orbital maintenance systems and are partially shielded from micrometeoroids, and any humans there are partially shielded from radiation, not

to mention that there's an 'outside' to go to if you get cabin fever. It's not just a question of bolstering our political claim to the entire system."

"I know, but it's a lot of delta-v to get to Enceladus." Iris shrugged. "At any rate, we'll be ready when Saturn 4 arrives. We can't wait."

Marshall nodded. "It'll open a whole new era of the study of Saturn."

When Wicahpi-Luta approached the table where he and Esther usually ate supper, he saw that Vahid and Tahirih looked rather grave. His first reaction was to find another table, but then he said, "Can I join you?"

"Yeah, sure. No problem," replied Vahid. "How are you on this Sunsol eve?"

"Pretty good. I didn't see you at brunch this morning. Did you enjoy New Year's?"

"Yes; wasn't that a great program? The play in the afternoon, the concert after supper, then dancing and the countdown to 2079 . . . so much fun."

"It was great. It's hard to believe we've been on our way almost a year."

"It's a big solar system, isn't it?" Vahid looked at Tahirih and the conversation seemed to hang in the air.

"I'm sorry if I interrupted something," said Wicahpi-Luta.

"No, that's alright," said Tahirih. "We're trying to figure out what to do."

There was a long pause. "Reverend Varma has decided to offer children's classes Sunsol afternoons--the same time as the ones the Bahá'ís are offering—and he suggested to people in the Protestant service this morning that they stop sending their kids to the Bahá'ís," explained Vahid.

Wicahpi-Luta frowned. “Why doesn’t he offer his classes at the same time as the church service?”

“So that the kids can attend the service.”

“I see. Esther said something about that. She went to mass last evening, before the New Year’s celebrations started, and she said that there was an announcement about a ‘Christian’ school for children on Sunsol afternoons.”

“Oh? So, the Catholic service is involved, too?” said Tahirih.

“Ask her.” Wicahpi-Luta pointed; Esther was approaching with her supper tray. “Good sol,” she said, as she sat.

“Good sol,” replied Tahirih. “So, they announced a ‘Christian’ children’s school at mass last night?”

“They did, and I think it overlaps with the time of the Bahá'í classes; 1 to 3.”

“That’s exactly the time we hold ours,” said Tahirih. “Reverend Varma announced it in the Protestant service this morning, and he added that people shouldn’t send their kids to the Bahá'í school.”

Esther frowned. “No one said that at mass. But we really aren’t very well organized. The parish council meets only once every few months. Sometimes we’re not sure who’s leading the mass, since we don’t have a priest and people don’t want Patrick, as deacon, to do it all the time. Reverend Varma steps in sometimes, but usually we watch a recording of the Sunsol mass in the Aurorae Cathedral.”

“The deacons have three or four years of consecrated host to distribute,” added Wicahpi-Luta.

"Well, it sounds like Varma is behind this," said Tahirih. "If he wanted that time slot, we would have been glad to move our school to another one. We're happy to cooperate; we want to support good interfaith relations. But it sounds like he's intentionally undermining our school."

"How big is it?" asked Wicahpi-Luta.

"You saw the kids when you spoke about Lakota traditions last month," replied Vahid. "Urania only has thirty-five kids between 6 and 18. Our class is attended by ten or twelve, depending on the week."

"Not bad; a third," said Esther. "The evangelicals were doing a small class before the Protestant service. I think it was attended by six or eight."

"Most kids don't get any religious education," said Vahid. "Our class is interfaith and focuses on virtues. We use some Bahá'í quotes, but we use quotes from the Bible and Qur'an and Buddhist texts as well. It's the primary service the Bahá'í community offers to Urania and we're glad to do it. Half of us are involved, any particular week."

"And so are others; I remember I came in and talked about the idea of sacraments, six months ago," said Esther. "It was a really nice bunch of kids."

"I think we'd send our kids, if you are still holding classes, whenever they are old enough," added Wicahpi-Luta. "Of course, we don't have any kids yet."

"I'm amazed you have time to run the classes," said Esther.

"It's service," replied Vahid. "We want to build community, and the main way you build community is to serve."

Esther nodded. "What are you going to do?"

“We don’t know,” replied Tahirih. “The Spiritual Assembly meets in a little while and will discuss the matter. We want to maintain and strengthen unity, but we also want to continue a valuable service.”

“They are great classes,” agreed Esther.

“We should go, in fact,” said Tahirih. “Good to talk to you, and thanks for the information about the announcement in the mass.” She grabbed her tray and stood up. “Ciao.”

“Ciao,” replied Esther and Wicahpi-Luta to Vahid and Tahirih. They watched their friends walk across the room and drop their trays in the return area.

“That’s really too bad,” said Wicahpi-Luta. “I thought Varma was a pretty good guy.”

“He is, but he is not warm to interfaith, as you know. He’s strong on ecumenical relations, but competitive about other faiths. I wonder whether he decided to make some trouble to see what advantage he can gain.”

“That’s too bad, because it could backfire. He didn’t want a peace pipe ceremony when I offered it, but the Bahá'ís did.”

“They live and breathe interfaith. I wonder how many devotionals they hold every week, individually and as a community?”

“Quite a few, and a lot of people participate in them, or hold their own and invite Bahá'í friends.”

“I wish Varma would warm up and offer something more than a worship service, Bible study, and now a competing children’s Sunsol school. I’ll have to ask him why he has done this.”

“It smells funny to me,” agreed Wicahpi-Luta.

She nodded and turned to her food. “So, are you guys starting the ion engine this week?”

"I got the text an hour ago. Yes, we're going to run it for two months. It'll cut two weeks off our trip."

"Good. We're all getting cabin fever, in spite of the gyms."

"Yes, that's the main reason for getting to Uranus faster!"

"Definitely." Esther smiled. "But we have our distraction tonight."

"It's time?"

She nodded. "My temperature is up slightly."

He nodded, both delighted and worried at the same time. "Alright."

7.

Agreements and Disagreements

Jan. 2079

"It's amazing what they've been able to build in five months," said Jacquie, looking at the wall-size three-dimensional image of Ceres-1.

"It is," agree Helmut. "They have an army of construction robots at work 24 hours a day, moving sheet metal and beams into place and welding them. As a result, they've completed the floors for five stories all the way around the 'ventral' end of the cylinder; that's the end lying against the ground on Ceres. That band of construction is 15 meters wide, so they already have 38,000 square meters of floor space; enough to house 400 of the 700 on Ceres, once the walls, wires, and pipes are installed! They've also installed the entire first and second floors for the next band, which is 25 meters wide. The third floor will be finished in another 5 weeks and part of it will be 'Central Square,' the plaza around which commercial and civic structures will be erected. The third band will be 20 meters wide and will occupy the very center of the cylinder; it'll be just one story high and will have a park on its floor. Bands four and five will be identical to bands 2 and 1 respectively in terms of width and complete it to the 'dorsal' end, which is the end cap farthest from the surface of Ceres. Altogether, Ceres-1 will have about 150,000 square meters of floor space. At 50 square meters of living and working space and 200 square meters of ecological space per person, it'll accommodate 600. Expanding the existing ecology outside the cylinder, it can easily hold 1,000 people."

"And it'll be finished in another year?" said Jimmy.

“Eighteen months for everything, but some people will start to move in just three months from now. Central Square and its businesses open in five months. Bands four and five will be built last.”

“I can see why everyone wants a cylinder,” said Jacquie. “Very open and spacious. Phobos is how far along?”

“Three months on a nearly identical interior design, including Central Square,” replied Jimmy. “With their larger robotic workforce, they plan to have it finished in 18 months total. They don’t need the interior ecology, so they’re aiming at a population of 1,500. The design of a second cylinder is already being completed.”

“And the 100-meter class cylinders for Swift and for Venus?”

“Ceres has started on one and will have it completed in six months,” replied Helmut. “It can be filled with water and launched to its destination in about a year. A second one can follow a year later. The question is, who to give the first one to: Swift or Venus. Our contract with Venus is older, but it is flexible and Swift is not.”

“I know what you mean. Jimmy?”

Khan eyes Helmut nervously. “I think we gave our word to Venus first, so they get the priority.”

“I see. Launch windows?”

“Either way will work about equally,” said Helmut. “Ceres has already launched a thousand tonnes of metals to Uranus via a Jupiter gravity assist; that was the most time sensitive.”

"What about the contract to supply 120,000 tonnes of water to Phobos and to Earth orbit within a year?"

Helmut shook his head. "Carter was too ambitious and never should have agreed to them. The water is available, but building the launch vehicles in that time frame is beyond Ceres's resources. It might have been possible if Ceres-1 hadn't been built, but it gave invaluable experience, and people badly need the open space. Living in caravels and galleons for years and years is hard."

"I can imagine." Jacquie reflected a moment. "How much water would a 100-meter cylinder hold?"

"Three quarters of a million tonnes; more than Ceres can feasibly launch."

"Okay. We'll send cylinder 1 to Swift and load it with the 120,000 tonnes of water we need in low Earth orbit and whatever hydrogen we can manufacture and whatever water we can include for Swift. That gets us the water we need, albeit, a year late. Any way cylinder 2 can make a stop at Phobos with the water it needs, then proceed to Venus?"

"We can look into that," said Jimmy. "There will be a launch window from Ceres to Mars opening about the right time, and Mars has a launch window to Venus fairly often. We could use one of the new gaseous core engines to move the cylinder from Phobos to Venus."

"Let's try that plan, then," said Jacquie. "Ceres must expand its capacities. Is the next passenger flight planned accordingly?"

"Well, there's still an issue," replied Jimmy, looking at Helmut nervously. "The galleon has a capacity of 150 from Earth to Ceres on a 6-month voyage, but it includes 25 planetologists

for the Martech-Ceres Department of Meteorics and Asteroids. Construction and fabrication wants those passenger slots."

"They left Phobos for Earth last year and have been doing visiting professorships, giving lectures, and completing research with colleagues," explained Helmut. "They went there knowing that the next flight to Ceres would come from Earth and they'd have berths on board."

"That must be a third of the department!"

"Exactly. They've been scheduled to go to Phobos; where better to study asteroids, than from the heart of the belt? We can't kick them off the flight now."

"No, we can't," agreed Jacquie. "Can we add an annex or shorten the flight time?"

"Either way, it'll cost," said Jimmy.

"Look, Ceres has to expand its power production tenfold in the next few years in order to meet its export goals, especially liquid hydrogen," said Jacquie. "If Ceres can manufacture a cylinder every three years for Earth and a cylinder every three years for Phobos, and probably one cylinder every three years for other places, and fill them with liquid hydrogen, we will have a really robust and capable capacity. That must be the goal. So make that happen. If a few of the planetologists have to take the next flight, that may be the best we can do."

"We'll figure something out," replied Helmut, worried.

Estherr did not talk to Reverend Raj Varma right away. She still found it hard to believe he was intentionally competing with the Bahá'í children's class. He had an excellent reputation for being saintly and fair, and she had great respect for him. But by the next Sunsol, it was clear that the Protestant children's class had shifted to the same time slot, and Varma again urged people in his

Sunday Protestant service to tell their friends not to send their kids to the Bahá'í class. He repeated the same in the Catholic mass Satursol evening, which he came to help run. A Jewish friend of Esther's told her that even the Jewish service discussed his request that Jewish kids not attend the Bahá'í children's program, a request everyone found puzzling, since none of them had any children of the right age. So Tuesol, Esther went to Varma's office on her way to work.

"Good morning, Esther, good to see you," said Reverend Raj, as he preferred to be called. He had arisen from his desk and approached her to shake her hand.

"Thank you, good to see you as well," she replied. "I had been tempted to visit you yestersol, but I know Monsol is your sol off."

"That's for sure! The weekend is full of Sabbaths, so I can't take either of those sols! How are you and Wicahpi-Luta doing?"

"Very well, thank you, though like everyone else, confinement to three galleons, two caravels, and two gyms is getting a bit tired. Two more years to go, too."

"I know, it's a long voyage. But we'll pass Saturn this coming summer, at least; that'll be a big milestone."

"It will be, and then we'll get to see how well the Helium-3 system works. The Helium-3 team seems a bit worried; they'd rather not compete with Saturn."

"But they're collaborating closely with them, too. It'll be good for everyone. Sit down. So, what can I do for you?"

Esther nodded and sat in a comfortable chair. She nodded. "Thank you. I was curious about something. I understand from my friends in the Protestant and Jewish services that you have asked people not to send their children to the Bahá'í children's class, and to take them to the

Christian school instead. I was wondering whether this was true, and whether it interfered with the good interfaith relations people have been building on this voyage."

"I hope it doesn't interfere in the interfaith work at all. We have a good, solid dialogue going on, and that has help strengthen interfaith understanding in Urania. But the Christians in this settlement are the plurality of the population; we're thirty percent of the population and two thirds of the *religious* population here. We should have our own Christian Sunsol school for kids. And why would Christians want their children to go to a Bahá'í school instead? That doesn't make any sense."

"Perhaps, but your new school replaces the old evangelical Sunsol school for kids, and I know some people in the Catholic community wonder whether 'Christian' really means 'Protestant.'"

Varma shook his head. "No, it does not. This is to be a Christian school for children, which means we stay away from controversial, sectarian subjects. The theology is that of the Apostles and Nicene creeds. There will be no position taken on sacraments or clergy or ritual; each group can educate their own, where those aspects are concerned. We will have times when the group can break up into Protestant and Catholic subgroups. The Protestantism I'll teach will be the basic theology of the Reformation."

"And who will teach the Catholic group?"

"That's up to the parish board. Maybe they should ask you; you're young and you know it pretty well!"

"But why did you move the time to 1-3 p.m.?"

"That's probably the most convenient time. It's hard to get kids up in time for a school before the Protestant service at 11. We think we'll get more kids after lunch."

"I see. Still, couldn't you have warned the Bahá'ís?"

Varma scowled at her. "Why are you worrying about the Bahá'ís so much, Esther? They'll do their thing and we'll do ours. Look, in the last two years they've had something like ten conversations. Some of the converts considered themselves active Christians, too. There's competition going on and we have to protect our flock. Ultimately, who has the truth? We do. We have to protect people from partial truth and from falsehood. Bahaism and Bahá'u'lláh are not the truth; Jesus and Christianity are. They have a lot of influence on the discourse here, and that worries me."

"So you're moving a Sunsol school in order to compete with them in discourse?"

"No! That's to protect the children. We'll work on the issue of discourse later. Meanwhile, the Philosophy Club plans to do an exposé about 'newer religions' and will start with Bahaism. They may cover Islam, too; there seems to be some interest in it up here. I hope they can get to Buddhism."

"That was founded before Christianity!"

"Yes, I know! I'm talking to them about it, though."

Esther shook her head. "I thought we were free to worship as we please, pray and think as we please, and convert from one religion to another if that's what we want to do. Isn't that part of 'mariner values'?"

"Of course, and no one is holding a gun to anyone's head. But freedom of speech is a mariner value, too. That's all we're talking about."

"I wonder. This is a close-knit community flying through empty space, confined to 80,000 cubic meters of pressurized volume, and we're getting cabin fever. Is it prudent to be attacking religions and competing for each other's children?"

Varma shrugged. "Well, I think we'll manage fine in our 80,000 cubic meters, debating these issues. Don't worry so much, Esther. What would your father do? Why don't you ask him?"

"Maybe I will, but he's not the type to engineer over competition. Consider the history: the Marsian Catholic church has sponsored a permanent Vatican Museum display to familiarize people with our great artistic achievements and has conducted several well-received 'God on Mars' conferences. Perhaps that's competition, but of a very low key sort."

"Maybe that's why the Catholic Church there isn't growing, too."

"Maybe." Esther was tired of arguing; she rose. "Thanks for your time."

"Sure, any time. Thanks for coming."

She nodded at that and headed for the door. "Ciao," she said, and stepped out.

She headed down the corridor connecting various small classrooms and offices together—seven religious groups had offices to store sacred items and to hold small meetings—and diverted through the chapel. She loved the magnificent, permanent "stained glass" display of a multi-racial crowd raising their hands to the heavens, which were dominated by a large gold ring in the center, with various planets and the sun visible around the edges. Normally the side panels were dark when the chapel was unoccupied and the display illuminated the entire space. But that day the side panels were set on the Protestant images, with Jesus preaching to a crowd on the right side of the main display and an empty cross on the left side,

with an image of a baptism farther to the right and an image of churches from around Earth farther to the left. It looked to her that the Protestants had taken over the space; after all, it was supposed to be available for anyone to walk in and pray any time. “Can you switch to the Bahá'í displays, please?” she exclaimed aloud, and instantly the Jesus was replaced by the Shrine of the Báb in Haifa and the empty cross was replaced by the Shrine of Bahá'u'lláh outside Acre. The churches were replaced by images of the Bahá'í temples across Earth—including the one at Aurorae—and the baptism was replaced by a group of multiracial people working in a garden together. “That’s better,” she said, and she walked out.

Tahirih was in the geology department, located in the galleon *Melindia,* so she headed to the hub of the *Ouranos* and cross the gym—where there was a fierce game of striker going on—to the *Melindia,* then down ramp 1/2 to her cubicle. Tahirih was surprised to see Esther. “Good morning!”

“Good morning.” Esther looked around; she didn’t want to disturb anyone else or even be heard, since Urania was a small and sometimes gossipy community. “I just spoke to Reverend Varma,” she whispered, and motioned to the hallway.

“Oh?” Tahirih rose and they walked out to the hall. “What did he say?”

“He wasn’t going to admit anything at first; he just said it is a legitimate to move the children’s program. But he finally admitted that because the Bahá'ís had converted some people, including some active Christians, and because you were so prominent in discussions of ethical issues here, the children’s class was a step to strengthen Christianity here.”

Tahirih nodded. “Fair enough. We haven’t had a lot of active Christians convert, by the way. He’s probably upset by Tomasina’s becoming a Bahá'í. She used to go to his Protestant services and his Bible study regularly.”

“Probably. He has also been talking to the Philosophy Club and they’re planning some sort of discussion about ‘new religions’ and plan to start with the Bahá'ís.”

“New religions?” Tahirih chuckled. “Maybe that explains why Tad Lind has been rather discourteous lately; more discourteous than usual, I mean.”

“I’m shocked the Reverend would ally with Tad and the ‘Philosophy Club’! They’re just a bunch of noisy curmudgeons.”

“They are, and it won’t amuse Anand or Gandhimohan, who are trying to maintain a friendly atmosphere.”

“Do you think I should publicize my conversation?”

Tahirih shook her head. “No, that’ll just make things worse. Don’t worry about it. We can handle Tad and his friends.”

“What are you doing with your children’s class?”

“We planned to move it to 3-5 p.m., but when we met with the parents on Sunsol, they said no, we prefer 1 to 3. So we’re leaving it right where it is. We had a few more kids than usual on Sunsol, too.”

“Good, that’ll serve Varma right!”

“Don’t worry about Varma, either. He has his concerns, and I understand them. We’ll manage fine. We won’t retaliate or anything; we want to strengthen unity, not weaken it.”

“How can you strengthen it!”

"With patience. Attacks tend to rebound on the attacker. Love and unity constitute the high moral ground."

"That's true. Alright, I won't say anything."

Helmut found it strange that he was the one to interact with people wanting carrier technology. Jimmy Khan was the logical one, as the head of spacecraft design, but the brilliant engineer was an inexperienced businessman and negotiator. Jacquie Collins was the other logical person, but she was too busy. So it fell on Helmut, who technically was Jimmy's boss in that the spacecraft design department was a part of Martech—though Marcraft, which executed the designs, was not—to handle the details, both the good news and the bad.

He decided to start with Irina Mukhamadova, the Director of the Venus Commission, with whom he had contact for years, though he had not been involved in the current round of negotiations. He checked the time at Magellan Station in Venus orbit—she alternated between Paris and Venus in her work—and started to record a videomail. "Good afternoon, Irina," he began. "I have been asked to confirm the details of our plans to send a 100-meter class carrier to Magellan in 2082. I gather the Europeans have rescheduled their financial support for Magellan anyway, so the delay is not a serious issue for you, which is most fortunate for all of us.

"The Commission will get our second carrier, not our first, which means our crew on Ceres will have more experience in its manufacture. We anticipate its departure from Ceres using a gaseous core nuclear engine in the fall of 2080 and its arrival at Phobos with water and liquid hydrogen six months later. Since you now have carbonaceous chondrite and nickel-iron sources

in Venus orbit, you don't need our water and metal, but we will send you all the nitrogen you need for the interior atmosphere of the carrier, and we can load it at Phobos with any manufactured items you need to complete it. The carrier should depart Mars orbit a month after arrival and will reach Venus in the autumn. The launch windows work out well, thanks to the power of gaseous core engines.

"Our negotiators will get a contract to you in the next few sols. We are happy you want a second carrier at a later date and hope a clause can be added to the contract with a hard and fast date. Let me know how I can assist. Bye."

Helmut reviewed the videomail to make sure it was right, then sent it. Next, he turned to his talking points for the message Zeke Swift needed. "Good morning, Dr. Zeke," he began, for Swift enjoyed being address in Marsian fashion. "I just spent several sols on Phobos talking to the folks up there, and we have a definitive plan. I think you will be pleased by it, overall. It won't be able to accomplish everything right away, but it is ambitious and allows more rapid expansion of our capacities than we had previously expected.

"In early April, not one, but two caravels will depart Earth on a six-month voyage to Ceres. This will allow us to move not 150 new residents there, but 300, including all the asteroid scientists currently on Earth awaiting departure, and an augmented engineering force. They will arrive at Ceres in October and will be able to take up residence in Ceres-1, which is now being filled with gravited housing and work space. They will be accompanied by 200 tonnes of industrial cargo, 100 tonnes more than originally planned. We have a spare old-series gaseous core nuclear engine at Gateway that can be used to get them to Ceres quickly and place them into Ceres orbit. Altogether, we will be spending a billion redbacks on this mission, double our

original plan. One of the caravels will remain at Ceres to expand the ability of the asteroid geologists to get to interesting objects. The main purpose of the augmented engineering force is to expand greatly Ceres's solar power production, with the goal of being able to produce 50,000 tonnes of liquid hydrogen per year for export by 2081. Currently, they can produce 5,000 tonnes at most, plus 40,000 tonnes of oxygen.

"As you know, Ceres has started on the construction of a 100-meter class carrier, and the basic cylindrical structure should be complete by June. This was the carrier we pledged to Venus, but we have renegotiated that contract. Venus will get our *second* cylinder, which will be complete and ready for launch to Mars in late 2080, where it will drop off water and metal supplies to Phobos, then continue on to Venus. Our *first* cylinder will go to you instead, and will be launched between early May and early July this year, depending on when it is ready. By then, Ceres will have 90,000 tonnes of liquid hydrogen and oxygen in storage; sufficient to push 50,000 tonnes to Earth on a one-year trajectory. We will fill your 100-meter class carrier with metal and mostly water, up to the 50,000 tonne limit. Four fifths of it will be for us; 10,000 tonnes for you. We anticipate its arrival at Gateway in mid 2080, which will allow your construction crew to move in and began to create living space in the open interior that will not be used to store anything. We will be able to include nitrogen gas for the atmosphere as well, because we are extracting ammonia dissolved in the water we are pumping up from the Cererian interior.

"I know you were hoping for more water; so were we. But the lunar mass driver won't be in operation by then, anyway. We hope to send a second carrier to Earth in 2082—arriving in early 2083—with as much as 400,000 tonnes of water, but that is dependent on the expansion of

Ceres's power production, water purification, electrolysis, storage, and launch capacities. If we can move that much water to Earth every two years, the cost should be less than any other launch system, plus we will be able to move metals of all sorts to LEO for industrial use.

"Let me know what you think of this arrangement. Ciao." He hit send. It would be some time before he got a reply; Earth was about twenty minute light minutes away that sol.

Helmut turned to other messages. Several meetings were coming up to plan Martech's expansion with the 2080 immigration, and it would get another major increase, because it was a generator of Marsian innovation and patent income. But he ignored those to open an email from Johnny Lind:

Helmut: Thank you for the kind invitation to lunch you extended me in the Gallerie the other sol. But I think I will decline. I'm always happy to bump into you and share a spontaneous conversation, but I am not one of those people who think everyone has to be friendly with everyone else and "get along." I respect you just fine; you are very bright and capable. But we inevitably will have differing points of views and disagreements, and that's fine too; politics is a process of hashing through differences and finding something that works for as many people as possible. Having lunch really won't change anything. Ciao.

Helmut stared at the message for a moment, uncertain what to say in reply. But then it occurred to him that Johnny didn't need a response, and probably didn't expect one anyway. He moved the message to a folder and read on.

A reply from Irina Mukhanmadova popped in. That was fast; round trip communication to Venus was over twenty minutes at the time. He pushed the play button. He could see she was unhappy.

"Thanks for the message Helmut. I think you aren't fully informed of things at this end. The European rescheduling of their support of our construction projects here was caused by the delay in your delivery; it is not a happy coincidence by any means! Ceres has a launch window to Venus every eight months, so a direct flight here is pretty easy to arrange. No detour to Phobos is necessary.

I wouldn't say that your water and metal are no longer needed here. Our first asteroid was delivered 2 ½ years ago and it has been completely cut up and processed. It has been reduced to bags of rock that provides us with radiation shielding. We extracted a few hundred tonnes of water from it; not enough for a carrier. Our second asteroid is five thousand tonnes, mostly of nickel-iron, but we don't have the space inside our warren of caravels and galleons for the extraction and fabrication equipment. We need a carrier to have the enclosed space to do large scale manufacturing! So we do want about a thousand tonnes of metal parts with the carrier so we can get construction started immediately.

"You must be able to appreciate our situation, Helmut; your crew on Ceres was confined to two caravels for almost a decade. We now have three galleons and one caravel and 300 people up here, but you had Ceres to walk around; all we have is a twenty-meter blob of nickel-iron and a new twenty-two meter blob of carbonaceous chondrite that's getting gobbled up and processed fast! The fourth asteroid will arrive next year and will be all of twenty-eight meters across in its longest dimension. Europe has spent seven billion redbacks getting us these four chunks of rock, and we hope they'll send us more, but what we really need is a carrier! Remember, it was our idea in the first place! I doubt we'll want a second one from you, also, because once we have the

first one, we'll be able to process our nickel-iron supply and make our own carriers. We may want your water, though.

"So, that's the situation. And let's not forget another thing: the Venus Commission has promised Magellan home rule once it has a carrier, because by then it will be a self-contained community. So you all have delayed the creation of the 'Venus Authority' by a year. With a carrier and substantial water shielding, we'll be able to raise families here and be a self-contained, autonomous community, doing very important research about the evolution of Earth's sister world. And we're close to Earth; it's fairly quick to go back and forth and takes less energy than anywhere else in the solar system, save the moon. So Venus has a bright future. But we need that carrier.

"I know it's too late to change the situation, but I'm telling you how it is, Helmut. Ciao."

Helmut watched Irina's face fade away, surprised. She had made some good points, but she also hadn't been completely fair. That strained the protocols of interplanetary communication, which called for a kind response that showed one was listening. Maintaining trust over the millions of kilometers was complicated, otherwise. He jotted down some points; he had an ace up his sleeve. He hit reply.

"Thanks for your quick and frank reply, Irina. I will be the first to admit that we over-promised, then dithered. We were in an unprecedented situation, with the expansion of Ceres, the new technology of the carrier that Magellan helped pioneer, the lunar mass driver, and the huge expansion in low Earth orbit investment. We wanted to be a big player in the new situation and we didn't know how to optimize our resources. But we never made legal commitments, and now we are in the position to do so.

"We weren't the only ones overcommitting and dithering, either. The Venus Commission pledged four billion redbacks to move four small asteroids to Venus orbit, and spent seven. Naturally, they were reluctant to commit funds to the carrier project. They weren't pushing us to sign a contract. No doubt they will welcome the one-year delay because of the overruns on the asteroid project.

"Routing the carrier via Phobos solves a big problem for us; we need to deliver water and metals there. It also can solve a big problem for you: Phobos and Aurorae can make a lot of the parts that you need to set up the carrier that you can't make easily. Furthermore, the carrier will allow you to bring more residents from Earth and its set up will require their labor, plus the work of additional robots. In 2080 we are planning the largest immigration wave ever, and it is very controversial. It will also be cheaper per migrant than ever before. So why not send your 300 carrier setup people here in that wave? They can get trained on Phobos by helping to set up the Phobos-1 carrier there, then they can board the Magellan-1 carrier and set it up during the trip to Venus. It'll arrive with your additional people, it'll save you money to get them there, and it'll be almost as set up as it would have been if we had sent you our first carrier! That's definitely a win-win situation for everyone. I haven't cleared that idea with Jacquie, but the idea of 300 fewer immigrants would be welcome, believe me. We are having a lot of trouble figuring out what all of them would do.

"Let me know what you think of that idea. I think it is a good solution. Ciao."

He hit send. Jimmy Khan had suggested the argument about sending Venusinan workers to Phobos, and the timing happened to work perfectly for it. But Zhang Baozhi, the Chief Executive of Phobos borough, had opposed it, because he was angling for as many as 2,000

additional residents on the moonlet. A few hundred more would strain housing and their skills might become competition later. So he had work to do with Zhang,

Meanwhile, Zeke Swift had replied, so Helmut opened that message. “Thanks, Helmut,” Zeke began. “I’m glad to hear that you’ve cleared the various hurdles, including opposition from Phobos to giving any work to Ceres. If I were Chief Minister of the Marsian Commonwealth, I’d be pouring my resources into Ceres and Phobos. The former has 200 million cubic kilometers of water, plus PGMs and the hundreds of thousands of tonnes of ‘waste’ nickel-iron from their production, which it can easily export anywhere in the inner solar system once it has the infrastructure to do so. It’ll quickly develop an advanced industrial infrastructure and become the queen of the asteroid belt. Phobos has capacities by virtue of its zero gravity and its location in Mars orbit, where it can import items from the surface cheaply and send them anywhere cheaply. Both need thousands more residents, especially as the capacities in low Earth orbit expand. And with the carrier you’re sending, I plan to expand LEO’s capacities massively. I wish you could send more water and liquid hydrogen, but send every drop you can. We’ll put them to good use.

“We need to talk again in a few months. It’s time to make a multi-year plan to coordinate LEO with Phobos and Ceres. That’ll remove a lot of uncertainty for all of us. Ciao.”

Helmut smiled as Zeke’s face faded away. He wasn’t sure all the various factors had stabilized enough to make reliable plans, but anything would be better than the current situation. He hit reply. “We’ll send you a contract in a few sols, Zeke, and we look forward to formulating a plan. Thanks, Ciao.”

He was now in a good mood. Frankness, clarity of communication, honesty; sometimes they seemed to work! It made him think of Johnny Lind's email to him. He opened it again and reread it, and now he a reply came to mind.

Thanks, Johnny, for your frank response. I appreciate your honesty and respect you as well. But just as two people can have differing points of view and disagreements, they can also agree on things. Let's remember that, too. Looking forward to seeing you around town. Ciao.

8.

Professional Standards

Feb. 2079

"So, they're proposing to fly three corvets to Neptune?" Helmut said to Jimmy Khan in surprise.

Jimmy nodded. "Corvets are the latest technology, after all; there's no reason to fly smaller vehicles there. They'll fly two caravels as well for transport within the Neptunian system. If you fly only two corvets, you have to worry about a catastrophe seriously damaging one, in which case you'd have to put everyone in the other vehicle, and that's not wise. Hence three."

"But they're rated for 320 people each in exploration mode!"

"Correct, and the caravels are rated for 50 adults each. That's 1060 people; Neptunia will be a big settlement! Of course, they'd launch with about 750 to 800 and anticipate that up to 300 children would be born during the trip. Even with the new gaseous core engines, Neptune's at least a three year voyage. Those people won't be returning for at least twelve years, probably fifteen."

"They'll probably return with university-age children," said Helmut. "In the early twenty-second century."

"It's just twenty-one years away."

"It is." Helmut shook his head in surprise. "And next year we send out two galleons and 300 people to Jupiter, to Saturn, and Uranus; 900 people and 6 galleons. And that's just so those settlements can keep up with everyone else's growth!"

"Phobos is growing to 3,000, Mercury is hitting 1,000, the moon has a transitory population of 2,500 . . . even Venus is determined to grow to 600."

"And they will. It makes Johnny's latest tirade against rapid growth even stranger, in my opinion."

"He's still trying to build up himself, and it's obvious to just about everyone," said Jimmy. "The northward equinox is in May and elections will be in early June. I think he's trying to build himself up for that."

"I hope you're wrong about that, but I think you are right. The recurrent mess on Earth is growing worse again, and we'd like to think we're better! It'll be a miracle if the mass driver is finished in 2082 as planned."

"I bet they'll do it," said Johnny. "Right now, investments in space are solid in spite of the gyrations of the new world dollar, not to mention all the climatic disasters and the terrible poverty and unemployment."

"Zeke is counting on it; he wants to have a thousand workers living permanently in Earth orbit by 2082, so that he can capture a large fraction of the contracts for orbital construction, especially orbital solar power."

"His people have been really innovative, too; he has hired a lot of young engineers. They've offered important innovations to the carrier design, but they've even contributed to the Prometheus shuttle and the corvet."

"I hadn't heard about contributions to the Prometheus."

Jimmy nodded. "You'll need to get involved in that issue, Helmut. I think Swift might phase out the Swift shuttle and acquire a license from us to build the Prometheus. If he does that,

his engineers will be looking at ways to improve the design. I gather he's convinced that any future terrestrial vehicles need to be designed to work on Mars as well, because we have so much experience and a lot of flight history."

"And the Swift shuttle landed horizontally, which is impossible here. That would be good for us."

"Ironic; it's back to his grandfather's design philosophy!'

"That's true. Thanks for the update, Jimmy. I always look forward to our weekly briefings."

"And I look forward to any tidbits you can bring from the cabinet meetings. See you next Frisol, Helmut."

"No, not next Frisol; I'm going to Phobos for a round of meetings."

"Okay. Good luck if you're meeting with Baozhi!" Helmut smiled at that; he was. Jimmy Khan rose from his seat and headed for the door.

Helmut turned back to his desk, which was covered by electronic documents. He shuffled through them and pulled up the proposal—urged by Swift—that Martech open a branch campus on Earth, preferably associated with Stanford. It was intriguing. But before he got very far, a live video call came in from Clara.

"Hi, dear, how are you?" he said, activating the connection.

"Excited! Can you come home for lunch! I know it's late, but this is important. Charlie and Siri have an announcement to make."

"Oh? Is it . . .?"

Clara nodded. “Yes, they’re pregnant!” She squealed it, in her excitement. “Charlie told me. They’re due in early October.”

“They didn’t wait long after completing their written and oral exams.”

“No, and there was no reason to. I just hope she’s careful about radiation.”

“They have been very careful. Don’t blame yourself, Clara.”

“How can I not, Helmut! I was crazy, not worrying about radiation when I had both boys!”

“I know, and we’ve gone over this many times, haven’t we? You can’t beat yourself up now; it does no good. Oskar has survived and is getting better.”

“Let’s hope that continues. Anyway, can you make it at 12?”

“Sure. I don’t have any appointments then, anyway. See you for lunch.”

“Great. Ciao.”

“Ciao.” Helmut closed the circuit. He was excited, too; he’d be a grandfather, at age 57! His father would be Mars’s first great grandfather, at age 87! Life was full of miracles.

He had an hour, so he turned to the emails of the Immigration Task Force; he had been added to several government task forces and that one currently took a sol a week of his time. He tried to wade through the endless discussion of needs to expand this function or that function, needs to encourage more businessmen to immigrate, needs to expand Phobos, needs to invest in more Martian polar research, needs to build an intermittently habited station on Olympus Mons, needs to expand the metal road network when the primary phase ends next year . . . it went on and on, and he could not easily pay attention. He finally gave up and went for a walk.

Ironically, he arrived home five minutes after noon; he had walked too far west and had decided to walk back rather than take public transportation. Ananda Thanarat and Kim Irion Thanarat, Sirikit's parents, had arrived, as had her older brother, Mahidol. Helmut had known the parents since he had arrived on Columbus 7, over thirty years ago. Kim, an eobiochemist, had arrived four years earlier on Columbus 5 and Ananda, an artificial intelligence engineer, on Columbus 6. They were slightly older than he, but technically as Chancellor he was their boss.

The conversation was focused on the pregnancy, so there was no secrecy or announcement. Helmut went straight to Charlie and Sirikit. "Congratulations, dear," he said to Sirikit, giving her a kiss. He reached down to hug his son. "So, October?"

"If the baby's on time," she confirmed. "We're very excited."

"Just watch your radiation exposure," said Clara.

"I will, but I spend most of my time at home or in my office, and both are well shielded."

"Even the outside areas are getting better shielded now," observed Sebastian. "I understand they're planning to install water bags against the inside of Andalus dome later this month."

"Yes, 1 meter thick; pretty good shielding," confirmed Helmut. "They developed the technology for Themis and have refined it quite a bit, since."

"I'll get it for Ukraine in about four years," added Kristof. "The Commonwealth is paying, too. It's going to be standard for all domes, from now on. They may increase it to two meters, too."

"Well, even two meters isn't enough for GCR," said Clara, referring to galactic cosmic radiation.

"It's a good addition, though," replied Kim, who knew something about the subject. "Even with an unshielded dome overhead, half an hour a sol outside is not a danger, and that's what most of us get. The analogy to sun exposure and sunburn is a good one."

Clara shrugged, not convinced. "So, will this slow down your dissertation work?" asked Sebastian.

"Probably," replied Sirikit. "That's my focus, right now. I have no courses to T.A. this semester, and Dr. Park has told me to do my research and writing, not his. I was planning to finish by June, but I can take until September. The summer was going to be light, anyway."

"She was scheduled to teach two courses in the fall, though," said Charlie. "That's not going to happen!"

"No, I'll take off the fall semester and shift those courses to the spring."

"Do you want a boy, or a girl?" asked Sebastian.

"A boy!" said Charlie immediately, and Sirikit added, "A girl!" Charlie smiled and said, "One of each."

"We'll start with one and see," concluded Sirikit.

They all chuckled. "Either way, they are a joy," exclaimed Ananda. "It is our blessing to create life, bring it into this world, then shape and form it, so that the next generation can carry forward humanity's progress."

"Well put," said Helmut, though he wouldn't have used the Bahá'í language Ananda had used.

"They're also a pain in the ass sometimes, but overall, they're worth it!" added Sebastian, with a laugh. "My boys, here, were very unhappy when I went to Mars on Columbus 2.

Remember, Kristof, the African violets I was surprised to find growing in a pot up here, and you figured out what kind it was, and ultimately helped us figure out where the contamination had come from?"

"Yes, that helped heal our relationship! I was a pretty angry teenager."

"Dad was a hundred million kilometers away," said Helmut. "That was hard."

"Well, here are all of us, on Mars," said Sebastian. "I just wish Mary could have made it, too."

"We still miss mom, after all these years," agreed Helmut, a note of sadness in his voice.

The doorbell rang. "That must be lunch," said Clara. "I pulled out all the stops." She rose and walked to the door; a four wheeled robotic cart with four long arms stood there. She directed it to the dining room table and they all rose and walked over to help place the beautiful plates and silverware that the cart had brought. In a few minutes they were all able to sit and the robot began to serve everyone, using all four long arms to bring the plates of food in over their heads. As they drank their mineral water it refilled their glasses, too.

It was a sumptuous feast, with soup, salad, real turkey slices, a rice and vegetable dish, bread, and various condiments. They talked, laughed, reminisced, and mused about the future. At one point, Ananda sat back and said, "Having children reflects a certain optimism about the future."

"Unless they're an accident!" replied Sebastian with a laugh.

"True, but up here, most of the children are planned," replied Ananda. "We have an educated population that plans their lives and careers fairly well."

"And we have reasons to be optimistic," agreed Helmut. "Mars is peaceful, economically stable, and growing. No terrorism, drug wars, mafias, or extremists."

"Not many extremists, anyway," said Sebastian. "But I will concede that we have achieved a fairly strong consensus about our basic social values."

"An oxygen supply that is easy to interrupt is an incentive to that," said Kim.

"True, but I think it helps to have well educated professionals and a lot of people who emphasize ethical values," said Helmut. "Our schools now stress virtues pretty effectively, I'd say."

"A Bahá'í influence, perhaps," suggested Clara.

"Not just Bahá'ís; religious people in general have embraced a common set of basic ethics," replied Ananda. "Interfaith efforts have actually worked up here, thanks to wise religious leadership."

"So, will you raise the baby Bahá'í?" asked Kristof, looking at his nephew.

Charlie looked at Sirikit, then nodded. "Yes, I think so. Children need a moral foundation, and I can't say I can provide that, but Siri and the Bahá'í community can." He looked at his parents, wondering what they would say.

"That's good," said Sebastian, and Helmut then nodded, followed by Clara.

There was a break in the conversation as everyone chewed, then Kim mentioned the "football" (soccer) contest between Meridiani Cowboys and the Aurorae Marines. The conversation turned to sports, including the four semi-professional striker teams on Phobos; since Charlie had helped develop the game, he followed it closely. They transitioned to dessert and coffee, then the Thanarats had to leave.

"We should go, too," said Charlie. "I've got to give a presentation morrowsol and have to finish getting ready for it."

"And I want to take a nap," said Sirikit. "And I guess I should enjoy having the excuse to do so!"

"Yes, definitely," said Clara. Everyone rose. "It was so nice to celebrate your good news this way."

"Thanks for the feast, mom," replied Charlie, giving her a kiss. "It was really special."

"It was," agreed Helmut, hugging both of them. "We're so proud, we could burst."

"Thanks," said Sirikit, kissing both of her in-laws. She and Charlie headed for the door, where they exchanged ciaos and headed out into the afternoon sun of Australia Enclosure. "That was really nice," said Sirikit.

"It was; really nice," agreed Charlie. "So, we're launched into the family biz!"

"We are, and everyone is unified behind us. Of course, we knew they would be, but a formal sit-down meal makes it all so much more . . . definite."

"That's true. I'm glad mom invited your parents and Mahidol."

"So am I. You know what we need to do now? Go home and send a videomail to Esther and Wicahpi-Luta! We haven't told them yet!"

"You're right, let's do that."

When Esther felt her communicator vibrate in her pocket, she was watching a late Frisol afternoon concert of the Urania Chorale. She didn't move to pull it out; the four-part harmony

was particularly beautiful and the song quite inspiring. The crowd rose to its feet the applaud when they finished.

"That was really beautiful," she said.

"It was good," agreed Wicahpi-Luta. "I've never been quite sure what to make of white man's music, though."

"Come on, you were raised on Mars, not on the rez!"

"I know, but dad always felt ambivalent about music like this. So did mom, in fact."

"I can understand that, but it is really beautiful. One of those pieces was sung by the Church choir at home."

"Yes, you already mentioned that." Wicahpi-Luta rose; the concert was over. "I like this idea of Frisol afternoon cultural events, while the kids are in aftercare. It starts the weekend off very gently."

"It does, and John Anand is determined to keep the pace quiet and not frenetic, even when we reach Uranus. It's easy to keep it slow now; we're not there. But it'll be harder after we arrive."

"Gandhimohan keeps saying over and over, 'focus on your families for two sols a week'! So he's reinforcing the message, too. We're going to establish a civilization, not a work colony."

"Let's see whether we remember that, in two years." Esther saw Tahirih nearby talking to Carlotta Singh, one of the settlement's psychiatrists and drifted toward them.

"That's a good example, Carlotta," Tahirih said. "That's the sort of example of service we want to impress on the kids."

"It won't take long; maybe 5 minutes."

"That's alright, we want two or three short examples, at most, then we'll have the kids develop an expression about service—it might be a skit or a drawing, for example—then we'll have a few more short quotations about the power of service to express ourselves, and that'll be it."

Carlotta nodded. "That sounds like a very nice program, Tahirih. Do you mind if I bring my seven year old?"

"No, not at all, she's very welcome, and she'll see friends there, so she should be comfortable."

"Good. Thanks." Carlotta nodded, happy about the request that she participate. She said ciao to Tahirih and headed on out the room.

Tahirih smiled. Esther walked over. "Sounds like you've secured another speaker."

"These little 5-minute talks about virtues expressed in action have worked out really well. I think we've arranged for 16 or 18 people to come in, over the next two months."

"Wow, that's a lot!"

Tahirih smiled. "And I have to admit that we started by making a list of all the kids on board and are approaching their parents first! Most are intrigued to talk about their careers as they express 'service, kindness, honesty, sharing, collaboration, and unity.' Those are the virtues we have been stressing."

"And the kids are coming?"

"And coming back; that's what's important. We now have 16 kids coming every Sunsol afternoon. So it's a service to the parents and the kids, and we help reinforce virtue."

"That's half the children on board," said Wicahpi-Luta, impressed.

“And the evangelical class apparently has shrunk by one or two,” added Tahirih, with a shrug.

“So, what are you going to do about the anti-Bahá'í lecture the Philosophy Club is planning for next Sunsol evening?” asked Esther.

“Several of us plan to go and listen. Perhaps we will respond. We don’t want to get into a debate or an argument, though. I am curious to see whether Varma attends.”

“I wonder, too, and whether he’ll mention it in the Christian services. He’s scheduled to help run the mass next week.”

“Well, let me know what you hear.” Tahirih waved. “Gotta go. Ciao.”

“Ciao.” Esther watched her friend go. She turned to Wicahpi-Luta. “I’m surprised they aren’t more worried about the lecture.”

“A few people convert, and some others get nervous,” said Wicahpi-Luta. “But we are all free to believe or not believe anything we want. I’m inclined to think Bahá'u'lláh was inspired by God somehow. I find the teachings quite attractive.”

“So do I, actually,” admitted Esther.

They headed out of the atrium, where the concert had been held, and down the ramp to level 2 where their room was located. Esther remembered the vibration and pulled out her communicator. “A message from Sirikit.”

“Oh, really?” Wicahpi-Luta pulled out his communicator. “I got it, too.”

They hurried home, closed the door, sat on their futon, and Esther pressed the activate icon. Sirikit and Charlie were sitting on the couch in their living room together. “Hi Esther and

Wicahpi-Luta!" began Sirikit. "We wanted to videomail you and let you know: we're pregnant! The baby is due October 2d. We just had a big dinner with our parents to celebrate."

"It was really nice," added Charlie. "We're thrilled, needless to say! And excited. It's a big, scary step, in a way, but we've taken it. We're still planning to get our dissertations done before the baby is born, then we'll take a few months of leave, then start our professional lives." He shrugged.

"I'm really excited, but I suppose I'm a little scared, too," added Sirikit. "But with all these mothers who are professional women around—both my mom and my mother in law among them!—everyone says it can be hard, but it's possible. We didn't take geminale, so we're expecting only one baby, not two. But maybe we'll have another one later."

"I hope so; Mars wants all couples to have two," said Charlie. "We'll see what the good Lord gives us."

"Anyway, we wanted you to be among the first to know. We hope you are doing well, out there! Give us a shout back, Ciao."

Their faces faded away on the screen. Esther turned to Wicahpi-Luta with a big smile on her face. "Shall we tell them?"

"We haven't told our parents yet!"

"We should have; I suggest we videomail them, too."

"Okay, but let's reply to Siri and Charlie first."

Esther nodded and pushed some icons to activate the camera on the wall opposite their futon. A moment later, the recording light turned green. "Hi, Siri and Charlie, and thanks for

your message," said Esther, "And congratulations! How very exciting, that you'll have a baby in October! Because we're due on September 28, if all goes according to schedule, anyway!"

She turned to Wicahpi-Luta, who wasn't sure what to say at first. "Don't tell anyone yet; we're going to tell our parents next. We had planned to wait another week or so, in order to be sure. We're really excited, too. Of course, up here, it seems like *everyone* is having babies. The first ones were born in the fall, and now they're coming along at the rate of one per week, and this fall it'll be two or even three per week. Our friends Tahirih and Vahid plan to start trying in September. It's rather strange, having it planned so much, but we are a small, confined community, so we have to plan. By the time we get to Uranus, it is said our population will increase from 505 to 640. We're part of that wave, I guess."

"Anyway, that's our situation. We're working on our degrees, too, but we're not under any pressure; the crew here is supposed to be taking their time and building family and community. We were just at a concert. There's something cultural every Frisol afternoon, every Satursol, and many Sunsol evenings. Almost everyone is involved in a singing group, an acting troupe, a band or orchestra, and a sports team. We have a lot of film festivals, too, if no group is planning a performance. It's a very nice, relaxing life, and the idea is to continue it after we arrive, too. The theory is that it won't actually slow us down much, but will enrich our lives, and I think that's true. We don't have the mall that Aurorae has, but we may have a better lifestyle."

"Congratulations again!" exclaimed Wicahpi-Luta, after a few second passed and Esther had not spoken further. "Keep in touch!"

"Ditto to that. Ciao!" added Esther. She closed the recording and sent it flying back through space to Mars.

Helmut was late. As soon as the autocar dropped him off outside the entrance to Aurorae Spaceport, he hurried inside. There were only two "gates," and except for times when the immigration wave was rolling in, only Gate 1 was used. He hurried up to it and spoke to the computer screen, "Can I still get on board for launch?"

The face of an automated attendant appeared. "Yes, Dr. Helmut, your personal assistant notified us you were late and there's a transport vehicle waiting for you." The door to the gate opened; he hurried through and sat in the vehicle as the door closed behind him. "The other passengers are already on board. Launch is in 31 minutes, so you have just made it," the automated attendant continued from a screen inside the vehicle.

"Thank you. I apologize for the unfortunate delay."

"We are able to accommodate you."

The vehicle detached from the gate and began to drive along a long duracrete road toward the launching pads some eight kilometers away. Once it was on the road, it accelerated smoothly to 100 kilometers an hour, whisking him to the waiting shuttle on Pad 6. He rolled by other Prometheus shuttles, some with passenger cabins, some being loaded with cargo; the pads were spaced three kilometers apart for safety. He reminded himself to plan his Frisol mornings better, because he often was on the flight to Phobos.

The autocar slowed as it approached the shuttle and its launch tower. It entered a small airlock at the base of the tower, the door behind it closed, and in a minute he was able to step out into a pressurized waiting area. He headed straight to the ramp and bounded up it; no reason to wait for the elevator. He had to go all the way to the top because the lower ingress tunnels had

already closed and retracted. The door of the tunnel at the top opened automatically for him, so he entered it, and the door at the far end opened to let him into the vehicle just as the door at the entrance to the tunnel closed. He was on board a mere 12 minutes after reaching the spaceport, at t-minus 19. Late, but not too late!

The seats at the top level were filled, so he went down to the next level, then the next. There he spotted an empty seat, so he headed for it and climbed in.

"Good sol, Helmut."

He turned to see who was sitting two seats away and it was Will Elliott! "Good sol, Will," he replied as he put on his safety belts. "What takes you to Phobos?"

"Staff meetings. The Mariner League headquarters is on Phobos and I talk to the three staff daily, but I try to visit them every month or two."

"I do the same every month or so with people at the Phobos campus. This time, I'm also getting a tour of Phobos-1."

"I'm envious; can't wait to get inside it. Do they have it spinning?"

"Yes, they finished enclosing it just two weeks ago and pressurized it last week. The spin up started Monsol, I believe, but just to a tenth of a gee. They plan to do all the interior construction in a tenth of a gee, then accelerate it to 0.75 gee when phase 1 is finished."

"That makes sense; enough gravity to move things into place, but not so much to make them heavy."

"And Phobos's gravity is so small, it really isn't noticeable either way."

"It'll be a revolution for Phobos; a *big* interior space plus a lot of space to grow into," mused Will. "Each level can accommodate about 600 people generously, and they could easily build ten levels if they wanted to."

"Exactly, but they'll build Phobos 2 before they fill it very much. The current collection of galleons and corvets can accommodate 2,000 and could handle an evacuation of Phobos 1 if it has less than 1,500."

"Of course. But it'll have a ten meter shield of rock around it, so it should be safe."

"And most of it will be buried, too. The interior volume is over 3 million cubic meters, so if you filled it completely with housing and office space, it could hold as much as 30,000 people. I doubt they'd ever fill more than half the volume, though, to leave a big, open center."

"And they'd build a Phobos-3 early on as well, for redundancy."

"Exactly, probably in 2084. Frankly, I find it hard to believe we could employ so many people on Phobos!"

Will nodded. "It's hard to believe. But Phobos has some nickel-iron and some water and it can get more from Ceres. Mars can provide it with everything else and it has very low gravity and a convenient delta-v to just about anywhere, so it should grow. If nothing else, the time will come when people with money will move there to settle, create their books or their art, and just *live* there because it's a good place to live. I think that time is less than a decade away."

"Enough people to support a mall?"

Will chuckled. "Basically, plus construction of some luxury condos!"

"Ladies and gentlemen, we are at t-minus 1 minute," said the Captain's voice over the public address system. "Please verify your seat restraints. This morning, we will experience a

peak acceleration of only 2 gees. Main engine cutoff occurs at T-plus 4 minutes, 40-seconds. We will then coast to Phobos for 5 hours and 45 minutes before executing a final 45-second burn to circularize our orbit and bring us down to Stickney spaceport. Landing will be on schedule at 12:20 p.m. For those on the return flight, departure will occur 15 minutes after midnight, with a landing at Aurore 6:10 a.m. morrowsol. Thank you for being with us this sol."

Will nodded; he settled into a serious mood for the last few seconds before launch. Talking in the cabin died away as everyone prepared themselves. The screens shifted to a camera on the vehicle's nose, looking out over the predawn terrain, which was fairly well lit because of the remnant dust of a big storm a week earlier. The countdown flashed on the screen, and as it approached zero the engines came alive with a rumble. Thrust quickly built up and the vehicle jerked skyward. The land began to fall away.

"How many launches?" asked Will.

Helmut shrugged. "Twenty?" he guessed.

Will nodded. "Me, too."

They didn't speak further during launch, but when the engines finally fell silent and the 5 ½ hour coast to Phobos began, Will suggested they head down two more levels to the lower passenger cabin, which was nearly empty. They sat and talked there the rest of the flight. Helmut was always amazed to see the development of Phobos borough; it consisted of three corvets set up as habs, able to accommodate 500 each, and four galleons able to accommodate 200 each. Tunnels connected the complex of vehicles to each other, to the spaceport, to three space vehicle "drydocks," to a large buried engineering complex, to the sports center where strike games were held, and to two 7-kilometer long chains of greenhouse bubbles that raised food for Venus and

the moon as well as Phobos. Attached to the greenhouse complex were spaces for up to three pairs of galleons where missions to Jupiter, Saturn, Uranus, and Neptune could train. Near the drydocks was Phobos-1, a large white, cylindrical structure. The foundation for Phobos-2 was being excavated as well.

The Prometheus landed with the slightest bump on Pad number 3 and the launch tower moved in to attach egress tunnels to the vehicle. In a few minutes, the passengers began to disembark and Helmut said good bye to Mars's first Chief Minister. He headed straight to the Phobos Hilton to eat lunch; he hadn't had anything to eat since midnight in order to minimize the risk of space sickness on the flight. Then he headed for Zhang Baozhi's office. The Chief Executive of Phobos Borough was the real reason he had come.

"Thanks for coming, Helmut," said Baozhi, shaking the hand of his visitor. "I hear you have a 2 p.m. tour of Phobos-1."

"That's right, Baozhi, the crew very kindly accommodated me, even though the cylinder is still closed."

"It is, but we may start letting people in to look every evening for an hour. Come on, I'm scheduled to get a tour later this afternoon anyway." Baozhi headed for the door before Helmut could protest. He had wanted a private tour, not one that would propagandize for Phobos.

Baozhi led Helmut down the corridor to the ramp well, up to the axis of Galleon Alpha where Phobos's government was located, and down to the main corridor that connected the outpost together. Once there, he pulled himself along at surprising speed; he had very strong arms and was used to maneuvering in Phobosian minigravity. Helmut did his best to keep up;

Ceres required very similar skills, but his arm muscles had weakened on Mars in favor of walking. Baozhi seemed to enjoy staying ahead of him.

They reached the base of Phobos-1 in 10 minutes. The cylinder was 200 meters in diameter and formed an enormous ceiling overhead. At the very center was a circular opening 12 meters across and at the moment a huge pile of metal construction materials was being raised up through it. They had to wait until the tonne of supplies had been loaded onto a trailer on top and dispatched; then the elevator floor descended and they stepped onto it with several workers and a smaller robotic cart with electronics. They held onto railings while the elevator ascended ten meters to the bottom of the rotating cylinder, where their elevator platform became the non-rotating center of a rotating bowl. Baozhi reached his feet out and stepped onto the rotating side of the bowl, thereby acquiring the tiniest amount of centrifugal gravity, and slowly walked up the rotating side of the bowl toward an exit. Helmut followed and was surprised to see the robotic cart roll off the platform and up the side of the bowl to the ramp, which spiraled "down" to the outer edge of the rotating cylinder. It was a long, 600-meter walk, and as they descended they steadily gained weight. Soon they were ambling along as if they were on Mars.

The enclosed ramp road, 12 meters wide, abruptly ended at a wide expanse of shiny metal that extended all the way across the enclosure to the opposite end cap. They stepped onto the curved surface—"flat" in the centrifugal gravity of the cylinder—and Helmut realized it occupied about 1/6th of the circumference of the enclosure. At the sides it dropped down about six meters.

"What's this?"

"Phobos Square, the future heart of the outpost. It's 100 meters long and wide; over 10,000 people could stand or sit here!" replied Baozhi. "And look up; a long way up! Ceres-1 has a central tube along its axis with lights and air circulation systems. We'll mount the lights strategically in various places on the buildings to illuminate this entire space uniformly."

"I thought you were following the blueprint of Ceres-1?"

Baozhi shook his head. "We changed our minds."

Helmut looked up; overhead was 200 meters above him, quite a long way, but it was disorienting to see people and robots working up there, upside down. "It's a big, amazing space."

"Imagine it at night with the bright spotlights off and the buildings up there looking almost like stars. It'll be beautiful. During the day we may engineer a fog bank in the middle so you see rolling clouds, rather than people upside down. We'll see." Baozhi pointed to the four sides of Phobos Square. "There will be 5 meters of buildings against the end caps, so the square will actually be 90 meters long, but it'll be 110 meters wide. The construction against the end caps will go all the way to the central axis and will overhand the square somewhat. The higher floors will have pretty spectacular views. The other two sides of the square will feature buildings one to three stories high, broken by streets that will run all the way around and back to the square on the other side."

"And what goes up there?" Helmut pointed to the space opposite the square, because the mass of the cylinder had to be evenly distributed in order to keep the rotation centered.

"Buildings of various sizes, but their overall volume and mass will equal what we have over here. Phobos Square will have tall buildings around it, but up there the buildings will be more evenly spaced and less high. There will also be a green space opposite Phobos Square and

just as long, but narrower. There will also be a circumferential green space with two brooks flowing into a pond, and possibly a series of waterfalls dropping down this endcap. Next to the pond, we will build the 'Center for Expression,' our center for the arts and a place where our various religious communities will worship."

"It sounds pretty. I can't wait to see it finished."

"It'll be prettier than Ceres-1!"

Helmut shrugged. "We'll see, Baozhi. They're refining their design daily, too."

"Anyway, Helmut, I wanted you to see what we could do. It's a very sophisticated enclosure; really beautiful, and the cost will be barely more than a billion. It should be good for several centuries, with proper maintenance. The buildings will be airtight advanced plastics and carbon fiber, not metal, since we don't have a lot of metal up here. Imagine what Phobos will be able to do in 10 years, or 20!"

"I know; what all our facilities will be able to do is really quite unbelievable. But Phobos will always be the leader in space. It has the population, the talent, the proximity to Mars, and quick access to a planet-full of resources. Ceres will be the queen of the asteroid belt and will be a natural resource center, but will always suffer from a certain amount of isolation. Low Earth orbit and the moon have a ways to go to catch up, but they suffer from natural resource scarcities and a deeper gravity well. Phobos's leadership is secure."

Baozhi turned to him, scowling. "That's a great slogan, but remaining on top takes money and a lot of work, and I am not particularly inclined to help the competition, Helmut. You should never have promised Venus that we'd train their construction workers. Who says they can't go

into vessel building? What else are they going to do, orbiting that hell hole? They can get partially completed shells from Ceres, finish them, and sell them."

"Europe will need to invest in Magellan Station big time first. That capacity will cost billions of redbacks. All we're doing is saving them a year of time and providing a hundred million redbacks of training. That's hardly a big assistance to a potential competitor! They want Phobos to sell them a hundred million in equipment, too, because they don't have the capacity to manufacture it. Better that they buy from Phobos than from Earth! Europe doesn't want a competitor, either; they'd prefer that Magellan buy equipment from European manufacturers. But Mars has a lot more launch opportunities to Venus than Earth, and Phobos has the lowest delta-v. Magellan Station will always have a special relationship with Phobos and Mars; a partially dependent relationship. It is to our long-term advantage to be kind and generous to them and build that relationship."

"And where will I put them, Helmut? Phobos-1 has to be ready for the immense immigration wave because they're coming here for transfer to the landing shuttles!"

"That wave will be 300 personnel smaller because the Venus workers are coming as part of it. Phobos-1 will have the room. You'll have several spare corvets and galleons as backup, too. The bigger issue will be training them to do the construction, but if they are merged with your work force as it builds Phobos-2, you'll get the second carrier completed a bit faster anyway."

"You have an answer for everything, Helmut!"

"Baozhi, as Chancellor of Martech, you can count on me to do everything I can to keep Phobos ahead of low Earth orbit, the moon, Venus, even Ceres. I can't speak on behalf of Jacquie, but I think you can count on the same pledge from her, and from the Mars Council.

Venus really isn't the risk; that comes from facilities in low Earth orbit. Working with Swift, we should be able to keep ahead, but it requires a partnership because the potential investment from Earth is so large."

"I know, and Swift's people have been very helpful."

"Good. The people on Venus will be, too. It's a bigger tent, and Phobos is the central tent pole!"

"Alright, alright, Helmut. I get the idea. I just hope you're right."

"So do I, Baozhi. Kind and generous professionalism: that's our standard, and it has served us well."

He nodded reluctantly. "I suppose it has."

"Allow me to summarize my points in closing," said Tad Lind. He looked at the audience, a bit nervously. The 17 members of the Philosophy Club, sitting up front, looked attentive and pleased. The dozen Bahá'ís sitting in the back did not, but their facial reactions were all over the place; Tahirih was attentive, Vahid taciturn. The three seats that had been occupied by Muslims were empty, their sudden departure when he questioned Muhammad's prophethood having made a scene. Father Varma looked angry; he had anticipated a scholarly refutation of "Bahaism" and had not been pleased by the opening assault on the ideas of God and revelation. Esther looked irritated, Wicahpi-Luta angry; Tad was not sure why they had come at all or why they had reacted those ways. Others in the audience looked generally displeased. He was not sure why; his arguments had been solid. He was particularly worried by the sour expression on Adla's face and

the pensive one on Gandhimohan's; the presence of the settlements number two and three felt intimidating.

But he started his closing argument anyway. "First, the very idea of God, in the late 21st century, appears to be an irrational holdover from an earlier, prescientific worldview, as the two proofs against God's existence that I outlined demonstrated. Second, the notion of revelation collapses once the notion of God is refuted, and the evidence for it, cited by Muslims and Bahá'ís—to mention only two religions—is not adequate to justify the claim of revelation anyway. Third, the Bahá'í claim that Bahá'u'lláh possesses extraordinary abilities is historically questionable when he is compared to Martin Luther and other great thinkers and writers. Fourth, the Bahá'í teachings aim to define unity in an inconsistent way and do not provide the means to achieve the goal. Fifth, the Bahá'í community, after over two hundred years, is still way too small to implement its teachings, and there is no evidence it will ever be able to grow sufficiently to do so."

Tad turned to Vahid, in the back of the room. "I now will turn the floor over to Vahid, so he can reply."

Vahid was surprised Tad had volunteered him; he shook his head. Tahirih rose instead. "The Spiritual Assembly of the Bahá'ís of Urania has asked me to comment on their behalf," she said. "We welcome the discussion of issues such as the existence of God and revelation that are important to many people in this community. We also welcome difficult questions about the Bahá'í Faith, which do not worry us and which we will be happy to discuss. But we are concerned about matters that the title of this event, 'Debate about Bahaism' raises. It is generally and widely understood that the Bahá'í community does not use or like the term 'Bahaism' and its

presence in the title of this event raises the legitimate issue whether the sponsors seek to discover the truth, or to stir emotions. The term ‘debate’ raises additional concerns. The Bahá'í community was not contacted or invited to offer its point of view in this gathering. A few sols ago, with no invitation forthcoming, we wrote and asked whether we could see the text to be presented, so that we could be properly prepared to answer the questions raised. But we never received a reply.

“I think all of us attended the Uranus Science Symposium last spring, where papers were presented on dozens of topics related to the world system we are voyaging to. Some of them were controversial, and when a controversial scientific issue was going to be discussed, a proper, scientific protocol was always followed. A presenter and several respondents were selected ahead of time; the presenter prepared his or her paper and sent it to the respondents; they prepared their comments and sent them to each other and to the presenter; and then on the sol when the discussion was to occur, all of them sat up front and exchanged their views in a calm, clear, professional manner. I think we can all agree this is a wise approach, because it focuses not on people or on emotional matters, but on the research issues, the methodology, and the implications of the ideas and conclusions being discussed. The result is not a ‘debate’; it is a consultative exchange that seeks the truth.

“We do not see those professional standards being adhered to in this event. Therefore, we propose to write responses to the paper that was just presented, possibly record them—as this event is being recorded—and post them on the web. We would encourage other theists and the Islamic community to post their comments as well, if they wish. If the Philosophy Club wishes to hold another discussion of this sort, we ask them to follow the standard professional format for

discussion. The purpose is not debate, but exchange about the truth. I think we can all agree that the questions just raised are important and serious. They deserve a proper, deliberative, professional discussion. We will be happy to cosponsor such a discussion."

Tahirih sat. Tad looked shocked; the Philosophy Club members, peeved; the others, delighted. "The entire so-called proof about God's nonexistence needs refutation," said Varma.

"Go ahead," replied Tad, jumping on the comment. "Who else has questions?"

"No, I'm not prepared to respond to that," replied Varma.

No one else spoke up for a moment. Then before someone could raise a question, Gandhimohan stood. "Thank you for the discussion," he said, politely, and headed for the door, followed by Adla. Much of the audience decided to do the same and rose.

"Ah . . . thank you for coming," offered Tad, uncertain what else he should say. Tahirih smiled; she couldn't disguise her pleasure at the conclusion. Vahid nodded to her and they both rose as well. As they exited the room, even the Philosophy Club members began to stand.

Gandhimohan and Adla were standing ten meters down the corridor and when Gandhimohan saw them emerge, he beckoned them over. They walked to him. "Thank you for the way you dealt with this so-called debate," he said. "We're a small community out in the middle of nowhere and still almost two years from our destination. I think cabin fever is setting in. People are behaving rashly toward each other."

"We have every intention of following Bahá'í standards, and they're even higher than the professional standards I invoked," replied Tahirih.

"I appreciate that because I don't want this to become controversial. I think your plan to produce a written response is a good one. A video recording of it is fine, too. The issue isn't

freedom of speech; we obviously want that. But we also want to avoid polarization because of our small size and our isolation."

"As I said, our goal is unity around the truth. We're against polarization and controversy as well."

"Good. Adla and I will talk to Tad. Seeking the truth is one thing; being provocative is something else entirely. Have a good sol."

Tahirih and Vahid nodded and turned away. Reverend Varma was standing nearby, waiting to talk to Gandhimohan and Adla, and he nodded to the two of them as they walked by. It was a positive gesture and seemed to represent a grudging acceptance.

9.

Unity and Disunity

April 2079

"I appreciate you coming to meet with me, Tad," said Gandhimohan.

Tad Lind looked around the café on the *Melindia,* one of Urania's three galleons. At the time it was closed, except for a few tables near the robotic attendant; they had crossed the rope divider and were sitting in the closed area, which guaranteed them privacy. "This is not easy, but I have some things to say to you as well. I appreciate you gave me some choices."

"My office may seem intimidating to some. Here; your favorite." Gandhimohan handed him a cup of coffee.

"How do you know that?" said Tad, suspiciously.

"I don't know what it is. I just said to the robot to order your favorite coffee, and apparently it knew."

Tad sipped and nodded. "It did. I guess the cafes are tied together."

"Of course. So, we both have things to say to each other; do you want to start?"

"Ah . . . sure. I don't object to you coming to our debate, but you had no right to intervene the way you did. We have freedom of speech up here, don't we? What would freedom of speech mean, if you can't say something people find objectionable? Freedom to say just nice things is not freedom."

"It isn't, I agree. But there is no absolute right to anything. No one has the right to stand up and shout 'Fire!' in a crowded theatre. People could get killed, and people have a right to life. If people hadn't wanted to leave, I wouldn't have been able to do anything. I had no authority to

enforce anything and I didn't issue an order. In that sense, I had the right to say what I said, too. The Bahá'ís were right, Tad; there are ways to discuss matters that are better and fairer, and the format you chose wasn't the best or fairest. It was designed for debate, as you said, not discussion, as the Bahá'ís said. Remember, the 500 of us are stuck with each other for at least a decade. We are a village. Let's not stir up trouble unnecessarily."

"That certainly wasn't our point, but the topic was a legitimate one. A dozen people have converted to the Bahá'í Faith, and that upsets a village, too. Varma switched the Christian children's school to compete with the Bahá'í children's class."

"And that worked out well, didn't it? People have the right to believe anything they want. No one made a spectacle of their conversion, but this is a small place and tongues wagged. People need to let go and get over it. I've met some ex-Bahá'ís who had become Christians; the road goes both ways. My question to you is, what will the Philosophy Club do now? The Bahá'ís issued their last response wo sols ago and released their videotaped response last night."

"Oh, they did? I didn't know; it took them over a month!"

"Their written responses are very long. They should have written something shorter, but their videotape is only an hour. My suggestion to you would be to drop the matter. I'm not sure it did your club any good; I suspect neutral observers will feel you were being excessively negative and aggressive, so in that sense the Bahá'ís will be seen to have won. Considering a million people watched the debate on Earth and are now reading the various responses and responses of responses, you probably did them good, rather than ill. There are a lot of fascinating questions that can be discussed without singling anyone out, like the eternal question of the meaning of

life, or whether we consist of more than a physical body. These are good questions to ask up here."

"Psychological questions, of the sort you can discuss?"

"Those are examples off the top of my head. I'm sure you can think of others. Your club could acquire quite a reputation for asking fascinating questions that everyone can engage in. We're slipping into a certain amount of boredom up here and a good serious, professional discussion of profound questions will be a good balance to concerts, plays, and striker tournaments."

"I agree, the Philosophy Club can provide quite a service, and that's what we thought we were doing. I still think we were providing a good intellectual service, too. I can't promise anything, Gandhimohan. We'll have to look at the Bahá'í videotape and see whether we want to invite them to another round. If so, it'll be on the 'professional' terms they laid out, since they won't participate otherwise. After that, we may want to discuss Islam or Christianity. Or maybe the soul and afterlife."

Gandhimohan shrugged. "I've conveyed my concerns to you."

"And I've explained mine." Tad rose. "Have a good sol."

"You, too." Gandhimohan watched the young man leave, unhappy with the result.

Tad wasn't unhappy; he was angry. He was careful not to show it as he walked out of the café, but he stormed down the hallway and headed to his quarters before going to work, where he called his dad and recorded a long message of complaint. His father's reply came an hour later. "Hang in there, Tad. I simply do not understand this idea that mariner culture needs to avoid conflict. How else can the public grapple with issues if people don't take bold stands! Mars has

passive, boring politics and it does not serve us well. It makes it almost impossible to be ambitious or seek leadership opportunities. The result is Jacquie: an uncharismatic administrator. There are loopholes, though, so we'll keep seeking them. Keep pushing the envelope; the Philosophy Club is a good medium for it because it deals with big questions. Midterm elections come up at the end of next month and I think we'll be able to shake things up some, down here. You can do the same up there. Ciao."

Tad listened to his father's message a second time, then thanked him. He wouldn't drop the debates, but clearly they had to be modified. He'd think about that problem.

"I invited all of you here because I couldn't sleep last night, thinking about those poor massacred people," Jacquie Collins said to a select group of advisors: Mikhael Shtokman, Yuki Tajima, and Emily Scoville-Rahmani.

"It's terrible," agreed Emily. "Really unbelievable. The Indians don't want more Bangla Deshis; they think they have too many Muslims as it is."

"I don't think it was a religious thing, Emily," replied Mikhail. "How many Bangla Deshis have fled into India; five million? The cyclones put a quarter of the country underwater last summer and the spring floods have put another quarter under the water this spring. They just can't handle that many migrants. Who can?"

"Still, sending in the army and ordering it to shoot . . ." said Yuki, shaking her head.

"It was the last straw, for me," exclaimed Jacquie. "I know there's nothing significant Mars can do. Even if we put our entire GDP into relief, it would be miniscule. We've pledged

0.7% of GDP, but the Scandinavian countries have long devoted over 1%, and that's the least we can do."

"Three hundred million redbacks, instead of 210," said Yuki. "That's still not much. The price of gold is holding up very well, so the budget can accommodate it."

"Generally, we're pretty helpless," asserted Mikhail. "They're calling this 'the year of extreme weather,' with a super El-Nino that will create a terrible drought in Indonesia and Southeast Asia, floods in the west coast of the Americas, and many hurricanes in the Atlantic. Last year's summer without heat caused 100 million people to migrate and 50 million starved to death."

"And Middle Eastern unrest has displaced another two million," said Jacquie. "And a tenth of the Netherlands is still underwater from the huge winter storm that hit three months ago. These disasters can only get worse, with sea level up a meter and forecast to go up another meter in the next thirty years. It's very depressing."

"That's one reason we're here," said Mikhail.

Jacquie looked at him and shook her head. "That's my problem, Mikhail. That's *not* a reason I'm here, and it shouldn't be a reason for all of us to be here."

"But we *are* here, and about all we can do is give more foreign aid," replied Mikhail.

"I wonder. How are the plans coming for the migration in 2080?"

"I owe you a report," he replied. "I don't have all the details in front of me, but I can summarize. We signed the last contract for liquid hydrogen delivery three sols ago; overall, we're getting 20,000 tonnes at an average price of a two hundred thousand redbacks per tonne. United Spacelines and Lufthansa have finalized their plans for a four-galleon complex. We have

250,000 applications for the 15,000 berths we pay for, and 12,000 have applied for the 3,000 pay-your-own-way berths."

"I wish we could cut down on that number, Jacquie," exclaimed Emily. "A thousand pay-your-own-way would be fairer to everyone. It'll be much less disruptive, too. The pay-their-own-way folks want to do their own thing. Usually, they don't want one of the jobs we've advertised, but they do expect a tax and business environment that will encourage the success of whatever they try."

"We now have legislation in place for them, and a budget, Emily. Your ministry has to implement the plan. I know it won't be easy. But you will have the outline of their business plan and a summary of their experience, so you should have plenty of information to use in deciding whom to accept." The Chief Minister thought and scowled. "Emily, how many 'low skill' jobs are we seeking to fill?"

"About five hundred out of the 15,000 job positions we've posted. It's the lowest percentage yet; just three percent."

"Robots and automation have replaced most such jobs," said Mikhail. "Which is another reason Earth is in such bad shape."

"I wonder," said Jacquie. "Let's say we could increase the low-skill job positions to 600 or even 700. One problem we have is that we accept smart kids right out of college to fill those jobs, and they then pursue a Master's degree and move into another position that requires more skills. What if we accepted some refugees and migrants instead? They could learn the low skill jobs and might even stay in them, reducing turnover."

"That might work," said Emily. "We've been trying to fill the positions with people who will stay in them, but the temptation to give the jobs to very smart university graduates is very strong. The refugees and migrants would bring a different form of diversity, too."

"It'll be controversial," said Mikhail. "Our selection process is heavily meritocratic. This feels the opposite."

"We already give family members of Marsians some priority," noted Jacquie. "I bet if we sent an email out to everyone, we'd get a hundred or two migrants apply who are relatives of Marsians! That'd help."

"Most countries have been trying to keep immigration under 1% of their total population in crisis years," note Yuki. "That's 330 people, for us."

"I bet we could arrange for about three hundred migrants," said Emily. "Not just low-skilled jobs, either. There are always some migrants with high skills."

"Then let's do it," said Jacquie. "It's a small contribution to the problem, but it's something we can do, in addition to raising our foreign aid allocation. We need to be generous. It's not just good for our fellow human beings on Earth; it's also good for us, because we have a reputation for good, stable, just governance, and generosity reinforces that image. So it is good for us as well as for Earth."

"It really doesn't amount to much, though," said Mikhail.

"I know, but it can't; the problem is a lot bigger than us. One of the biggest contributions we can make is our example. I feel better about that, now."

"Frankly, I'm disgusted," exclaimed Esther, vehemently. She waved her lunch fork for emphasis.

"It's not that bad," replied Tahirih, shaking her head. 'The Philosophy Club has specified the subjects to be 'discussed'—they didn't say 'debated' so we won that concession—they have proposed a time, and have agreed each side can provide the other with their points and their counterpoints ahead of time."

"So, will you accept?" asked Wicahpi-Luta.

"We'll see," replied Vahid. "The Spiritual Assembly has to meet."

"The Philosophy Club has criticized you for relying on ghost writing for your responses," added Wicahpi-Luta.

"Not ghost writers," replied Tahirih. "Collaborators. The counter-arguments to their points were discussed ahead of time with various people on Earth and Mars and the entire response was approved by the National Spiritual Assembly of Mars, under whose jurisdiction we operate. This is an important difference between us and the Philosophy Club. They are treating this like a gentlemen's debate where the important thing is who can come up with the more clever argument on their own. Getting help is some sort of sign of deficiency. But as far as we are concerned, this is investigation of the truth, and when you investigate the truth, you consult and collaborate!"

"You don't act macho," added Vahid, vehemently. "That's just stupid."

"But that's what they are; stupid!" exclaimed Esther. "They won't leave well enough alone; they want to defeat, not find the truth! I think what they really want is attention. They want to prove that they're the smartest, and people of faith are inferior!"

"I think you're right," agreed Tahirih. "So the Assembly really has a difficult decision to make."

"You wouldn't refuse, and let them debate—er, discuss—without you, would you?" asked Wicahpi-Luta, surprised.

"Maybe we will," replied Tahirih. "They'll release the video and we can release a counter-video, just like last time. Unity is what's most important here; truth is important, but it's secondary."

"Really." Wicahpi-Luta was startled by that and looked at the wall to ponder the idea.

"I certainly agree with that," said Esther. "Frankly, I'm even more disgusted with Reverend Varma and the Catholic Parish Board than the so-called Philosophy Club. Varma never thanked you for defending the ideas of God and revelation, did he? He looked pretty upset when they raised those issues in the first meeting. And note the points they want to discuss this time are all focused on Bahá'í claims!"

"I do wonder whether Varma pressured them to drop the rest," agreed Vahid. "No, Varma hasn't been in communication with us at all."

"Though the Islamic community of Urania has," added Tahirih. "We sent them the draft of our defense of Muhammad's prophethood. They provided several additional qur'anic quotations and thanked us. Why are you upset with the parish board?"

"They refuse to say anything. I went to Patrick O'Hare. I know him pretty well; he was the eighth child born on Mars, so I grew up with him around. He's eight years older than me. His dad is super-Catholic and was constantly pushing my dad be more conservative. Patrick was an altar boy and his dad was a deacon. Anyway, I told Patrick about the situation and suggested the Parish Board say something. He wasn't willing to say anything at all. I think he enjoyed the Philosophy Club's attacks."

"Don't blame the entire board about that," said Wicahpi-Luta. "Patrick is just as conservative as his dad is. He's the most conservative Catholic in the settlement. I'm not even sure why he came, since it's hard to be Catholic without having a priest!"

"He's an ordained deacon and I wouldn't be surprised if the Vatican allows him to consecrate host, once the supply runs out," replied Esther. "That could mean people could confess sins to him, too!"

"No thanks!" said Wicahpi-Luta. "He's already controversial in the Catholic community here, wouldn't you say? Because most of the Catholics here are pretty liberal."

"Yes, that's true," agreed Esther.

"Anyway, we're not worried," said Tahirih. "How are you feeling, by the way? Sick?"

"Yes, in the mornings," replied Esther. "But I'm managing. I'll go to work after lunch and work until 7 p.m."

"So, that's why we haven't seen you at supper as much," said Tahirih.

"Are you ready for the flyby of 2047AX341?"

"Pretty much. We'll miss it by 150,000 kilometers; it won't be a close flyby. But our laser should zap up some good data, and our long-range cameras have already been imaging the thing in considerable detail. I'm in charge of the infrared spectroscopy and I have to work with Tad, because he's in charge of surface mapping!"

"How's that working out?"

"Pretty well; he's a professional. The proposed date for the discussion is almost a month from now because of the need to concentrate on the flyby."

"I was wondering," said Wicahpi-Luta. "Sound like Gandhimohan's theory that the debate is a function of boredom is wrong."

Tahirih shook her head. "I disagree with him; this has nothing to do with boredom. It's ego, pure and simple."

"And some people have that, boredom or not," said Esther.

10

Future of Mars

May, 2079

Marshall went out onto the balcony of their new condo, high above Cathedral Square. Willie, age 10, was there, looking over the huge space.

"So, you like it?"

Willie looked at his father. "I love this place! And I love my new bedroom and its view, I just wish I had my own balcony, like you and mom have!"

"Maybe in a few years we can move into another place and you'll have a balcony, too." Marshall's eyes lingered on the view again. Cathedral Enclosure was 150 meters high, 200 meters wide, and now 200 meters long; the orchards, vineyards climbing the walls, flowers mixed with vegetables, and grassy areas in the last 100 meters to the right were still getting established. At the far end was a temporary wall and two new tunnels, 100 meters long, were being melted at 90 degree angles from each other to continue the expansion of their underground housing. Directly below and in front of them was Cathedral Square, a plaza 50 meters wide and 30 meters long, with commercial and public buildings surrounding it on three sides. The condos continued upward 50 meters from the square and projected out over it and out along Cathedral Enclosure, each with its own private balcony. In Titan's low gravity, building shapes that looked like they would fall down were easy to create.

"Come on in, Willie, supper's ready," Marshall finally said. He turned and headed into their living room, Willie following.

A robotic cart had just arrived with the dinner they had ordered and was placing it on the dining table for them; Amy and Millie, age 5, were already seated. The males sat and dished out their food. “So, how was everyone’s day?” asked Marshall, as they began to eat.

“Good,” chimed out Millie, without supplying further details. Marshall nodded only; he was busy eating.

“We’ve finished planning the new layout for N-5,” said Amy, referring to one of the settlement’s original 75 by 35 meter cylindrical bubbles. “We can at least double its agriculture.”

“As expected,” said Marshall. “I watched the Enceladus crew set up the solar power unit. They had no problems at all; it inflated perfectly and they had it tracking the sun in two and a half hours.”

“Pretty good. How much power?”

“Thirty-five kilowatts; the most you can make with a sphere one hundred meters in diameter, out here!”

“At least it doesn’t mass practically anything and can be manufactured pretty cheaply.”

Marshall nodded. Willie looked up from his food. “Dad, when can I go outside?”

Marshall was started by that. “Willie, you’re just 9 ½.”

“You were 9 ½ when grandpa took you outside for the first time, and you say the equipment’s so much better now.”

“I suppose it is, but Titan is a very dangerous place.”

“And Mars isn’t?”

Marshall scowled at that. “They’re both dangerous. Remember, if I take you out, there are a dozen other kids who will want to go outside, too. I’ll need to talk to the Council about it and we’ll need to set a policy.”

Willie rolled his eyes. “Policy.”

There was a pause in the conversation, then Amy said, “We need to talk about the dacha.”

“Yes, you’re right.” Marshall looked at the kids. “So, we’ve been in our new condo for a week, now, and everyone really likes it, right?”

“Yes!” said Willie, and Millie nodded as well.

“Good. Because we can’t afford to pay mortgages on this place and on the dacha, and we haven’t been to the dacha for over a week, now. In two months, 185 more people arrive here, and they need to live somewhere. Some of them want to live in the dachas; others want condos here in Cathedral. So your mother and I have decided we’ll sell the dacha, so someone else can live in it.”

Willie looked at his father, shocked. “No! I want to go there to stay, sometimes! I want to be able to chase the rabbits!”

Marshall shook his head. “I’m sorry, but like I said, we can only afford to pay for one of the two places, and this is much bigger and more comfortable. You’ll still be able to visit the enclosure and chase the rabbits if you want, but we just won’t own the dacha there anymore.”

“Dad, you’re the chief executive, so just pay yourself more!” said Willie.

“Sorry, it doesn’t work that way,” replied Marshall patiently.

“Two people want to keep their dachas, so N-4 won’t change,” added Amy, patiently. “We haven’t stayed there since we moved in here. Do you want to go there tonight?”

"No, I have homework, then I want to watch something," replied Willie. "Can we go this weekend?"

Amy looked at Marshall. "Have you gotten in enough exercise this week?"

"I'm close. If I go work in an office in the *Von Braun* morrowsol and get more gee exposure, and if I get an hour of exercise running up the ramp to the surface on Satursol morning, I should be alright."

"Okay. I don't have either of those options, but I could go to the *von Braun* or the *Korolev* for exercise over the weekend."

"We're there every day," said Millie resentfully. She and the other kids mostly hated going to school in rotating classrooms, where the gee was double Mars normal. It was an unpleasant contrast to Titan's 0.12 gee, in which they reveled the rest of the week. Monsol mornings were the worst.

"I can give you a tour of Titan 1, also," volunteered Marshall. "The spin-up should be complete by tomorrow. The first foundation strip is finished and is angled to give one a flat floor all the way around the perimeter. I bet we could jog around and around on it, if we wanted to!"

"Let's wait on that until you can open it for everyone, and I don't like jogging with you, anyway. You're too fast."

"Alright," said Marshall. "Let's enjoy the dacha this weekend. It'll be a month or so before we have to move out."

"Even after that, we'll probably be able to stay in N-4 sometimes," said Amy. "There's no plan to remove the housing and fill the volume with seven or eight floors of agriculture. That's what they plan to do with N-1 through N-3. I think N-4 will have at least one unit that people can

rent out for the weekend, like a hotel room. So we may be able to stay there for quite a long time, if we want."

"I want," said Willie insistently.

"Alright," agreed Marshall, wondering how much children could or should influence the design of Titan settlement.

Amy began to tell them of the work her biology team was doing to convert N-5 to agriculture, because the dachas there had been removed and floors had been installed all the way to the top of the bubble so that crops could be grown every vertical meter or so. The settlement needed to expand its output in preparation for the arrival of Saturn-4 in late June; it was also building up its reserves to equal 18 months, with an eventual goal of 24 months of provisions so they'd be safe against almost any disaster. She explained the plans simply, so that even Millie listened and understood what she was describing. Then Marshall described Titan-1's progress for the kids. Willie had a contribution, too: in school that sol they had talked about the launch of 300 people from Earth to Ceres.

As Marshall helped clear the table of dishes and store them back inside the robotic cart, his communicator buzzed. The nature of the vibration told him it came from Earth, so he slipped away to his little home office, next to the master bedroom, to play the videomail.

He did not recognize the face that appeared on his screen, of a South Asian man about 40 years old, with black hair and light brown skin. "Good sol, Dr. Elliot, I am Dr. Arun Chandrasekaran, and I am in charge of the construction of Mariustown, the new settlement being developed by Swift Space," he began. "I don't know how much you are familiar with our plans. We are building inside Marius Lava Tube North; this is not the one with the famous skylight,

where the Europeans' Marius Station is located, but in another lava tube a dozen kilometers to the north. Your father was present when the North Tube was first drilled into, in March 2034; in fact, your mother was in charge of the drilling operation! There's a section of the north tube that is 500 meters wide and 200 meters high; it is a truly enormous interior space. We're widening the existing access way so that it is fifteen meters wide and high; big enough to haul in almost anything. The plan is to inflate the largest bubble anyone has ever constructed to fill a section of the tube about 200 meters long. The space between it and the rock will be filled with insulating foam. We have a robotic team in there spalling off loose rock and removing protuberances in preparation. We are also building a carrier to provide rotating housing. It'll be 200 meters in diameter, like yours, but it'll probably be 200 meters high, to fit the lava tube. The eventual goal is to build 2 carriers and inflate at least 2 big bubbles, able to accommodate several thousand people. Mariustown, in short, will be the largest city on the moon. With a metal road connecting to both poles and a metal road connecting it to the mass driver and Parenago, we anticipate it will acquire employment contracts to run things all over the lunar surface.

"Dr. Swift suggested I contact you to request contact with your architects and construction supervisors for Cathedral enclosure. It is similar in size to what we are building, and with your Titan-1 carrier, it will even have a similar supply of rotating housing. Titan's gravity is not that much less than the moon's, so we face similar construction limitations. Both of us are working with Martech's Center for Space Construction, so we are collaborating with the same group. We thought collaboration between our teams would be mutually beneficial.

"I am attaching a three-d simulated tour of Mariustown, for your confidential viewing. The details will probably change quite a bit, especially in consultation with your and other experts. I look forward to your reply, Dr. Elliott. Goodbye."

Marshall clicked on the link and ran the simulated tour. The cavern was noticeably larger than Cathedral; it was hard to believe that such natural spaces occurred underground on the moon. The carrier was filled to a considerable degree, leaving a fairly small axial open space. Titan-1 would be filled as well in its final construction phase, but that would be some years into the future; Titan and the moon, unlike Ceres and Phobos, had sufficient gravity for a lot of day-to-day living outside centrifugal gravity, so the people on the larger worlds could have large low-gee spaces instead. The carrier design Mariustown was pursuing could probably accommodate 20,000 people, and they were talking about building two of them.

Marshall hit the reply icon and copied Shiyoko Takashima, Director of Construction. "Thank you for calling, Dr. Arun. I am copying your message, by way of introduction, to Shiyoko, our Director of Construction. I had heard from Helmut Langlais that you might call. I was unaware of my parents' roles in the discovery of the Marius North lava tube; thank you for telling me about that! That happened six years before I was born. I am sure Shiyoko will be glad to exchange ideas and experience with you and your team. The gravity of Titan and the moon are fairly similar, but our carrier has to spin in a thick atmosphere and yours doesn't. We also keep our oxygen content at 12% of total pressure. So there are important differences. The other obvious difference is that we can melt a cavern of any size and shape, whereas you are constrained by the lava tube.

"But I suspect we could create a long list of similarities. We are always interested in technological innovations, and Swift Space has a reputation for them. The arrangement Martech has made with your company can be extended to Titan, if there are technological and patent implications. We look forward to it. Ciao."

Helmut and Clara Langlais looked for a seat near the front of the meeting; they wanted to have a good view. Surprisingly, many seats in the front row were empty. As they moved toward some empty seats, they passed Jacquie Collins, her husband, Mario Esposito, and their 9 year old daughter, Mary. "Good sol," said Helmut to them.

"Good sol to you as well," replied Jacquie. "Your dad isn't coming to the Future of Mars Forum?"

"He's watching it at home; it's a lot of walking. Have you seen Sirikit and Charlie?"

"They're back there." Jacquie pointed several rows back and to the left. Helmut looked; Sirikit and Charlie waved to them, but had no empty seats near them.

"Thanks, I see them, but it looks like we'll have to sit up here." He looked around. "I've never been in the Futbal Stadium before. I remember when I arrived last year, they were still building it."

"It was dedicated in the fall with a big match against Cassini. The Cassini team won, too; I was here. Very sad." Jacquie pointed to the risers. "We've only built the southern end and the western side of the stadium so far because that's more seating than we need at the moment. We can accommodate 10,000. We might eventually expand it to 50,000; we can easily do it."

"It's perfect for the Future of Mars Forum. The entire town can fit in here."

Andalus was just too small, but it was cozy and it had better atmosphere than this place." Jacquie shrugged. "From the point of view of public safety, also, this is much better. Australia enclosure is so much bigger and has about 100 times as much air."

"And much better radiation exposure," added Clara.

"True, but they're planning to add water bags with 2 meters of water to Andalus dome in another year or two," replied Jacquie. "That'll reduce the strain on the dome and will improve both insulation and heat expulsion, since the water can be heated to 40 Celsius and will radiate most of that heat straight up to the sky."

"That's the great thing about living in here," said Clara. "The dome is never covered by curtain insulation at night, so you can go out to see the stars, but it never gets cold outside, nor does it get too hot during the day. The heat storage and expulsion system works really well."

"Glad to hear it," said Jacquie. "Ramesh has to build another one right away, and Marfab has an entirely new second set of construction equipment for the Central Highlands to build big enclosures up there. The new water-equipped dome is a key innovation, if we're to keep up with immigration."

"Did you see the op ed piece by Johnny Lind?" asked Helmut, certain she had. "I couldn't believe it."

"And it'll come up this sol; you can be sure of it," said Jacquie. "In election years when the Chief Minister is not up for reelection, the Future of Mars Forums tend to be more negative."

"That's true," said Helmut. He waved goodbye and headed toward the nearest empty seats. As he and Clara sat, he said to her "I wish the immigration issue wouldn't come up."

"It always has. Just keep a reasonably low profile, dear. You're already pretty busy and I'd rather not have you elected to anything else!"

"I don't want that, either," said Helmut.

Just then Érico Lopes stepped onto the stage set up in the corner of the stadium where the two walls of bleachers came together. His face immediately appeared on the large screens as well. "Good afternoon, everyone, and welcome to our first Future of Mars Forum," he began. "We will have two of them, each at 2 p.m. Aurorae time on Sunsol. People are watching at every outpost, on Phobos, Ceres, and every place where Marsian residents live; there are live gatherings right now on Titan, Callisto, and Urania, for example, and we are told there's even a gathering in Houston, Texas. We will take questions from all these places, either by audio or by email, as well as questions from the 10,000 people gathered here this sol.

"As all of you know, on Mars our elections involve no campaigning, nominating, or mentioning of names. The Future of Mars Forum is a place where people can express their desires, dreams, and proposals for Mars, debate them, and debate the Commonwealth's current directions. It is not a campaign forum, but it may prove useful for people trying to understand the issues and consider the various people whom they could vote for in their district. The Chair of the event—myself, in this case—has been selected because he is ineligible to be voted for. I may not look it, but I am now 71 years old and have retired from active government service!

"To participate, you need to email your question or your request to speak, including your phone number, to futureofmarsforum.mars. When it is your turn, we'll call your phone and you will be able to use it to speak to everyone. Without further adieu, I recognize Father Greg Harris,

who often makes the first comment in the forum, in order to get the discussion started. Father Greg."

There was a pause as Greg answered his phone and rose from his seat, and the camera zoomed in on him. "Thank you, Érico. I think we all must start by thanking the Commonwealth—the Chief Minister, the Mars Council, and the cabinet—for their wise and effective leadership over the last two years. We had a very successful immigration of 9,000 people; we sent a total of 4 galleons to Uranus, Saturn, and Jupiter; we sent two galleons to Mars; we have completed a carrier on Ceres and one on Phobos; we have initiated a program to supply large quantities of water and metals to low Earth orbit and Phobos from Ceres at revolutionary reductions in cost; we have developed the ultimate gaseous core nuclear engine, which promises reasonably rapid and inexpensive transportation throughout the solar system; through automation and robotization we have more than doubled the economic output of Mars in the last four years; and we are less than a year from completing a metal highway system that will connect every major outpost, from Cassini to Tithonium and Uzboi, a system that will also move oxygen and methane among our major population centers via built-in pipeline. I don't think any of us could have imagined this immense expansion in our capacities nearly 13 years ago, when we became an independent nation! We will complete the initial settlement of the planets of the solar system in the next six years, oversee significant helium-3 extraction for Earth's electrical systems, and grow to 100,000 people in the next two decades. We may indeed initiate interstellar expeditions early in the next century. This is who we are and where we are going; the context for our discussions this sol. Thank you."

Father Greg sat to warm applause and Érico quipped, “Father Greg, I wish we could still vote for you! Thank you for your warm-up. Elsie Jordans will address us next on the subject of terraformation.”

A middle aged African woman rose from the southern bleachers and the camera zoomed in on her. “Thank you, Dr. Érico. I would like to know why we are not devoting more resources to terraformation, which would seem fitting considering our enormous increase in automated capacities lately. As I understand it, we have been releasing perflouromethane into the atmosphere at Thaumasia and Tithonium; 100 tonnes per year at each place, with a planned increase to 500 tonnes per year this year. The Thaumasian release immediately disperses, but the Tithonium release remains in the Mariner canyon system for many months and builds up there, so it provides a way to model the effect of future concentrations. As I understand it, the preliminary data has been disappointing, with almost no noticeable increase in daily temperature at Tithonium, and this has been a problem for the large cactar forest being established there. So I am wondering, what can be done about improving the heating effect? How quickly can we expand perfluoromethane production? And why aren’t we trying powerful brute force methods, like hydrogen bombing the caps?”

“Good questions. Perhaps the head of the program could comment briefly? That’s Ernest Wright, I believe.” Érico paused as Wright called in and they could connect him to the public address system. He rose, nervously, from a seat near the front.

“The thermal modeling estimated the resulting convection inadequately, and we are now revising the model,” he began. “There has been a 1 degree Celsius increase in the vicinity of Tithonium, though, and even up on the Thaumasia Plateau there has been a slight warming

effect. We anticipate increasing production to 1,500 tonnes per year at each facility in about two and a half years, and at that point the heating will accelerate enough for Tithonium to become noticeably warmer. We anticipate evaporation of several buried glaciers—we'll strip off the dust cover to help—and their water will condense as frost at night, which will both slake the thirst of the cactars and increase the nighttime temperature low quite significantly. The bottleneck for increasing production is power, but several wind farms will be opening on the Uzboi and Tithonium highways over the next year and will supply their power as methane and oxygen via the pipelines.

"As for bombing the polar caps, we need to open negotiations with several key nations on Earth about the idea, because we have sworn off the development of nuclear weapons, and that would need to be revised. It's a delicate political matter, but it is by far the cheapest way to provide heat to the poles, and the radioactivity is a relatively minor problem, since we are already inside pressurized facilities anyway."

"Thank you, Ernest. Our next question has to do with immigration and comes from Francois Colmar, who lives in Dawes. Francois."

There was a pause for his phone to be activated at Dawes Outpost, but momentarily his face appeared on the screen. "This is a perpetual issue: Aurorae grows and we don't. When will Dawes get one of the new enclosure making systems? If 18,000 people are coming next year, how many will settle in the Central Highlands?"

"I think I'll ask Ramesh to answer the first question, and Jacquie to answer the second."

Ramesh rose eagerly and almost started before his phone was turned on. "We're expanding our equipment as fast as we can, but we have to import some proprietary equipment

from Earth, and manufacturing 700 million redbacks of equipment is not quick and easy," he began. "A new system, like the one here at Aurorae, will be complete in a few months at Cassini and will start on a 1,000 meter by 800 meter enclosure; quite large, able to house and feed 4,000 people. When it finishes in two years, it will be moved to Dawes to make a similar enclosure there. We plan to have a system set up and running permanently at Cassini in four years, one in Uzboi in six years, one for Meridiani in ten years. Meanwhile, Aurorae will be getting additional systems as well. But with the completion of the metal road system early next year, it will no longer be necessary for an outpost to raise all of its own food, so an expansion in population is not predicated on completion of these large enclosures. Cassini could feed Dawes, or vice versa, or both could be fed from Aurorae. Agriculture is our largest use of land. The creation of polder needs to be as cheap and routine as possible, and that's what Marfab is doing. One outpost could release its CO_2 into the atmosphere and another one that produces surplus food could put its extra oxygen into the global pipeline system so that it could be used anywhere. We have a whole new flexibility, now. I anticipate building domes that are 1.5 kilometers wide and 2 to 3 kilometers long in the next few years."

"Jacquie, will you comment about the destinations of the arrivals?"

"Sure, Érico." Jacquie rose. "Arrivals have to go where they have jobs, and most of those will be at Aurorae. Just four years ago, mining was our largest economic mainstay. It had to be expanded, especially gold production, so the gold producing outposts saw considerable expansion. They are now better integrated into a planetary economy, thanks to the metal roads, but the integration process is incomplete. Marfab, Marcraft, Marchem, and our other big companies can now expand operations to other outposts, specialize their operations, and ship

product back and forth on the metal roads, but the planning for expansion has just begun. We anticipate that as much as 12,000 of the 18,000 who arrive in the next two years will settle at Aurorae, but the twenty-second columbiad will see that percentage drop considerably."

"There are quite a few questions about immigration," said Érico, looking at the emails on his screen. "So perhaps we should turn to that theme for a while. One person, responding to your reply, has already asked, 'Why hasn't the planning process to expand the big companies' operations in the Central Highlands proceeded farther along?'"

Jacquie stood again. "The Mars Council passed legislation four years ago to assist financially with the creation of new operations. There are tax incentives as well. But the companies have been slow to take advantage of them because it is logistically easier to put everything in the same place. The Commonwealth does not control the companies; they are only semi-public. These are decisions they have to make on their own."

"Thank you," said Érico. "There is also another question, 'The twenty-second columbiad will involve 18,000 immigrants and a fifty percent increase in our population. Can we anticipate that from now on, we will see a fifty percent population increase every two years?'"

"I don't have a crystal ball," replied Jacquie. "Remember that each person requires 100 to 200 square meters of farmland, 75 square meters of housing and work space, up to 10 kilowatts of electrical production, about 300 tonnes of water to make the polder and for radiation shielding, and about 2 tonnes of oxygen for the atmosphere we have to add to our enclosures. If you multiply that by 18,000, you have a sense of the huge task we face. That's another reason we're expanding Aurorae. With three metal roads and pipelines converging here, there is a lot of power that can flow here from wind farms and solar arrays all around. New Hanford processes

2,500 tonnes of ground water per sol for deuterium; that sounds like a lot, but it's enough for only 8 people the way we use water now, 2,100 per year, 4,200 per columbiad, and we have 18,000 coming. So we have a dozen new water wells being drilled as we speak, to extract 15,000 tonnes of water a sol from underground aquifers. We can't move a huge operation like that to Cassini or Dawes; they aren't big enough to support them. So they have to grow proportionally, like everyone else. We'd like to expand deuterium production, to process all the water we extract. We'd also like to expand perflouromethane production faster. Both are very energy intensive, and we are expanding power production as fast as we can to keep up with the population growth. So these issues all influence each other."

"So, it sounds like a fifty percent increase isn't practical," concluded Érico.

"It is challenging and can be accomplished. If the twenty-third columbiad involves 25,000 immigrants, we'd already have the capacity to handle 18,000 of them, so we'd need an expansion to handle 7,000 more. We can do it. The big bottleneck will be the space transportation system, and it's hard to say whether we can expand it beyond a hundred thousand per columbiad. We can expand our population thirty to fifty percent per columbiad for the next few, at least."

"Thank you, that's a clear response. We now have a question about bringing refugees from BanglaDesh and other places torn by war or natural disaster. Johnny Lind of Aurorae."

Helmut looked at the screen, startled, as Johnny's face appeared. He turned to Clara. "It looks to me that Érico is intentionally creating debate!"

"I think so. This is livelier than our usual forums, though, where the questions are in no particular order and responses to questions have to wait fifteen minutes or more."

"True." They turned to the screen as Johnny put his communicator to his mouth.

"The concerns I want to summarize were very well expressed in a *Mars this Sol* op ed published Thursol. I have long been very concerned about a very rapid expansion in our population and I was strongly, publically, opposed to the goal of 18,000, when it was debated in the Mars Council last year. I think a twenty-five percent increase per columbiad is just fine. That would be 9,000. It would be much easier for us to accommodate that number, it'd be less of a strain on our resources, it'd leave more resources for other things, and it would make assimilation of the arrivals easier. It would also allow us to continue a 25% expansion longer, because I doubt when Mars has a million people we will be able to manage an immigration of 250,000 per columbiad, let alone half a million, as it would be at the present rate. If the ultimate cap on immigration is, for example, 100,000 per columbiad, at a fifty percent increase per columbiad, we'll hit that number nine years from now, when we have a population of 239,000. That's not very far into the future. On the other hand, at a 25% increase per columbiad we'll hit that number in nineteen years, roughly when the new century begins, when we have a population of 400,000. Either way, we will be a growing, vigorous nation, one attracting to Earth's young, we will be an example to humanity, and we will help lead humanity across the solar system and to the stars.

"But my concern in the op ed is the plan to bring 300 refugees to Mars. Why? Why? Earth is predicted to have 25 million displaced persons this year, largely from rising sea level, though wars in the Middle East and Africa are major contributors as well. Even if all 18,000 migrants were refugees—let's round it up to 25,000 for convenience—we'd accommodate only one thousandth of the total. Three hundred is a bit more than a hundred thousandth of the total!

It's a ridiculously tiny contribution to a massive problem, which really isn't our problem, since we have known about and understood climate change all along; in fact, we are intentionally trying to engineer global warming up here. My Dutch relatives are refugees from the great flood earlier this year because no matter how hard Holland tries, it can't raise its dikes fast enough to protect the country from the sea.

"So, our contribution isn't even worth considering; it isn't even a drop in the bucket. But what will we do with these refugees? Why are we importing people who lack basic skills we need, when we have over 150,000 qualified applicants for the 18,000 berths? What will we do with 300 relatively unskilled people? Is it charity to send them to a planet that requires advanced computer skills to do practically anything? It is an absolutely ridiculous, idiotic idea."

Johnny sat definitively to a scattering of applause. Helmut, furious, had begun to type madly about half way through. Érico looked at Jacquie, but he hesitated to call on her, even though she was half crouched, ready to stand from her seat. She was angry, too. But he hesitated to make the Future of Mars Forum into a "debate the Chief Minister" session instead. He glanced at the subject lines of the emails on his screen and scrolled down a bit to find someone else qualified to respond. "I see Helmut Langlais wants to comment about this subject."

That surprised Helmut; he had not expected to be called on right away. A moment later his communicator buzzed with the call from the public address system. He stood and activated the call. "Thank you, Érico," he began, collecting his thoughts. "First, regarding immigration; the assumption that 100,000 is the max we'll ever achieve is questionable. We may find, for example, that in a few years 50,000 is all we can manage, so we'll cap it at fifty for a few columbiads, at which point efficiencies and new technologies may allow 80,000 or 100,000.

Who knows what we can manage in 2100 or 2150. A million or two million may be possible at some point. No one would have thought, in 2036 when six people landed here, that 9,000 would have been possible. In 1492, no one could have imagined millions crossing the Atlantic every year. Currently we can handle twenty-five percent, thirty-three percent, even fifty percent per columbiad. The plans are underway for fifty percent and we are not encountering bottlenecks. No one has said we'll aim for fifty percent in the twenty-third columbiad. We'll see what the Chief Minister proposes and the Mars Council approves.

"Second, regarding 300 refugee immigrants: the fact that we have understood and even encouraged global warming here is irrelevant to the crisis facing our fellow human beings on Earth. We are a tiny country and we are pledging to take in the equivalent of one percent of our population in the form of refugees. The earth has almost ten billion people; one percent is 100 million people, four times the number of refugees that need accommodation. If everyone followed our example, the refugee problem would be solved. Our goal is not to solve the problem, but be a good and responsible member of the family of nations and encourage others to do the same. We can even help some of the poorer nations to accommodate refugees, because we have pledged 100 million redbacks for that purpose.

"So that is why we should do it. Who will come as a refugee? Johnny's assumption that the refugees have to be unskilled is incorrect. His Dutch cousins, displaced by the floods, can apply, and I suspect some of them are highly skilled. I suspect if we could contact everyone up here, we could find close to 300 relatives that would qualify as refugees. That would reunite many families, which is another goal of our immigration policy. Finally, we do need some unskilled workers. The number of jobs is fairly small; a few hundred only. Right now we get

college students, who then go to Martech to complete their training and move out of the unskilled jobs. They're reasonably good paying jobs, too. So if we do import refugees with fewer skills, it will because we've matched them with a job."

Helmut sat to applause, but Johnny jumped up. "May I reply?" he said, loudly enough for Érico to hear him, even though his communicator was not connected to the public address system.

"Sure, just wait for your communicator," replied Érico.

Johnny stared at Helmut, waiting for the sound to come on. As soon as he heard a tone come from his communicator, he activated the link. "There are several problems with your argument. First, we're talking about a miniscule act; why should we bother with it? Why would it influence the other nations? Why waste our resources on such a small gesture? Second, will these refugees be family members, or not? If so, they can apply under that provision of the law, so why add another provision? If they are unskilled workers, they can apply via that provision; why add another? And if they are skilled, they can apply for specific skilled jobs, so why add a refugee provision? Finally, I didn't hear you defend the policy of a fifty percent growth per columbiad or not. Are you in favor?"

Helmut rose. His communicator was still on, so he turned to Johnny. "You said in your first comments that we were an example, we inspired the youth of Earth, etc., so what kind of example shall we be? Taking in a few hundred refugees and launching an expedition to some asteroid are both small examples, and we are a small nation. Big problems on Earth need to be solved a step at a time, and if we take a step, that may encourage others to do the same. Why shouldn't we take that step and help? It's our share, after all. As for refugees applying under the

family provision or for specific skilled or unskilled work, all those categories have more applicants than slots. This will give refugees a leg up if they are qualified, and many of them can be. That's why we have multiple provisions; we want people to come here who are not just qualified based on work skills. We are also considered about diversity, uniting families, etc. Let us also take some refugees.

"As for the scale of our immigration program, I think you misunderstood my point, which was actually not that different than yours. You rejected a fifty percent goal for the upcoming columbiad just now, and in your vote in the Council last year. I supported the fifty percent goal both times. You seem to favor a 25% goal until we reach some magic ceiling of immigration. I said there is no magic ceiling and the goal needs to vary from columbiad to columbiad based on technology, resources, and our priorities. That's flexible, not rigid. I never heard a real reason why you reject a fifty percent goal this coming columbiad, either, when we clearly have the resources to accomplish it."

"My main concern is excessive prioritization of our resources on one thing when we could devote more of them to terraformation or consumer goods, and the problem of assimilating so many people."

"If we followed your argument, we'd have half the population we have now, half the GDP, and the larger share of the pie devoted to these other items would still be smaller overall than it is now. Growth lifts all boats; there is no doubt about that. As for assimilation, where are the semi-assimilated masses? The people who arrive are already familiar with our culture; they study it devotedly on Earth and take classes about it on the trip out. I see no danger there."

"It's a question of sacrifice. You can't overburden people and ask too much."

"Sacrifice? We're almost caught up with the advanced economies of Earth. We have 20 sets of clothing in our closets instead of 200; that's excessive sacrifice? And if we didn't grow our population and gain economies of scale, we'd have a lower per capita income anyway."

"And with that comment, we will move on to other matters," interrupted Érico. "Thank you, gentlemen, for your exchange on this issue, it has thrown a lot of light on it. If you have more things to say, they can be published in *Mars This Sol*."

11.

Midterm Elections

Late May/June 2079

As the final burst of applause from the Future of Mars Forum echoed through the three cafeterias of the Urania settlement, John Anand Tian switched on his microphone and camera and said, "Before we disperse, folks, let's have a quick 'Future of Urania' forum. What do you hear that was especially relevant to our situation?"

There was a pause while the 500 people on board considered the request. "The obvious concern I had was when someone on Titan asked whether Mars was pledging to make a regular passenger run to all of the outer worlds," said Jasmine Smits. "Mikhail Shtokman's answer was 'that depends more on the economic output of each settlement than on the Marsian government.' We'll need to seek clarification on that point."

"I think that's the right answer, though," replied Anand. "We're used to thinking in terms of an annual Marsian and terrestrial subsidy of a certain amount for each of our settlements, especially Jupiter. I'm not saying there won't be subsidies, but in the last few years the paradigm has shifted significantly. Ceres has a significant economic output from PGMs and now water exports, and is almost self-funded. Saturn and Uranus will have Helium-3. Robotic manufacturing has made all of us far more self sufficient than we ever could have been in the past, and the ability to make our own carriers frees us from dependence on the vehicles that transport us to our destination. The *Persa, Ouranos,* and *Melindia* are the largest costs of this expedition, and once we build and move into a carrier, we can free them to return to Mars to bring us more people. These ships are not going to become our settlement; they're going to

become our lifeline and go back and forth every six years. The same can be said of the vehicles of Uranus-2, which launches from Mars next year. Mars will either supply them with new gas core engines and the hydrogen propellant for the journey, or charge us for necessities from Helium-3 profits."

There was a pause. Many in the audience were nodding, as this had become obvious in the last year; others were absorbing the new perspective and looked surprised. "What about reactors?" asked Wicahpi-Luta, who was completing a certificate in reactor maintenance.

"We'll have to buy those, or be given them," confirmed Anand. "We won't have the ability to extract uranium and concentrate the right isotopes. But we won't need many reactors because we can build solar concentrators that are a thousand meters in diameter, if necessary."

"So, where will we build?" asked someone.

"That's the crucial question," replied Anand. "It is dependent on an ample supply of nickel-iron, since we'll need a lot of metals. We know, from magnetic anomalies, where many such bodies have impacted and created craters, but we'll need ground truth to be sure. Another issue is delta-v. Do we want to be on Miranda because it is the smallest moon, with the lowest surface gravity and escape velocity, and closest to the Helium-3 extraction station in the Uranian atmosphere? Do we want to be on Umbriel because it is right in the middle and conveniently located to reach all four of the other major moons? Do we want to be on Oberon, farthest out of Uranus's gravitational field? I think the answer is, if there's nickel-iron on Miranda, we want to be there."

"We will also need a location within 7 degrees of the equator," added Adla. "Anywhere else will experience 42 years of dayspan, followed by 42 years of night span."

"Any hope we'll get input into the science priorities of the Chinese equipment?" asked someone.

Anand smiled. "Let's just say that their scientists have priorities that are very similar to our own. We still need a lot more data about the equatorial regions of Ariel and Titania, primarily high-resolution spectroscopy, but also magnetic data. Our own satellites arrive in six months and we'll get plenty of data then. Anything else about the Future of Mars Forum?"

There was a pause. "We don't have to worry about refugees," commented Tad Lind, reflecting his father's position.

"True, but we sure could use some of that immigration," replied Anand. "Let's hope we'll have two galleons going back and forth every six years, carrying 300 people to us each time. That's an average of 100 per year, 10,000 per century, and if all those people have children, that's 20,000 immigrants. That's possible now, and the technology keeps getting better. Assuming that terrestrial society doesn't collapse—which is not altogether clear—then Helium-3 reactors will have an important future, and we'll have a reliable export. We need about two billion redbacks per year. The same for Saturn and Neptune. That should be possible in a decade." Anand looked around the cafeteria of the *Ouranos,* where he was located. "Thanks everyone," he said in conclusion.

People rose and headed to their quarters or work spaces. Wicahpi-Luta shook his head and said to Esther, "Tad had to get that comment in!"

"Yes, he did," she agreed. She looked at Tahirih, who was sitting nearby. She heard the comment and shook he head.

Tad, who was also in the cafeteria, walked toward the four of them. “So, you Bahá'ís won’t debate—I mean ‘discuss’—with the Philosophy Club.”

“Nope,” said Tahirih, shaking her head. “We’ll be glad to record a video response, but the Philosophy Club does not strike us as a fair and disinterested partner.”

“Disinterested? Of course we’re not disinterested! We think you all have kooky ideas and we want to demonstrate it!”

“And we want a neutral exchange aimed at truth, not at scoring rhetorical points,” replied Vahid. “We get that if we respond to your programs our way. If you want us sitting at a table with you, with an audience, we need different conditions.”

Tad shook his head. “I don’t believe it. You’re just avoiding us.”

“Then accept our invitation to you. We sent it last week,” said Tahirih.

“That wasn’t much of an invitation! It was a rejection!”

“No, reread the third paragraph. We said you could ‘join us’ in a discussion.”

“Alright, then,” said Tad. “I think we will.”

Bill Hollingworth very slowly crouched down—the gravity of Themis was so low, he had to hold onto a railing to push himself down—then he let go and leaped upward into the air. He spread his wings right away to control and angle his flight because the dome holding in the oxygen atmosphere was only 20 meters above him and he didn’t want to run into it. He curved his flight just enough to miss it; he looked up at the eighty meters of carbon dioxide atmosphere above the plastic sheet, and the real triple-dome above that, with its meter of water to shield them from solar radiation and some of the cosmic background radiation.

"Flying's the only way to get around," Bill said, as the rest of the Themis Council—Zach Hatcher, Tom Shepherd, Lori Chen, and Irene Langlois—leaped into the air behind him.

"That's true, because the ground has been almost completely taken over by weeds," replied Lori, the chief of ecology. It was true; the entire surface of Themis was now oxygenated and some species had adapted to the slightly acidic virgin regolith with enthusiasm. Grass species grew up to 4 meters high in the low gravity; some prairie flowers stood even higher.

"How fast are they making oxygen?" asked Bill, panting. "It still seems rather low to me."

"It is low; 0.15 atmospheres or 75% the level at terrestrial sea level," replied Zach, who was chief science officer. "We have to keep it down; we don't want any fires. The plants are converting CO_2 and water into plant matter and oxygen pretty fast; the dome rises 3 meters a week. Of course, we're moving into aphelion and that will drop to 1 meter a week, in the next few months, and the temperature in here will drop to 10 Celsius. The carbon dioxide layer will be used up in about two years and we'll have 100 meters of oxygen around us."

Bill pointed to a robotic grass harvester at work below. "Are we able to cut the grass and sequester it fast enough?"

"The pile's getting pretty big!" said Lori. "And it's drying out and returning a lot of the water to the system. In two years, we won't have to release carbon dioxide into space anymore; we'll have a pretty big carbon reservoir."

"But we'll be releasing oxygen, unless we can store more of it," said Zach. "We can pump some of it inside Themis and dissolve a lot of it in the South Sea."

"That's a problem we never anticipated, when the Prophet sent us here," said Irene. "The only way to maintain a balance here is to maintain storage reservoirs, which is expensive and time consuming."

"It takes half of us to run the ecology," agreed Bill. He pointed up at a spacesuited figure 100 meters above their head. "And to patch the dome against micrometeoroid punctures."

"A constant task," agreed Irene.

They flew southward from the two caravels along the border separating the "Badlands" from "the plateau" where their gardens were growing. Many vegetables were growing reluctantly; they still had to rely on the aquaponics inside the ships for most of their food. But corn grew very well, so they had a big half hectare patch of it and they were eating a lot of corn. Like the grass, it grew tall in Themisian gravity. From the corn patch, they flew over the drop-off of land to the shore of the South Sea and flew over the expanse of waters to the other shore, which was just 300 meters away. The water was now blue-green with algae and their first efforts to introduce fish—tilapia—had failed. They were waiting for Martech biologists to tell them how to improve the chemistry of the brew so that fish could survive.

After crossing the South Sea, they completed a half circle along the shore and landed at the Overlook, a prominent spot on the southern edge of the Plateau. The sun was setting there, but it would reflect off the dome all night, so it would never be completely dark. They pulled themselves down onto some benches and stowed their wings. "It's so beautiful here," said Bill.

"It'd be a shame if we have to sell it to Quint," said Irene, immediately bringing up the issue of discussion.

"We can't do it," added Tom, emphatically. "He's a big wig billionaire whose robots are displacing tens of millions of workers. We need support from someone who understands our agricultural, nature-based approach to life."

"Well, we aren't exactly the Amish of the solar system," replied Bill. "And we need his robots, too."

"How bad is the situation?" asked Tom.

"We don't have enough money to charter a flight here, so we can't get supplies. That's the relevant number. If we sell to Quint, he'll fly here to see the place and we can use the money to buy equipment, which can arrive on his flight. We get a free infusion of equipment. You know what we need."

Tom nodded. "It's rather grim. We can repair equipment, but since we can make a limited range of plastics and alloys, the replacement parts often don't fit right or break quickly. The three-d printers are going day and night. We don't have enough people to maintain everything."

"Infrastructure is deteriorating," agreed Irene. "We need to be working 70 hours a week or more in order to keep up."

"And I can't order that; morale will collapse."

"Most of us are working almost that anyway, on a volunteer basis," said Zach. "But making it official will be bad."

"Has George made any progress getting more support from Mars?" asked Lori.

Bill shook his head. "Jacquie won't make any commitments. George tried to ask a question about Themis during both the first and second Future of Mars Forums, but it wasn't

selected. The immigration and refugee issues have taken up all the time and energy. Does everyone understand we need to vote for him as our representative?"

"It should help to have a rep in the Mars Council," said Lori. "We've been spreading the word informally, since it's a violation of the 'no campaigning' law."

"I've been a bit more direct. It does me no good to be the rep," said Bill. "Participating via video at the speed of light would be a real pain. Besides, we won't have to pay George to lobby for us, if he's on the Council!"

"Does he think he can manage to get us a flight every few years?" asked Tom.

"Probably," said Bill. "The flight they sent made things worse, in a way; we didn't need another ten people, and we should have hauled in more equipment. But we'll plan the next one better. There's no launch window for another year, and it'll take six months for the supplies to arrive, so we can't expect anything from Mars for a year and a half. That's why I think we need to sell this land to Quint."

"But he wants five hectares," said Lois. 'That's a sixth of the surface! And what will he do with it!"

"We may be able to talk him down a bit," replied Bill. "But he wants privacy so he can write and have peace. We want to have forests here, so perhaps we can arrange a dual-use zone."

"Put his house on the woods." Lois looked around at the weeds and grass growing all around them, then nodded. "That would work. We were planning to make the Badlands forest. Could he accept some of that area as well?"

"We can ask. I think we have no choice, my friends. We can't stall him much longer, either. Remember the emailed he sent me yesterday."

"Yes, with a reminder the launch window from Earth opens in six months," said Zach. He thought, then nodded. "We had better see what deal he'll give us."

"I agree," said Lois. "I don't like it, but it may be the best we can do."

"Alright," growled Tom, and Irene nodded as well.

"Thanks," said Bill. "I'll call him right away."

Sunsol night, June 2, 2079, 24:39; it was a funny time to be up, let alone in a large family gathering. Sitting with Helmut and Clara were Charlie and Sirikit, and Sirikit had her computer screen open in front her. The results of the previous Mars Council election in 2077 spread out before her so she could compare. All they had to do was wait another 35 seconds.

The chronometer counted down the last 35 seconds of the Martian sol, then rolled over to 0:00:00 on Monsol, June 3. It was midnight. Charlie clicked on the link that took them to a web page with the election results.

"Ah," said Helmut, looking at the names of those elected.

"Let's look at the differences," said Sirikit. She pushed some buttons and projected the elections of 2 years earlier next to the just-concluded election. "Of course, the Central Highlands outposts got a larger proportion of the immigration wave last year, so they gained 2 seats, which Aurorae's total dropped from 33 to 30. That makes the comparison a little tricky. Charlie, can we switch the vote totals to the percentages in each district?"

"Sure, I can do that," Charlie, and he began to work on his computer.

"Look, I've been elected to the Mars Council twice!" said Helmut, with a laugh. "I'm one of the representatives of Ceres, but I was also elected as rep for this district!"

"That's a vote of confidence," said Clara. "But you can't do both."

"No. I'll accept Ceres's vote and the next highest person in district 4 can serve."

"That's Cathy McIvers," said Charlie. "She was on the Council already, so that puts her back on."

"And it shows people liked your approach, to vote for you over her," noted Sirikit. "Look at the percentages for Johnny Lind." She pointed. "Last time he was the highest vote getter in district 7 with support from 55% of the voters, but only 43% of them voted for him this time."

"Good," said Clara. "Negativity doesn't pay."

"Lyle Quincy is down a bit, too; from 61% to 55%," said Sirikit. "The Marsian voters do like a bit of drama so that their elections aren't too boring, but they are turned off by strong negativity."

"Even Ramesh declined a bit, and he was pretty good this time," noted Charlie.

"Who else do we have here," said Helmut, scanning the list. "Interesting that George Tobin was elected to represent Themis. But that makes sense; he's their lawyer here."

"And Marshall Elliott represents Titan," said Sirikit. "Anand Tian represents Urania. That's fairly predictable."

"I wonder how they'll participate meaningfully," said Helmut. "It's strange to have someone who lives on the Earth serving, but there are over 1,000 Marsians on Earth."

"Shades of the olden days when landowners had a collective vote," said Charlie. "I'm glad that ended."

"Me, too," said Helmut. "Anyway, let's get to bed, now. The pundits will be all over the results morrowsol. The bigger question is what the new Mars Council will do when it meets in a few weeks."

12.

Saturn Space

Late June/early July, 2079

The tunnel connecting Titan outpost to the newly arrived Saturn-4 vehicle—the galleon *Andromeda*—was cold and rapidly getting colder. Marshall opened the door to the tunnel, holding his breath while the air analyzer in his ear piece checked the atmosphere. "Oxygen content nominal. Methane is absent," the analyzer reported.

"Please turn up the heat to warm the tunnel to 10 Celsius," he said, taking his first breath. The air was so cold, it hurt Marshall's lungs. He hurried walked along the short tunnel to the base of the *Andromeda*, arriving just as the elevator door opened. Out stepped a woman about 45 years old with short auburn hair accompanied by a black-haired man of about the same age. "Commander Christine Niehaus, I presume?"

"Thank you, Chief Executive Marshall Elliott." She extended her hand and they shook. "This is my husband, Juan Leon."

"Pleased to meet you," said Marshall, shaking hands with him.

"Permission to enter the outpost?"

"Permission granted to you and the entire crew. Welcome to Titan. This way; let's get out of the cold."

"Yes, let's! I'm surprised the tunnel is so cold."

"Titan is *very* cold." Marshall led the way; he was already shivering. In twenty meters, the inflatable plastic tunnel curved downward and stopped at a door. They opened it and entered near-warmth. "This part of the tunnel is underground and well insulated."

"I'm sorry I never got to see any of the surface!" said Christine.

"You can suit up and go for a walk later; we have a few very nice geology trails outside. We've considered establishing the 'Titan Country Club' gold course, but it really is too cold outside to play golf, and in the low gravity, the ball would go too far, anyway."

"Country club!" said Christine, laughing.

"How was the flight? I suppose that's a rather mundane question."

"We were in touch with your ground control daily, so I'm sure you followed the details closely. This was my longest command; I've commanded two galleon flights from Earth to Mars. Juan and I are here to stay for five to ten years."

"You are very welcome, too. Opportunities to fly in this system are increasing; we anticipate sending expeditions to a lot more moons in the next few years."

"What's the population of the Saturn system now?"

"Eight eighty-one. Forty-two will be leaving for Mars in the fall, but we'll probably have a hundred or so kids born in the next two years."

"We're getting close to a thousand."

Marshall smiled. "We are."

The ramp turned a corner and became a spiral that descended 150 meters to the bottom of Cathedral enclosure. In the center of the spiral staircase was an elevator; they entered it and began to descend. Marshall turned to Juan. "So, what do you do?"

"I'm a spacecraft systems engineer; I'm certified to fix almost everything on board, and can probably figure out the things I'm not certified to fix as well. It's a perfect job to have with a wife who is a ship commander."

"Indeed! And we use most of the same systems here, so you'll be plenty busy when you're not flying."

"We figured that was the case. Thank you for meeting us, Dr. Elliott. I'm surprised you had the time, considering that this sol is the first sol of the new Mars Council."

"Well, the speed of light limits my participation! Currently Mars is seventy light-minutes away; double that for round trip communication. I submitted my votes for the Council officers this morning, before the formal inauguration. I was sworn in in the chambers of the Titan Council by our chief judge. After I'm done showing the two of you around, I'll return to my office to read a transcript of the deliberation I've missed; I can read it faster than watch it."

"And skim the boring parts," said Christine. "I didn't know a transcript was available."

"It is. It was arranged for the eight 'off-world' representatives; that includes one of the Ceres reps, the others being on Mars and present in person. Every evening I'll record some contributions to the deliberations, for the record."

"It must be frustrating to be representative and be absent," said Juan.

Marshall nodded. "It is, but I'm grateful, to be involved, too. Most of us in the Saturn system are Marsians."

"Though that may change with the arrival of the Chinese ship," said Christine.

"Maybe. I doubt they'll send more than a galleon-full, though."

"I wonder whether they're trying to muscle in on the Helium-3 production," wondered Christine.

"That's what everyone's wondering, and whether they're trying to isolate Uranus even more."

The elevator stopped and its doors opened. “The elevator is the fastest way to go up or down, but I highly recommend the ramp as a source of exercise,” said Marshall, pointing to the bottom of the spiral ramp. “It rises 150 meters in a spiral 750 meters long. If you run at 12 kilometers per hour, which is about 6 meters per second, you rise 1.2 meters per second, and that roughly doubles Titan’s gravity to 0.24 gees. If you really push yourself to 24 kilometers per hour, you hit Martian gravity. Either way, add some weights and you can get your musculo-skeletal exercise.”

“How long does it take to get to the top?” asked Juan.

“Not as long as you might think; I get to the top in a bit less than two minutes. Then I jog back down and repeat five to eight more times, then I go take a shower!”

They walked straight out onto Titan Square. Steel and glass buildings rose five stories on three sides. The fourth side opened onto an enormous park-like space of trees, grass, flowers, and vegetables, with vines climbing up the sides and condos extending outward above. The lighting was very bright and the air smelled fresh.

“Wow!” said Christine, taking a deep breath. “My crew will be thrilled by this!”

“We still are,” replied Marshall. “We felt the need for a high, soaring, wide space, because some people never go outside. Even when you do, the sun is barely visible as a bright spot, Saturn is a ghostly presence at best, and it’s always hazy and overcast. We’re thinking of making future enclosures even larger. All we need to do is slope the next tunnels downward so the far end is even farther underground. Some sol, we might have 250 meter ceilings!”

“And you can fly in here?” asked Juan.

"Yes indeed." Will pointed to a third floor balcony. "Right there, above the store, is one launching point. You can also take off from the square itself, but not near the tables. But we ask people not to soar up more than fifty meters. If they make a mistake, they'll get pretty seriously injured if they go too high. Kids aren't allowed to fly in here until they're 12."

"That makes sense. And what do we have here?" asked Christine.

"The store—it's part of the Silvio's chain—the food court, which provides eight different kinds of food, the beauty salon and barber shop, the used goods store, the art gallery, eight art studios, and two lawyer officers." Marshall pointed to a door. "That's the way up to your condo."

"We can manage the rest, then," said Juan. "We have the number, and I assume the door will open for our voices or our earpiece chips."

"Both," agreed Marshall. "Then see you both at the welcoming dinner here, tonight."

"Thanks," said Christine, shaking his hand again. Then the couple headed across the square to the entrance. Marshall headed to his office as more of the 188 arrivals began to cross the square to explore the store or head to their units, either in Cathedral or in one of the old dachas.

Once in his office, he turned to the transcript of the Mars Council meeting, which was still streaming in live. There had been a long series of ballots to elect the Council's Speaker; it was the second most important position on Mars. If the Chief Minister was incapacitated, the Speaker became the Chief Minister. Johnny Lind had been the early favorite and had held the position the previous two years, but his vote total was consistently less than fifty percent plus one. Helmut Langlais was tied with Yuri Severin, the former Chief Executive of Titan and now a representative from Aurorae, for the second highest number of votes. Marshall considered

changing his vote from Severin to Langlais, but figured the vote would be over before his ballot arrived. Sure enough, a few minutes later Helmut asked people not to vote for him because Martech was too demanding on his time already. Severin was elected in the next round of voting.

Marshall switched to the live video to watch the next part: election of the Council's Secretary, which was nearly as important as Speaker, because the Secretary oversaw the staff and the records and was also a crucial figure in counting votes. Jacquie had been Secretary, not Speaker, before her election as Chief Minister, and that had given the position even more importance. It took two ballots to elect Cassandra Fuller, a business woman in Dawes, to the position.

The agenda indicated that the rest of the afternoon would be dedicated to review of the rules, followed by a vote to confirm them, so Marshall closed the video and decided to skim the transcript later. He turned to his email. Jake Alexandropoulos, the Mariner agent in Beijing, had responded. *Dear Marshall: I have inquired further with the Ministry of Space Exploration about the crew breakdown for their first Saturn expedition. They have confirmed they want to send 175 personnel, so the galleon will be very full. I asked about safety and they said they had ideas to increase the legal accommodation of a galleon for a two-year voyage. I also asked about the large number of atmospheric scientists. They said that between Saturn and Titan, there was a lot of atmosphere to study! I have asked for additional information, but I am not sure they will be very forthcoming. We're in a weak position. The Community of Saturn doesn't have legal standing as a sovereign nation but isn't under a sovereign nation either. I've copied William Elliott; perhaps he'll want to talk to Jacquie. Mars has some weight, so it could throw it around on our behalf.*

That was not what Marshall wanted to read. They couldn't stop the Chinese; their legal claim over the entire Saturn system still had no legal precedents. They could always refuse the Chinese supplies and assistance, but that would create a permanent rift that could split sovereignty over the system permanently between two entities. The emphasis on atmospheric science seemed to suggest interest in Helium-3 production, too.

Not sure what to say, he set the message aside for now. There was a video mail from Anand, so he played it next.

"Good sol, Marshall," Anand began. "At the welcoming dinner tonight, please convey Urania's congratulations to everyone for the successful and safe arrival of Saturn-4. We look forward to our passage through the Saturn system in four weeks and the video conference that is planned. We'll also be following the deployment of the Helios-1 aerostat with great interest. Helios-2 is ready to go as soon as we reach Uranus and we hope your experience with the shakedown will help us get our system running smoothly and quickly.

"Say, I received a very strange and surprising email a few hours ago from the Ministry of Space Exploration in Beijing. As you may know, for the last few months their Uranus project team has been emailing us, asking what our exploration priorities are, then a few weeks later their satellites 'coincidentally' happen to be in the right spot and they make the observations we need. It has worked out very well. We actually don't need them very much anymore because our own probe arrives in September, with three dozen communications, GPS, and remote sensing satellites and six landers. After that, the Chinese and Euro-Indian systems will want to coordinate with us.

"But back to the email: the Ministry of Space Exploration was informing us of their intention to send a galleon to Uranus in 2081. It's be a three to four year trip to arrive here with a projected stay of at least five years. They would build on their ice moons experience in the jovian system to explore the five big moons of Uranus and a number of the smaller ones. They'd also do extensive atmospheric research and leave a constellation of probes behind for additional research later. They cited study of Uranus's metal-silicate interior as a particular interest.

"Needless to say, we are puzzled by this, and I understand the Chinese are planning an expedition to Saturn. It sounds like they are continuing to expand their presence on Callisto as well. Do you know anything you can tell me? It's not clear we can do anything; they were informing us of their plans, not asking permission. Legally, we aren't even there yet, so it's not clear we could block their expedition in court. But we would like to negotiate effectively. Thanks. Bye."

Anand's face disappeared from the screen. Marshall leaned back in his chair, thinking about the Chinese. He hit reply. "Thanks, Anand, for the call. They are planning to come here in 2081 with a galleon and 150 personnel for a minimum of 5 years. I suspect the Saturn and Uranus vehicles will come together because of the gravity assist opportunity; that would explain the full roster on each vehicle and resolve safety issues. They plan to send a lot of meteorologists. I suspect they are preparing for Helium-3 harvesting, which they are free to do. We have no legal control over the vast helium supplies of the atmospheres of Saturn and Uranus. Nevertheless, it is galling, and I am not sure how we can avoid being taken advantage of. I suggest you talk to Jake Alexandropoulos, the Mariner representative in Beijing. He's serving as

our go-between with Beijing. He could do the same for you. We had better work together on this, too. Bye."

He hit "send" and thought about the situation more. He probably should consult with his father, the Secretary-General of the Mariner League. This was a crucial time for Mariner League resources; it amplified the voices of the small outposts.

Anand replied almost right away; they were only about one light-minute way. "I agree, Marshall. Saturn and Uranus will have a Helium-3 monopoly for some time. Neptune won't go into production for about seven years and its supplies won't reach Earth for ten or eleven. With advanced gaseous core engines it may be possible to harvest helium from the jovian atmosphere, but transportation would be expensive and the helium concentration in the upper atmosphere is lower, anyway. We need to work together to protect our only export. I'll contact Jake; he was on my tasks list already. Let me know what else to do. Bye."

The rest of the afternoon, Marshall was disturbed by the implications of the Chinese plans. He wonder what they could do; their claim to the entire system was legally uncertain, their legal obligation to help crews in distress was clear, and the danger of a separate, permanent outpost disputing their claim and competing for the Helium-3 market was serious. It cast a pall over his day.

But the welcoming dinner cheered him up; the tables and chairs set up across a third of the expanse of Cathedral Square were bustling with happy people. The excitement and energy were palpable. The buffet tables were loaded almost to overflowing with an immense variety of foods, including real shrimp; their first harvest from a salt water biome they had set up. At dinner, Marshall was amused to listen to Willie quiz Christine about the Helium-3 aerostat, its

size and shape, how much helium-3 it would extract from the atmosphere, whether it would earn Titan enough money, and how quickly it would start to work. They were questions on everyone's mind.

When dinner was finished and the robots were clearing away the dishes, Marshall rose to address the crowd. "We are here to welcome Saturn-4, so allow me to say it again: welcome, my friends and colleagues. Welcome to a new planet-system, and new world, a new community, and many new opportunities for career, family, and advancing human knowledge and civilization.

"We welcome 85 engineers associated with the Helium-3 aerostat and the Peregrine nuclear shuttle. Both are cutting edge technologies that required billions of investment and the best in late 21st century creativity. We understand the aerostat, already sitting in its hanger on Enceladus, is ready to go. It constitutes the most advanced artificially intelligent machine ever built. The Peregrine body has been constructed here and the integration of the solid core nuclear engine and advanced avionics will take a year or so. By then, the aerostat should have Helium-3 ready for transport to space and ultimately back to Earth. Our initial goal is a tonne a year, worth a billion redbacks, increasing to two or three tonnes the year after that. It is difficult to say what demand will be. Helium-3 reactors can't be built until a supply is available. They are expensive and may take years to be finished, even decades to become common. Meanwhile, wind and solar power has become the cheapest source of power, and solar power stations in low Earth orbit are being built as we speak. Helium-3 has a lot of competitors; it will remain one power source for terrestrial civilization among many. We can manage on a billion redbacks year of income, 2 would be much better, 3 or 4 would be optimal. Will we get that, and Uranus, and Neptune eventually as well? We don't know. Either way, we're here to stay, our scientific research in this

system will continue to expand, the human presence will grow, and the Saturn community will become the Saturn Commonwealth. As of this sol, our population is 881; the largest human community beyond Mars. We'll exceed a thousand in about two years.

"We have many other people to welcome. Ecology is getting 30 more researchers; surface geology, 40. Solid core nuclear propulsion is gaining six engines and a dozen engineers. Father Sean Greene is our first clergy person and will establish the first Catholic parish beyond Mars.

"Enceladus Outpost will expand to a regular population of fifty. Its biggest expansion will be as our interplanetary spaceport, which means it will gain 25 megawatts of power and hydrogen production and storage facilities. The galleon *von Braun* will be stationed there permanently. At least one expedition will be out, visiting one moon or another, almost constantly. Our study of Titan now embraces thirty scientists full time, who are doing field work almost continuously. Titan Outpost will have completed phase 1 of the Titan-1 carrier in a year and a half, another 40,000 square meters will be added to Cathedral enclosure in two years, and another 75 megawatts of geothermal and wind power will be available in two years.

"We can look forward to two years of hard work and great accomplishments. Tonight we have a concert; morrowsol is a holiday to celebrate the arrival. After that, our work begins. I look forward to collaborating with all of you to move Saturn forward."

"Well, this is the happiest non-victory party I've ever been to," said Sebastian to his family. They were all eating supper together at his dining room table, and the fact that Helmut had not been elected speaker of the Mars Council had been hinted at, but Helmut had never taken the bait.

Helmut looked at his father. “It really is just as well, dad. Being Chancellor of Martech is more than a full time job; it’s exhausting. There is so much to do just to coordinate everything, because the various departments and schools have gotten used to doing everything on their own, with fairly minimal collaboration. It’s a whole different model of administration, to get the parts talking to each other and sharing long-term visions. Then there are the related semi-public companies like Marcraft and Marbuild that rely on Martech for technology development, and now there’s the possibility of opening a campus associated with Stanford in California . . . there’s no limit to the things that need to be considered, rejected, or developed further.”

“Oh, I know,” said Sebastian. “But you could have put your stamp on the Mars Council, too, and that would have been an important accomplishment as well.”

“At least Johnny Lind won’t be the speaker,” said Charlie. “His stamp would have been divisive, like the previous two years.”

“Maybe he’ll learn his lesson,” said Sirikit. “The public was not pleased, and neither were his colleagues in the Council.”

“I don’t know,” said Kristof. “The decline in votes wasn’t that large, in both cases. He could chalk it up to other factors, or the need to be more clever.”

“That’s what worries me,” said Sirikit. “It appears that people are gradually figuring out ways to campaign without campaigning, to spread division subtly rather than overtly, to form parties informally rather than formally. It’s a slippery slope.”

“I think the Marsian public will tolerate only so much of it, though,” said Helmut. “All we have to do is turn on the news and watch the crazy, dysfunctional, corrupt politics that reign on earth.”

"Why do you think Johnny does this?" asked Clara. She looked to Helmut, who pondered the question.

"I think he genuinely feels he has a right to assert himself and express his ambitions," replied Helmut. "On Earth, at least, the pendulum has begun to swing from a culture of let-it-all-hang-out, express-all-your-feelings-frankly to one of more subtle expression and internal discipline. But Johnny is definitely not from that point of view."

"No," agreed Sebastian. "Yuri was his commander on Titan. Do you think that will help?"

"Maybe," said Helmut. "I think Johnny has a lot of respect for Yuri. That's one reason I asked people not to vote for me. If I had been elected speaker, Johnny would have been a constant thorn in my side, because he sees me as a rival."

"That's true," agreed Charlie.

"In a way, you still are," said Sebastian. "Because Yuri may be a good facilitator of deliberations in the Mars Council, but he doesn't strike me as a potentially brilliant Chief Minister. Neither does Cassandra Fuller."

Helmut looked at his father a long moment and saw the hope in the old man's eyes. Sebastian had been Commander of Columbus 2, and therefore was himself portrayed on the wall in the Capitol Building that displayed the progression of Mars's leaders since the first landing forty-three years earlier. Like father like son; it was a compelling idea. "It would be quite a challenge to be Chief Minister," Helmut said slowly. "One I would enjoy, at least for a little while, before the weight of responsibility nearly crushed me! Because it is a very difficult and demanding job, and made even more difficult by the fact that we exert far more influence on terrestrial affairs than our small size would suggest, and even more influence on space

exploration. But when Jacquie's term ends, I will have been Chancellor barely four years, and that's not enough time to make a mark on the institution. I need at least eight years, I think. Perhaps in twelve years, I could feel ready to tackle it."

In twelve years, you'll be 69," replied Clara. "That's getting on the old end of things."

"Yuri will be 69 when Jacquie's term is up, which is one reason I think he's not the best choice," agreed Sebastian.

Helmut shrugged. "We don't run for office up here, remember? If we start, we'll fall into the same pattern we see in Johnny."

Tad looked at the table of refreshments in the back of the room and scowled. "You're love bombing people!"

"We are not," replied Tahirih. "It's called hospitality."

"We didn't provide any of that!"

"I know," replied Tahirih, pointedly.

Tad glanced at the chocolate chip cookies yearningly, but only for a moment. "This is not a proper way to conduct a debate."

"We're not debating, we're discussing," responded Vahid. He pointed to the chairs. "Set up for a discussion, too."

Tad's eyes grew large. "A circle? Why?"

"We can all see each other, and we are all equal," replied Tahirih.

Tad shook his head, irritated by the format the Bahá'ís had set up. "We never talked about these details."

"Did we need to?" asked Tahirih.

"You're trying to persuade people by being nice to them."

"No, we believe hospitality and unity are the proper preconditions for an open-minded investigation of truth, so we are creating those conditions."

"Tad, don't worry about it," said Gandhimohan, who had just arrived and was walking over to them.

"But this should be a professional gathering, not a lovey-dovey one."

"What, professionals don't like chocolate chip cookies?" Gandimohan reached over and took one.

Tad shook his head disapprovingly. He looked at the seats up front and decided to sit.

Others began to come in. Philosophy Club members sat on the right side next to Tad, talking excitedly among themselves, eating the cookies and drinking the punch. Crystal Parker, the other speaker for the club, arrived as well. Tad was put off by the whole thing, but with Gandhimohan there, he couldn't say anything to Crystal. Bahá'ís came in and sat on the left side, nervously talking among themselves. Others came in and sat with friends on one side or the other, or sat in the middle of the circle, facing the speakers. "A circle; very indigenous," said Wicahpi-Luta approvingly, as he and Esther headed for seats in the middle.

"It's to remind us we are community," said Tahirih.

People began filling in the second and third circles as well, after grabbing cookies and punch. Finally, they reached the top of the hour and it was time to start. Gandhimohan went up front and sat between the two sides an whispered with Vahid and Tad, who were seated nearest to him. Then he stood.

"Good evening everyone, and welcome to this meeting jointly sponsored by the Spiritual Assembly of Urania and the Philosophy Club. Yestersol I was asked whether I would serve as the neutral chair of the gathering. I agreed on the grounds that the discussion by professional and collegial, which both agreed to. So far, I see a very pleasant and friendly atmosphere and an inquisitive audience. This is a great format and I hope that various groups agree to sponsor discussions of this sort on challenging issues. We have almost eighteen months to go before we reach Uranus; lively and profound exchange about important matters for all of us will not only keep away boredom, but will strengthen our community and its shared values. Even after arrival, discussions like this should continue. We're not just going to Uranus to harvest Helium-3, after all; we're going there to set up a new branch of human civilization.

"The primary subject tonight is whether there is such a thing as revelation from God. The philosophy club says no. The Bahá'í community says yes, but they do not insist on it being obvious and absolutely persuasive to everyone; in fact, if I understand their 'principle of separation and distinction,' they are arguing that there is such a thing as spiritual discernment, a capacity that would be of no use—as would free will—if the spiritual laws and principles of the universe were as obvious as, say, the law of gravity. Both sides have written fairly short papers; they will take 15 or 20 minutes each to present. The rest of the session will be devoted to questions. So without further adieu—"

Suddenly, an alarm began to sound. Gandhimohan stopped in midsentence, frozen, waiting for an announcement. Everyone was absolutely silent. Then an automated voice said, "A fire is reported in the upper agriculture sections of sector 3 of the *Melindia.* We ask all personnel

in all of sectors 3 and 6 of the *Melindia* to evacuate from the vessel immediately, we repeat, immediately. Please report to your work stations in the *Ouranos* or the *Persa.*"

Gandimohan immediately jumped up and headed for the door. "Gandhi here; I'm in the *Melindia.* I'm heading to the affected area immediately." His voice trailed off as he disappeared into the hallway.

Tad stood as well. "We had better evacuate. Part of this room is right above sector 3." He headed for the door, but Tahirih rose as well.

"Wait, we aren't in sector 3 or 6! We should await orders!"

"Go ahead; but the fire is under our feet," said Tad, heading for the door. Some members of the club joined him; others stood, uncertain. Some Bahá'ís and other members of the audience rose as well.

"They know we're here," said Tahirih. "We should await orders because only so many people can exit the vehicle at once."

"Looks like we'll have to reschedule this event," said Crystal.

The intercom crackled again. "The personnel in sectors 1 and 5 please evacuate now and head for your work stations on the other two vehicles. The people in the *Melindia* meeting area should evacuate as well."

"That's us," said Tahirih.

Everyone headed out. Esther looked at Wicahpi-Luta, a panicked expression on her face. "What should I do? My biome is in sector 3!"

"I know, but you can't go down there now," said Wicahpi-Luta. "The sector will be flooded with water and carbon dioxide. No one can go in there."

"That's true. I'd better report to the ecology office on the *Ouranos*. This is terrible. The biome might be destroyed. We might need some of those species."

"We'll have to wait and see. We can't go there."

"I know."

They headed up the spiral ramp to the ship's axis, where a tunnel gave them access to both of the ship's exits; the dorsal exit let to the caravel *Columba* and the ventral exit to the *Ouranos.* Meanwhile, Gandhimohan had gone down the stairs and entered the outer area of sector 3's upper ecology unit, a low-gravity area in sector 3 that raised some of their crops and had one cubicle containing their North American prairie biome. He couldn't go any farther. "The fire appears to be out," said Adla Ndung'u, who was the day officer, as well as a member of the Council. "You can't go in, Gandhi, we've replaced the oxygen with CO_2."

"Is there anything I can do here?"

"Not really. Come over to the *Ouranos.* Anand and I are already here, gathering information; we've called an emergency cabinet meeting."

"Alright, I'm on my way." Gandhimohan turned to the door one more time. He really wanted to open it and look in, but that would just let smoke into the rest of the ship. Some obviously had escaped through the ventilation system; he could faintly smell burned plastic. He touched the door to see whether it was hot. It wasn't.

So he headed back up the spiral ramp to the axis, where there was still a crowd of people evacuating. "Please exit in an orderly but efficient manner" was being repeated over and over again on the intercom system, and people were pretty orderly, though they weren't calm. Gandhi waited his turn; people pressed him to move ahead of them. He hurriedly floated across the

zero-gee gymnasium that filled the bubble between the two ships and entered the *Ouranos,* where he descended the green-colored 5/6 spiral ramp to the bridge on level 4. Everyone else had already arrived in the small board room attached to the control area.

"This does not affect the overall efficiency of eco," said Dr. Johann Koch, the Director of Ecology. "No volatiles escaped the ship. We may want to convert part of our water budget back into water; currently, we've stored a 34.2 percent of it as liquid hydrogen and oxygen. We might need the extra water temporarily to clean up the mess, and we could use the extra power to give the other ecological areas more light, to speed up their photosynthesis several percent."

"We've lost water into the section, too," said Adla. "The sprinklers discharged a thousand liters; that's a tonne of water. There must be several centimeters of it sitting on the floor. Moisture sensors in the two levels below are going way up, too, so it's leaking down into the engineering area below and into at least five personal quarters in the area below that. There's CO2 and smoke leaking downward into the rest of section 3, also, so the people residing there will have to remain out for at least 24 hours."

"How many rooms?" asked Anand.

"Twenty. A bit fewer than in a normal section, but that just means there are more labs effected. It'll be three or four hours before we have the carbon dioxide cleared out and people can enter; meanwhile, we have three robots in there already and the engineers are doing virtual reality to assess the damage."

"I hear it doesn't look too bad," said Karl Forbes. "The engineering labs there do fabrication; the same stuff that's done on the other ships. So capacity may be reduced somewhat, but nothing essential has been wiped out. My guys are already in there checking out the

equipment. I'll have a complete report in a few hours, but my guess is that engineering will be back up to speed in a few weeks."

"But back to ecology," said Anand. "In addition to the North American prairie biome and lots of soybeans, what else was in there?"

"Vegetables," said Johann. "Upper section 3 of the *Melindia* was typical: three ships, six sections each, upper and outer ecology areas each, 36 areas altogether. The crops in there are probably a total loss, but they're only 3% of our total production. The loss to our soybean production is more serious; sixteen percent. Our soybean reserve is rather low right now, also, because of all the babies being born; they need soy milk and other products the soybeans are used for. That will be a big inconvenience for six months or so."

"Inconvenience," said Anand. "And the biome?"

"The fire was in the wall separating it from soybean compartments. It was probably electrical," said Adla. "The biome got a heavy dose of water and CO_2. The ecologists will have to go in and assess the damage. It contains 50 species of plants and insects and fed two species of birds. The plants are available in seed form. I don't know about the others."

"The birds would be dead," said Johann. "They were right there in cages."

"So; extinction of two species," said Anand. "Maybe more; I won't minimize the importance of insect diversity. An inconvenient decrease in products made from soy for several months. A few weeks of work to fix up the engineering labs. Twenty people displaced for a few sols, maybe a week or two if there's water damage. How long before we determine the cause of the fire?"

"Give me two sols," said Adla. "We shouldn't have wiring problems like this."

"At least the fire suppression system was fast." Anand looked around the room. "One question left: do we abort to Saturn? Samantha, what would it take?"

"A small course correction any time in the next week to ten sols. The recommended route would take us within 100,000 kilometers of Saturn—just outside the rings—to maximize the benefits of a firing deep in Saturn's gravity well. We'd use up almost all of our liquid hydrogen and it would take our facilities and the ones on Enceladus almost two years to produce the fuel to resume our trip to Uranus. Planetary alignments would still be alright at that point, but barely."

"It's good to know we have the option, and a safe place to abort to," said Anand. "But is it necessary? I am inclined to think it isn't."

"Agreed," said Gandhimohan. "Crew morale might suffer more from the abort than from this minor fire."

"If we aborted the flight, we'd have the frustrating prospect of watching Saturn's helium-3 production start, while our Helium-3 team either helped or sat back and watched," added Adla. "This fire does not endanger us or our mission."

"That's why the ships are divided into six sections and why ecology is separated even further," added Johann. "We have tremendous redundancy. We could get to Uranus right now even if the *Melinda* had suffered extensive damage."

"I don't know about that," replied Karl. "That'd be very risky."

"We would abort to Saturn, under those circumstances," agreed Anand. "Alright, I sense we have consensus. We will not abort, but we will remember the option is open for ten sols and will reconsider if we discover something new. Johann, come up with a plan to resolve the soybean shortage. I want reports about the damage to the labs, the quarters, and the biome in 24

hours. Adla, Gandhi, you stay and help me draft a statement about this incident. I need to say something to the crew right away, then I'll have to deal with the questions from the media, which will start to arrive in another hour. Alright?" Anand looked around at the others; no one asked a question. "Thank you, everybody."

13.

Planning Ahead

"Why do people keep saying 'shouldn't they abort?' said Charlie, disgusted. "A 2-minute fire, water spilled, some soybeans have to be destroyed and replanted . . . who cares?"

"They haven't been in space," replied Helmut. "A billion people on Earth are freaked out. It's a chance to educate them. It's a chance to review safety features, too, and figure out the electrical fault that caused the fire. It appears the electrical wiring robots need some reprogramming to avoid the problem again. It's a simple fix."

"One of a million simple fixes that we could find the hard way," said Charlie.

"I feel terrible for Esther, though," said Sirikit. "It's her biome that was ruined! She'll be fixing it for the entire rest of the flight."

"Ten species of insects and two species of birds . . . extinct on Urania," said Helmut. "So, did you hear Martech is getting a seed repository?"

"Really?" said Sirikit. "Like the one in Svalbard?"

"A smaller version, but yes, basically; fifty tonnes of seeds altogether, coming on six different space vehicles next year. Our agricultural research team needs the entire genetic range in 5,000 plant species. We're developing some amazing genetically engineered crops and we need the diversity. The facility will have twenty small enclosures—B-75s—to grow and crossbreed species."

"And it'll be here?"

"Yes, Aurorae. Yes another thing for everyone else to complain about, but let's face it, Aurorae's by far the biggest outpost and there are economies of scale when you put something here."

Charlie interrupted to point to the screen. "We're at T-minus 10 now."

"Oh, let's watch," said Helmut quickly. The three of them turned to the live transmission from Ceres. A carrier-200, a fat "tuna can" 200 meters in diameter and 100 meters high, sat on the surface 20 kilometers southeast of Central Outpost, filled with liquid hydrogen, liquid oxygen, and water, and carrying 100 tonnes of platinum-group metals, 500 tonnes of cobalt, and 1,000 tonnes of nickel. Sticking vertically into space from the top of the carrier was an old-fashioned solid-core nuclear engine; old technology, but that meant it was cheap and very capable.

At t-minus three, a ring of Prometheus engines, each able to produce 500-tonnes of thrust, lit up around the periphery of the carrier. They built up in thrust and at t-minus 0 the carrier rose from the surface. Once it was up fifty meters, another ring of engines set 50 meters in from the carrier's outer edge and a cluster of engines at the very center of the carrier lit up as well. There was now enough distance so that their exhaust could go somewhere; a vehicle 200 meters in diameter would confine the escaping gasses too much, otherwise. Twenty Prometheus engines were now hard at work and the 90,000 tonne vehicle rose quickly into Ceres' sky. In thirty seconds it began to pitch over horizontally to build up speed; Ceres orbit only requires 300 meters per second. The entire launch took five minutes; they sat, glued to the screen, not talking, the entire time.

"Alright, orbit," said Helmut, relieved, once the engines had shut down. "These Prometheus engines are very reliable."

"When's trans-Earth injection?" asked Charlie.

"About three hours from now. They need to detach the Prometheus engines, so they can be reused, and move the carrier a few kilometers away from them, so the solid core nuke's exhaust won't fry them. They say this will be the longest firing of a solid core nuclear engine in history; about 48 hours! But at the end the carrier and its cargo will be moving at 5 kilometers per second, the velocity it needs to get to Earth in a year."

"Mr. Swift should be pleased," observed Sirikit.

"He must be tickled pink this has worked so far. I'm sure I'll get an excited email from him within an hour. The media is eating it up, too; it's important to have good news from space after the Urania fire! The carrier will still have 10,000 tonnes of liquid hydrogen and 35,000 tonnes of water when it settles into Earth orbit, but they will take up a small fraction of the interior volume, so Swift will be able to start phase one of the conversion of the carrier to housing and work areas right away."

"Not as much propellant as we hoped," said Charlie.

Helmut shrugged. "Our estimates went up and down every few months. Ceres did a magnificent job of getting their solar power output arrays and hydrogen production facilities expanded, and they will expand them even more in the next few years. They are now set to become the main source of hydrogen in Earth and Martian orbit. It's quite a milestone."

"A very important development in the solar system economy," agreed Sirikit.

“We still don’t have Iris?” asked Marshall, looking at the wall screen. It showed her empty office. He had just returned to the meeting after standing on the balcony, admiring the inside of the Titan-1 rotating enclosure.

“Not yet,” replied Ryoko. “She popped on briefly and apologized she had to handle something and she’d be right back.”

“At least we have a beautiful view,” exclaimed Tomas, speaking loudly because he was still out on the balcony. “It’s too bad we have all these terraces, though. I’d prefer a smooth, unbroken cylindrical surface.”

“With Titan pulling at 0.12 gees in one direction and centrifugal gravity pulling 0.85 gees at right angles, the cylinder surface would be an unpleasantly steep slope,” replied Shiyoko. “I admit it does take some getting used to.”

“Everything inside looks tilted at a funny angle,” agreed Ryoko. She looked around the partially finished room they were meeting in. “But this will be a great school for the kids. The people who have moved their houses or offices in here like it.”

“And it’s a good place for exercise; we all need terrestrial gee,” said Marshall. “We won’t need a Titan-2 unless we want redundancy. We can use this place with the cavern enclosures very skillfully.”

“Anyway, while we’re waiting for Iris, what’s this item number 3, ‘using horticultural robots to maintain lawns and balconies’?” asked Anne Hollingworth, anxious to begin the Saturn Council meeting.

“Most people have a little lawn or a small balcony with a few plants, and they are often not very attractive,” replied Marshall. “My rose bushes on my balcony are often wilted because I

forget to water them. If the horticultural robots were available—for a fee—to water and weed, people would plant more flowers, vegetables, and flowering trees on their little spaces and they'd be better maintained."

"The robots would do this while they're doing agricultural work?" asked Anne, skeptically.

"Exactly," said Tomas, who was in charge of horticulture. "Here in Cathedral, the walls are covered with vine crops like cucumbers, beans, and peas, so the robots are crawling up and down the walls to water, harvest, and prune all the time. It would be easy for them to water, weed, and do other basic maintenance."

"How much time?" asked Anne.

"Maybe three to five percent more time than they are spending now, and the price of the service would be reasonable," replied Tomas.

"That sounds good," said Kurt Hollingworth, looking at Anne to melt her skepticism. She looked back and nodded reluctantly.

"What are you talking about?" asked Iris, who had suddenly reappeared on the screen.

"Using the horticultural 'bots to maintain plants on private terraces and balconies, for a small fee," replied Marshall. "And it sounds like we have a consensus. How are you doing, Iris?"

"Pretty well," she replied after an eight-second time delay, because Enceladus was half way around to the other side of Saturn at the time. "We're just about recovered from the double-whammie of being ready for a potential rescue of the Urania mission, then the Uranus-Saturn conference."

"The latter was really excellent," said Kurt. "A lot of exchanges of ideas and research."

"It was really important for us," said Iris. "The engineering team had already integrated pretty well with the Helium-3 team that arrived last month, and they knew the engineers of Urania's Helium-3 team, but the rest of us didn't. but now all of us know each other fairly well."

"I gather they had a lot of good ideas for getting the Peregrine back on schedule," said Sydney.

"Yes, because they encountered some of the same issues and had come up with solutions," replied Iris. "And because we are already familiar with dropping aerostats into Saturn's atmosphere, we gave them some good advice as well."

"So we're back on schedule for September 30?" asked Marshall.

Iris nodded. "Yes. The aerostat arrived ready, except for a few design improvements that couldn't be implemented during the flight because of limited materials and manufacturing capacity. We've got them incorporated and now we're checking and rechecking the software. *Aethon* is the smartest piece of artificial intelligence ever developed."

"We're learning a thing or two about artificial intelligence," agreed Shiyoko. "The next round of software upgrades for a lot of our robots will incorporate important improvements."

"Well, we now have a second supercomputer," said Anne.

"So, that's item one," said Marshall. "Shiyoko, gives us the construction update."

She pointed out the window. "Titan-1 is coming along very well, as you can see. Phase 1 is on schedule. The horticultural level was finished last month and is producing quite well. Most couples with babies or very small children have moved into their houses. The kids move into the school in January; Martech-Titan moves in on February 1st. We'll start on phase two offices and housing March 1, to be ready for arrivals in 2081."

"And Cathedral East and West?" asked Marshall.

"They'll both open in January, extending our enclosure length from 200 meters to 400. The waterfall where they join Cathedral South, however, will take another month or two. We're having problems modeling its impact on humidity in the enclosure and how to control it."

"We'll figure that out, though," added Tomas. "The plants for both of them are growing in the nursery and are ready to go. There will be a tropical forest along the western half of Cathedral East and a Mediterranean forest along the eastern half of Cathedral West, and as we lengthen both enclosures we'll lengthen the forests. That will give us beautiful woods to explore and areas to develop as well."

"I hope the trees get big enough so we'll have real forest; that's one thing from my visit to Earth that really impressed me," said Marshall. "I suppose with genetic modification and ideal conditions, the forest will be pretty impressive in ten years, too. Iris, can you talk about the Center for Study of Enceladus?"

"Sure," said Iris. "Now that we have the *von Braun* here, we have the accommodation for a permanent population of up to 150, and with the U-75 we have a lot of volume for manufacturing, so Enceladus is in the position to establish some permanent educational institutions, even if they are small. We don't anticipate having more than 100 here for the next few years and most of them are engineers for the Helium-3 system or for the spaceport, but we do have a commitment to keep five to ten geologists and biologists here permanently to study this remarkable little world, so we want to establish a 'Center for the Study of Enceladus' as a branch facility of Martech-Titan. That means devoting some space on the *von Braun* to the Center—the existing geology and biology labs, mostly—and devoting a budget of five million

redbacks per year, exclusive of salaries, of course. This is mostly shuffling around money that already goes to the geology and biology programs. It will require one full time permanent administrative position, and we think we have someone who can do it." She looked at Anne Hollingworth nervously, because Anne was usually the person who watched spending like a hawk.

There was a pause to wait for someone to comment. Then Marshall said, "I think this is a good diversification of our university, and it strengthens Enceladus borough. That strengthens our claim to be the Saturn Council and have sovereignty over all of Saturn space."

"What is the latest with the Chinese?" asked Anne.

Marshall shook his head. "They aren't saying why they want to send 100 here, other than 'international research on Saturn and its moons' and 'comparative planetology with Jupiter.' That's all legitimate. But in the last few sols, the Mariner league representative in Beijing has heard rumors that the government is considering the funding of a helium-3 extraction system and a robotic shuttle to bring it to Saturn orbit. Apparently their estimate is it'll cost 18 billion redbacks, exclusive of the costs to get the system here and set up infrastructure here to run it."

Iris laughed. "Our system cost less than half that!"

"Of course," said Marshall. "Martech is cost efficient and we have already amortized infrastructure costs. The Chinese have been approaching various investors to see whether they can fund a rival system. But our system will start functioning in less than three months, so investors are hesitant. No one is sure what the demand will be or what increased production will do to the price. But if they contract a private operation to develop the system for them, they can probably do it for ten billion, including infrastructure, and that gets attractive. So we are not safe.

Our legal claim over the entire Saturn system is tenuous, partly because we aren't claiming to be a sovereign entity and partly because there are so many worlds in this system. We are on much stronger ground if we state the conditions under which we will provide support services for vehicles and personnel in the Saturn system. If we refuse any landing privileges to or support for an alternative helium-3 extraction system, it becomes much more expensive and risky."

"But we come off as callous of human life and greedy," said Anne.

Marshall nodded. "I agree."

"I think we are better off declaring independence, claiming sovereignty over the entire system, and systematically visiting every single one of the hundred or so worlds in the system so we can legitimately lay claim to the whole thing," said Anne, quietly. "Since Kurt and I are leaving in three months, I suppose I am free to make this proposal; people can blame me and then I leave! But I am serious. If the aerostat is successfully deployed in Saturn's atmosphere and begins to extract Helium-3, we are in a position of great strength. By mid October—when we're scheduled to leave—it'll be clear to everyone that Saturn now has a source of income and no longer needs subsidies. It can negotiate for the things it needs and pay for them itself! Titan 1 is up and running, Cathedral is big and getting bigger. We have a bioarchive with twenty ecologies. We have two boroughs. We're pushing close to a thousand people, which some say is the minimum size for a real community. A thousand people on Earth is a ridiculously tiny number of people to claim sovereignty, but we're over a billion kilometers and almost a light-hour and at least a two-year voyage from anyone else. Mars can't be our home world; it's too far away and too small. We're too diverse to belong to any nation on Earth. So who are we? We're Saturnians!"

She looked around at the others, who were startled—even shocked—by her comment. "Anne, you have always been one of the most conservative members of this Council," said Marshall.

"I have; I am very cautious spending money, for example. But as mayor, I doubled the size of Aurorae and oversaw plans to expand it to one hundred thousand people. Sometimes you have to recognize your situation and be bold." She looked at Marshall when she said that.

He took that as a criticism, but he caught himself before he reacted. "You may be right about that. This is a topic we need to thinking through."

"The aerostat enters Saturn's atmosphere September 30 and by October 5th it will start extracting Helium-3," said Kurt. "At that point, the Council should express its decision to declare sovereignty over the entire system and call an election for November. The Future of Saturn forum is a perfect place to discuss the issue. Anne and I will be leaving, so there will be two vacancies, and we have already said that at the next election Titan's membership on the Council will go from seven to eight. So we will have a nine-member Council rather than seven, and it will have at least three new members. It will know the will of the people from the Future of Saturn forums and it will have heard international reaction for over a month. It can make the final decision whether to declare independence or not."

"That gives us time to plan a systematic effort to reach every moon over a kilometer in size," said Sydney. "Once the Peregrine is finished and flying, the engineers can turn to manufacturing robotic rovers. If we put a rover on every moon, with a twenty-five meter solar concentrator and solar panels for power mounted on top of it, we'll have a presence everywhere."

"We can still get the necessary electronics from Mars, too," noted Shiyoko. "The actual rover body is not hard to build, and we can send a crew to every moon to deploy them."

"That would certainly solidify our claim," agreed Marshall. "We need to think about this idea carefully. You are right, Anne, there are times to be bold, and the successful deployment of the Helium-3 system is the best time. Let's all sleep on this idea and exchange some emails about it. We can talk about it in more detail at our next Council meeting."

At his own insistence, John Anand Tian had a small office. Half the long, thin space was filled by a desk, the surface of which was usually covered by electronic documents; some of them appeared on the walls as well, so he could refer to them easily. The other half of the room had two chairs so he could talk to one other person easily, at which point he turned off all the documents and had a clean desk with a surface that appeared to be mahogany. If no one was in the office with him he liked to wheel or pace back and forth sometimes, to think. If he had to meet with more than one person he used the adjoining conference room.

When he arrived on Monsol morning he was pleased to see he had a reply from Jimmy Khan at Martech about his request for information about the purchase of a carrier-200. He had sent his request Frisol, but Jimmy was notorious for long work hours, as his two divorces testified. Anand sat and immediately commanded his electronic assistant, Mitzie, to project the videomail on the screen in front of him. He frowned when he saw a woman sitting next to Jimmy.

"Good sol, Anand," Jimmy began. "I was surprised to hear from you, so soon after the fire and then right after the science conference with Titan. You must never sleep; like me!

Anyway, I was intrigued by your question whether Phobos or Ceres could manufacture and send to you via a high speed trajectory a carrier-200 of the sort being made for low Earth orbit and Venus. It might be possible for the late 2081 launch opportunity from Mars; that's just two and a half years away. It might be easier from Ceres, since its launch opportunity is later. The problem, however, is that you can't receive the carrier before late 2085; maybe early 2085 if we spent a lot on hydrogen. That's five years after you arrive in the Uranus system, and I doubt you want to live in your ships that long. You should be able to build your own sooner than that.

"Yestersol I was discussing your email with this person, Dr. Mercedes Patel, and she had quite a few ideas relating to your request. Consequently, I'll turn the floor over to her." He gestured to Mercedes.

"Thanks, Jimmy. We've met once or twice very briefly, Dr. Anand, but you may not recall. I'm one of Martech's project planners; I'm a systems analyst by training and I've worked extensively for Marcraft as well. But last week I was appointed Director of the Neptune Project, so I have plunged into that effort."

"And she's already shaking up the planning committee," added Jimmy with a smile.

"Thank you," replied Mercedes. "Isn't that what Marsians are supposed to do? My parents were Indian-Brazilians and they were good at shaking things up in Brazil, too! But of course up here it's all done rationally, based on science. Your request for a carrier-200 for Uranus impressed me. Not only are you not at Uranus, you just had a fire. It shows confidence, I suppose based on Saturn's preparations to deploy their aerostat. Everyone is anticipating that, so this is a good time to make big plans.

"Anyway, I got to thinking about the time necessary to get the carrier to you, and the amount of time and resources you have to devote to build your own. I checked your human and industrial resources and estimate you can build the carrier you requested in two and a half years, assuming the Uranian moons have the metals you need. You arrive in December 2080 and if you start by December 2081, it'd be done by June 2084. You'd have a space able to accommodate literally thousands of people; vast future expansion. You'd also have a disincentive against building a second one and thereby acquiring redundancy.

"This got me thinking about how Neptune would face the same problem and it occurred to me that we needed to depart for Neptune with the carrier we would move into. That requires rethinking the launch stack, and we have only a crude idea what that would look like. But it probably means flying two corvets instead of three because the carrier's volume can be used for the ecology and for emergencies. We may be able to reduce that to one corvet if part of the carrier is set up. We can't set up the whole thing because the quantity of water needed for radiation shielding—tens of thousands of tonnes—is prohibitive, but we could set up part of it.

"However, it makes no sense for Neptune to use a 200-meter class carrier. Corvets are 65 meters in diameter. A 100-meter carrier would fit us much better; 75 meters might be even better. Jimmy and I are looking at a redesign to produce a carrier 100 meters in diameter divided into two compartments, each 50 meters high. We would do all our set up on the flight out; we'd live in the corvet because it would provide much better radiation shielding, then on arrival we'd just need to melt ice and pump the water into the carrier's outer tanks.

"That produces a carrier much more appropriately scaled for the outer solar system. You could enclose a 100-meter carrier 50 meters high in a year, could pressurize it and start setting it

up, and start to work on a 50 meter extension. You'd be completely moved in by the end of year two and the extension would be pressurized and ready for use as well. You wouldn't have the high interior space of a 200 meter carrier, but you could always build that later for redundancy when your human resources increase. Meanwhile, you'd have outside, since your outpost will be set up on the surface of a moon."

"A one hundred meter space is pretty open and airy," continued Jimmy. "I'll attach a file for you to view; it's a three-d exploration of a carrier-100 we created several years ago, before the 200-meter size became the standard. The main difference between the two designs, frankly, is emotional. Everyone wants a big open space; a high ceiling. For all we know, 300 or 500 meter class carriers may be standard in a decade or two. But for the outer solar system, even with the new gaseous core engines, we'll need something smaller. We might even want a carrier that is fully usable on the surface of a small world, but in cruise mode most of it would be for temporary use only because of cosmic radiation issues. By the time you get to Uranus, the design for a Neptune 100-meter class carrier will be complete, so you would be able to use it with whatever minor refinements you want."

"We could even design the space together, so it suits both settlements," added Mercedes.

"Anyway, let us know what you think. Bye."

Jimmy's videomail ended at that point. Anand clicked on the attachment and asked Mitzie to convert the entire wall into a three-dimensional screen. In a moment he was standing on a terrace looking out over a huge interior space that wrapped around and closed overhead, 100 meters above. A spotlight embedded into the structure above was sun-like in its brilliancy and

hid some of the buildings; if one didn't look closely the impression was of living in a steep-walled valley rather than the inside of a cylinder. It was quite impressive.

But he had seen three-d simulations of 200-meter carriers and had done a virtual reality of Phobos's and Ceres's. They were bigger and more impressive. The emotional dimension was not one to dismiss quickly. He had reply.

"Thank you, Jimmy and Mercedes. Let me show our videomail and the simulation to the cabinet. I agree with everything you said, including the issue of emotion. I am of two minds about your proposal myself, though the practicality of the smaller design is pretty important. So I'll get back to you.

"Mercedes, congratulations on your appointment as Director of the Neptune Project. I do remember meeting you. In fact, I remember you asked a question about Helium-3 production in last week's Saturn-Uranus Conference! There weren't many comments and questions from Mars and they had to be taped ahead of time based on the written texts, so they made an impression on me. I'm delighted that you are already so engaged. Let's talk often, as often as you'd like. Saturn, Uranus, and Neptune need to be coordinated, so I hope we can get to know each other and collaborate. I look forward to it."

"Five weeks: the wait was worth it," said Esther to Tahirih over dinner, the sol after the "discussion" between the Urania Bahá'í Community and the Philosophy Club.

"It was unavoidable; the fire was followed by the flyby, then the conference with Saturn. I think that kept everyone busy," replied Tahirih.

“I was listening to talks about nuclear propulsion, carrier construction, Helium-3 extraction, Peregrine construction . . . it was constant,” said Wicahpi-Luta.

“We even managed a meeting between the Bahá'í communities of Urania, Titan, and Enceladus,” added Vahid. “It was fun to talk about our communities and outposts.”

“So, what did you think of the discussion?” asked Tahirih. She was very curious, but tried hard not to look or sound it.

Esther thought a moment. “It was very impressive. I can’t say anyone’s mind was changed. The Philosophy Club people thought they had won because they prevented the proving of the existence of revelation; the Bahá'ís even agreed it was not provable from a neutral, rational point of view. The Bahá'ís felt they had won because they presented quite a sophisticated collection of indirect proofs; proofs the Philosophy Club would never have taken seriously in the first place. The neutral audience would have been impressed either way, depending in their preconceived notions.”

“Interesting,” said Vahid, who was not so pleased with her response. “I agree that it was a tough argument for either side to make. But I do think that if we could get everyone to agree on the basic premises, we could then make a philosophical argument that is persuasive to everyone; at least everyone who is rational.”

“Perhaps true,” said Esther. “But that may take more time than anyone has.”

“Perhaps,” Vahid reluctantly conceded.

Tahirih smiled at that. “I take it you were impressed by our arguments, though.”

“Oh, very much! I accept your basic argument that if revelation were an empirically measurable phenomenon that could be studied scientifically, everyone would have no choice but

to believe in a God who reveals. The ethical and metaphysical laws of the world would be as obvious as physical laws. No one dares to defy the law of gravity, so people would have no choice but to be good and faithful. That would strip away most of our free will; we'd be automatons, spiritual slaves, and would be unable to better ourselves."

"We'd live in a kind of utopia, but would be unable to make decisions about it, and we'd have nothing to compare it to, so we wouldn't even realize it was perfect," agreed Vahid. "The club tried to argue that maybe revelation should be a *little* more obvious, but who can take a useful stand there? How do you know it isn't fairly obvious; compared to what?" Vahid threw up his hands.

"Beside that, I find the club's tactics offensive," said Esther. "They're pushy, discourteous, suspicious, and cynical. Perhaps those are legitimate sentiments on Earth; it's disorganized, selfish, corrupt, chaotic, materialistic, super-competitive, and riven by ethnic and religious loyalties. But Urania is a team with a purpose, it is fairly equal, it elects a consultative leadership that doesn't—that really can't—enrich itself, it is diverse but has a strong common culture, and does a fairly good job of listening and balancing positions. Discourtesy, pushiness, suspiciousness, and cynicism all undermine that. They're unnecessary here."

"Mostly," replied Wicahpi-Luta. "And let's face it, on Earth suspicion and cynicism have a certain survival value. Both my father's people and my mother's people—the Lakota and the Maori—have experienced genocide."

"But not on Mars," replied Esther. "Your father is distinguished and your mom won a Nobel Prize! We've escaped the mess on Earth; that's one of the reasons people want to go into space. But the Philosophy Club and some religious fanatics up here don't seem to realize that."

There was silence for a moment; it was clear Esther was referring to Reverend Varma. “Perhaps we have calmed them down a little, though,” said Tahirih. “I asked Gandhimohan how he thought it had gone, and he replied ‘perhaps you have belled the cat.’ I think what he meant was the Philosophy Club can now continue their desire to conduct ‘debates,’ but they’ll now do it more courteously and positively. They want to turn to various ethical issues and debate Gandhimohan! And it appears he’ll agree.”

“That’s good,” said Wicahpi-Luta. “We’ve got fifteen months of floating through space before we reach Uranus. Some lively but fair and courteous debate would be good for the community.”

“I agree,” said Vahid. “And I’m glad they plan to leave the Bahá'ís alone, because this was exhausting and difficult for us!’

“But it was good for us, too,” said Tahirih. “It helped to pull the community together.”

“And it’s pulled a few of us closer to you,” added Esther. “You’ve left me with a lot to think about.”

14.

Arrivals

Sept. 2079

Marshall could picture the aerostat *Aethon* clearly in his mind as the vehicle approach the outermost wisps of Saturn's atmosphere. Crudely, it was shaped like an old fashioned space shuttle, a stubby-winged lifting body 30 meters long and 6 meters in diameter, its curved belly covered by a black thermal protection system. But in so many ways, it was radically different.

The image on the control room screen was tiny; the long range telescopic cameras were too far away to capture much. A moment later, the dot began to glow faintly and develop a tail. "I am now entering the atmosphere," *Aethon* reported simultaneously.

Marshall glanced at the data screens. The *Aethon* was blazing through the outer skim of air at 26 kilometers per second, over twice Earth's escape velocity. Saturn was a tough place to visit and even harder to leave; he wondered whether humans would ever descend into the atmosphere. The *Aethon* was the smartest piece of equipment ever built, but there was no guarantee it'd control its entry and establish itself into the planet's outer atmosphere.

"Don't worry, the data looks good," said Toru Takahashi, who was in charge of the control room.

"If it isn't good, there's not much we could do."

"Probably nothing." Toru smiled and shrugged fatalistically.

The room was absolutely silent as the blazing dot moved across the face of Saturn on the screen. The *Aethon* was taking 5 gees as it used its forward motion to hold itself from falling

toward Saturn's crushing depths. Its velocity steadily dropped and it sank deeper and deeper into the ocean of hydrogen and helium.

"Getting buffeted by winds now," said *Aethon*.

"That's a good sign," commented Toru. "You have to be moving close to the velocity of the wind to be buffeted."

"Good."

"Deploying drogue parachutes now," said *Aethon.* There was a momentary pause as part of the upper aeroshell covering the vehicle was ejected, followed by the deployment of drogues into the supersonic slipstream. About a minute later *Aethon* reported, "Deploying the main parachutes."

A camera on the vehicle came on so they could watch the process. The remaining upper aeroshell ejected, exposing a flat top surface covered by large boxes that contained the parachutes and balloons of the aerostat. They watched parachutes 1, 2, and 3 fire, then alarms began to go off. "Parachute 3 has failed to open," said *Aethon,* then a moment later, "Parachute 2 has failed to open."

"Both of them?" said Marshall, alarmed.

"Both of them. This is not good."

"Can the *Aethon* compensate with its jet engines?"

"We'll see." Then Toru added, "Theoretically."

The *Aethon* settled deeper and deeper into Saturn's atmosphere. The view from the high-definition cameras was spectacular, but they watched the screen nervously. It crossed the one atmosphere level, then the two-atmosphere level, passing through wispy clouds of pale

yellow ammonia ice, descending toward a turbulent layer of water-ice clouds at the 2.5-atmosphere level. “Tail winds persisting,” reported *Aethon.*

“How deep can it go?” asked Marshall.

“Not much farther. The problem isn’t crushing; the gas is getting inside and equalizing the pressure. The problem is the cold.”

“Turbojet engines coming on,” reported the *Aethon* that moment. The aerostat contained two nuclear reactors, arranged side by side across the middle of the vehicle; atmospheric hydrogen and helium was being pulled into them and run through them, heated to a high temperature, and being expelled through nozzles in the vehicle’s bottom, giving it lift. The altitude stopped dropping and the horizontal velocity, which was too high to deploy the balloons, began to decrease.

“We should be alright now,” said Toru. “The nuclear turbojets can be run for hours; maybe days.”

“Deploying balloons,” reported the *Aethon* that moment. Saturn’s atmosphere was 97% hydrogen and 3% helium; the only thing that was buoyant in it was heated hydrogen, so one reactor began to direct part of its exhaust into the first balloon. A camera on the deck showed the balloon rapidly filling directly overhead. Then second and third balloons began to deploy over the bow and stern, inflated by hot gas from the other reactor. It occurred to Marshall that the *Aethon* resembled Captain Hook’s pirate ship; a rounded bottom, pointed front, square back, and a flat top, but with three cables extending upward to three balloons rather than three sailing masts.

The *Aethon's* altitude began to climb. The control room erupted in applause. "Descent has stabilized," said the aerostat. "Heading toward the half-atmosphere level. All systems nominal. Reactor thermal output has been reduced to the ten percent level. Activating the helium extraction systems."

"That's a test," said Toru. "We won't start full extraction of Helium-3 for ten to twelve sols."

"I understand," said Marshall. He pointed to action on the deck. "Deployment of the first sonde?"

A moment later a small, round sphere was ejected sideways off the deck and the *Aethon* reported its deployment. "Yes," said Toru. "That's one of the armored ones, able to descend to a pressure level of several hundred atmospheres. Another one will follow in a minute or two. When the first one explodes—it has a liquid oxygen charge inside—the second one will pick up local reflections of the shock wave."

"Aeroseismology."

"Only possible in super-dense atmospheres."

They watched the deployment of the second sonde a minute later. Cameras on both sondes showed them falling quickly through layer after layer of clouds, the image dimming each time as Saturn's feeble sunlight was diffused and reflected away. After ten minutes the camera had to switch to infrared, to penetrate the darkness. Ammonia-laced raindrops began to accumulate on the lens and blow off.

"How long will it descend?"

"As many as ten hours. It can go most of the way to the Frenkel line, where the atmosphere begins to behave more like a solid than a fluid. The data is pouring in too, thanks to the presence of the *Aethon* to retransmit it to space."

"The aerostats will revolutionize our understanding of Saturn."

"Absolutely. We now have a permanent observatory on Saturn, one we can resupply, repair, and develop.

They lapsed back into silence. Marshall turned back to the screen showing the deck of the *Aethon,* which had almost reached the half atmosphere level where it would usually be stationed. Ammonia flurries were falling and blowing across the deck and it almost looked like a sailing ship in a snowstorm. The rings arched across the hazy sky; he was surprised to see a fuzzy orange ball—Titan—above them. It reminded him of a rising full moon on Earth.

"First test of the Helium-3 extraction system is complete," reported *Aethon.* "Everything is nominal except for slightly high voltage on the compression pumps. Sending in a robot to investigate. One point two grams of Helium-3 have been produced."

The control room applauded again. "Of course, that's not much," said Marshall.

"But it's the amount the test was supposed to make," said Toru. "Don't worry about the voltage; that's nothing. The system is designed to produce 3 kilos per day. That adds up and becomes a tonne in a year, worth a billion redbacks."

"Marshall nodded. "Good. I think it's time to make a big announcement; are there any more excitements coming up?"

Toru shook his head. "More Helium-3 tests, but we've tested the system so much, we know it'll work. The next big event is the explosion of the sonde in eight or nine hours."

"That's what I thought." Marshall walked over to an unused table whose surface was a screen, sat, and logged into his personal account. He pulled up his talking points, then activated the public address system. "Attention everyone. As you no doubt know, the aerostat *Aethon* has been deployed successfully in the atmosphere of Saturn. It has already launched two sondes into the planet's deep layers and the first Helium-3 test run has extracted 1.2 grams of Helium-3 from the atmosphere. The *Aethon* has passed its most demanding test; entry, descent, and deployment. It did this in spite of the partial failure of two of its parachutes.

"Tonight we will have a grand celebration on Titan Square, with a sumptuous dinner. The dinner will be followed by a very brief meeting with the Saturn Council. The purpose of the meeting will be to discuss the future of Saturn and whether we should declare ourselves a sovereignty, now that we have a stable and reliable source of income. We are a community of nearly a thousand people, two boroughs, a habitation of extensive underground caverns containing over twenty ecologies, with an interplanetary spaceport. We have visited all the major moons in the system and some of the smaller moons, with a plan to visit the rest and plans to visit the larger ones regularly for ongoing research. Our future is bright; our growth is assured. I look forward to your reactions to the Council's presentation."

"I think you know why I have summoned you here this sol," said Ambassador Zhao Tao to Will Elliott and Jacquie Collins.

"Dr. Ambassador, one does not 'summon' a head of state," said Jacquie. "I came because I was invited, not summoned, and came willingly. Furthermore, I didn't even know you invited Dr. Will to join us, presumably because he is Secretary-General of the Mariner League."

"That is the reason, Madame Chief Minister, and I apologize if I come off rather strongly, but the government of China is extremely concerned by the developments on Saturn. The communities on Titan and Enceladus do not now, nor can they in the future, constitute an independent sovereignty. They are an autonomous scientific community. The sending nation was Mars and if anyone can claim legal responsibility for their community, it is Mars. The Mariner League is a useful tool for the various deep space communities, so Dr. Will is a logical person to invite to this meeting as well. The two of you must stop Saturn's move to declare sovereignty."

Jacquie was taken back by that comment. "Mr. Ambassador, you have no right to make that demand and we have no power to accomplish it, anyway. They're over a billion kilometers away."

"Mars sent them out and bankrolled the expedition. You established the Helium-3 company and by law have a voice in its operations."

"Have you read the charter?" asked Jacquie. "The partners—the investors, among whom we have 31% of the shares—have a say over operations if they are inefficient and get a percentage of the profits. The 'Saturn community' as it is called in those documents has a 25% share by virtue of the labor they are putting into the project. The remaining investors are electric companies, private or semi-private; not governments. Our share is the largest because Martech designed the systems and Marcraft built part of them. Urania has an identical charter. There is nothing in the charter about sovereignty; that we assume they have it or that they can or cannot claim it. The charter provides no legal grounds for objecting to a declaration of sovereignty, assuming they decide to do that."

"You may recall that when the Helium-3 company was being chartered, the issue of sovereignty came up," added Will. "The terrestrial partners didn't want to have anything to do with that issue; they saw it as a legal quagmire. That meant the charter provided no leverage over the Saturn community."

"And Chinese electrical companies could have invested," said Jacquie. "But at that time the Chinese government was opposed, partly because the Mariner League was forming. That position did not do China any good."

"As you said, their claim over the entire Saturn system is a legal quagmire," replied Tao. "We will oppose that strongly in the courts. We can even oppose it by flying our own expedition to Saturn to harvest Helium-3."

"We have no control over what China does," persisted Jacquie. "But there many legal ways the Saturn community can refuse to cooperate, which would make your expedition more difficult and expensive. Meanwhile, you can purchase Helium-3 from the Helium-3 company at a reasonable market price. They have no plans to gouge non-partner companies."

"China can't afford to be at the back of the line, though. Helium-3 is one of the solutions to the terrestrial energy crisis. And China is a central leader in terrestrial affairs. It needs its independence."

"We can't help you with that," said Will. "The legal situation is adverse to many of China's choices, Mr. Ambassador. The Saturn community has landed expeditions on twelve of the thirteen moons of Saturn over 50 kilometers in diameter, and the thirteenth will see a crew in the next year or two. Those landings produce claims of territoriality. They are reinforced by 'active telepresence'—people operating in robotic bodies via virtual reality—which already

exists on five of Saturn's moons, and that number will soon expand immensely. With the deployment of the *Aethon,* there is now 'active telepresence' on Saturn itself, and no technological possibility to send people there anyway. Maritime law has been extended over this issue already; if you land on one major island, you can claim the entire archipelago, including all the little islands. That law is the basis of the Mercury, Venus, and especially the Jupiter Commission. I don't think China wants to undermine the legal basis of the claim of the Jupiter Commission over the entire jovian system."

"I can't speak on behalf of my government, where that's concerned."

"But history already does," replied Jacquie. "When the Mars-American-European expedition arrived, you didn't want us to set up a separate outpost, so we joined yours, and we expanded it immensely. At that time there was no other moon the expedition could go to. But as you know, further technological development and further exploration has revealed a few areas on Ganymede where a moderate radiation environment exists and can be ameliorated."

"Are you threatening to counter any move by us into Saturn space with a move into Jupiter space?" asked Tao Zhao, calmly.

"No, I am acknowledging possibilities you are already aware of," replied Jacquie.

"And with the development of reliable gaseous core engines, Helium-3 can be extracted from the jovian atmosphere," added Will. "In another decade or two, the price will become reasonable."

"And by then the price of extraction from Saturn's atmosphere will be even lower."

"We're not getting anywhere here, Mr. Ambassador," said Jacquie.

"So, what will you do?"

"The Secretary-General of the Mariner League will convey the extreme concern of the government of China to the Saturn Council and its Chief Executive," said Will. "The government of China should convey its concern in writing to me or to the Mariner League's Beijing representative, and we will pass it on."

"You mean, the occupant of the Mariner League desk at the Marsian embassy in Beijing," corrected the ambassador. The Chinese government had refused to give the Mariner League representative diplomatic status, but had recognized him as a diplomatic staff member of the Marsian embassy.

"Whatever," replied Will. He rose. "It's always good to be in contact with you, Ambassador Zhao."

"Thank you, Secretary-General Will." The men shook hands. "I appreciate your time, Chief Minister Jacquie."

"We always want to know the concerns of the Chinese people." They shook hand as well, then Jacquie and Will headed out of the office.

They stepped out of the embassy and onto Andalus Square. "So, you'll give Marshall a full report?"

"Absolutely. It sounds like China is planning to extract Helium-3 after all."

"If they can fund the technological development. That may be difficult. Everyone knows He-3 will be available for purchase in about three years, but no one knows whether the market will be big or small. A Chinese operation starting to supply Helium-3 in ten years may find the market saturated, or the sales price too low."

"They can afford to take the chance, though; they have plenty of resources. You're on the Neptune Committee; I'd share this conversation with them."

"Will you call Urania?"

"No, you do it, as Secretary-General."

"Alright I'll send all three of them the same email," agreed Will. "Thanks, Jacquie. Good to see you, even under these circumstances."

"Thanks Will! Ciao."

"Ciao." He waved goodbye to the Chief Minister and headed across the square. Will wondered what all the arguments for and against sovereignty were. He had thought about the subject many times and had heard many arguments, but it was always easiest to bounce the question off someone else. He pulled out his communicator. "Zoe, can you send a voice mail to Helmut Langlais, please? 'Hey Helmut, do you have 5 or 10 minutes? I just had a conversation with the Chinese ambassador about Saturn. I'd like to ask you about the sovereignty issue.' Please send that, Zoe."

"I'll do that," replied his automated assistant. Will turned and headed east, toward Helmut's house and university office. Before he had left Andalus enclosure, Zoe said, "He says 'this is a good time but only for a few minutes. Come on over.' He's at his house right now."

"Thanks."

It was a five-minute walk. At the moment Mars was weeks away from the southern summer solstice; the sun was as far south as it got, the shadows in equatorial enclosures were at their longest and insolation at its minimum, and the dust season was in full swing, so it was winter in the enclosures that were set up for that season. Huron enclosure was downright cold

and snowy; Colorado enclosure was crisp and had frost; he hurried through them. Yalta and Catalina were cool and damp. Australia was tropical at the southern end, the cold air and temperate climate settling to the lower, northern end. Helmut's house had tropical flowers in its yard and no hint that they might be threatened by cold. He rang the doorbell.

"Come on in, Will," said Helmut, at the door.

"I hope this is convenient."

"Convenient enough, considering the topic!" Helmut let Will into the living room, where Charlie and Sirikit sat with Clara. Sirikit looked so pregnant she was ready to pop. She shifted uncomfortably.

"How are you doing, Sirikit?" asked Will.

"Well, I'm headed to the hospital later this afternoon. The baby was due two sols ago. But all the indications are that she's coming pretty soon."

"Congratulations about that. I really shouldn't have called, this is much more important!"

"No, we're just sitting around right now," replied Helmut. "And you said 'Chinese ambassador' so I want to hear what he has to say."

"I'll be sending the Neptune committee a copy of an email about the meeting, so you'll see the details there, but I can summarize. It's hardly a surprise: they are furious about the possibility that the Saturn Council might declare sovereignty over the Saturn system. They wanted Mars and the Mariner League to pressure them. Ambassador Zhao implied that China might send its own Helium-3 extraction system."

"There have been rumbles about that for some time. As you said, this is hardly a surprise."

"Based on your experience on Ceres, does sovereignty make sense, economically and socially? It seems to me that Saturn has the same characteristics as the other members of the Mariner League: it is autonomous, isolated, it's 95% self-sufficient in manufactured items and equipment, and its 100% self-sufficient ecologically. But it's the largest community off Mars, it's old—Ceres and Callisto are older, but they were very small, whereas Titan started out large—and it has an entire world with an atmosphere and resources, including geothermal power and wind energy. The rest of the outer solar system is heavily dependent on expensive nuclear power."

"I'd say it's in a very different situation than Ceres," said Helmut. "It made sense for us to become a borough of Mars because we were a tiny outpost and needed outside investment to grow. Now that Ceres has gotten that investment, it's tightly integrated into the Marsian economy, it has grown—we're about the same population as Saturn—and we're pulling our weight economically. Ironically, I now see rumblings that Ceres may want to pull out of the Marsian Commonwealth and declare sovereignty. It isn't very loud or strong, but it makes sense; with PGMs we have plenty of income, and our exports of water, hydrogen, and construction materials to Phobos and to Earth orbit have given us a permanent role in those economies. Ceres is now looking at the rest of the asteroid belt around it and wondering what it should do to expand out into those other worldlets. With the arrival of the Department of Asteroidal Studies for Ceres Martech—a third of the department that had been on Phobos—Ceres now has very significant exploration capacity. I'm not sure what else Mars can or should give it."

"Really? Interesting. One thing that has changed radically in the last fifteen years is robotic manufacturing. For two billion redbacks, almost anyone can have a factory able to manufacture almost anything. Automated nanotechnology is developing fast, too, so computer

chips and other tiny devices will be added to those capacities in another decade. As a result, none of the settlements need much outside financial subsidy."

"Except to support further immigration," agreed Helmut. "That's still hugely expensive, both the flight and the outpost infrastructure. But most communities provide the infrastructure by keeping the construction share of their workforce at the 30 to 35% range."

"And even that percentage is dropping," said Will. "The biggest expense is nuclear materials, since uranium, plutonium, and americium require large facilities."

"Copper is hard to obtain, too, and some other elements," agreed Helmut. 'But they don't cost much to import."

"If I can say something, I think there is an important counterargument," exclaimed Sirikit, who had been listening patiently. "Saturn is self-sufficient economically only if it can export helium-3. Until last week, everyone questioned whether the aerostat would arrive, whether it would deploy successfully, and whether it would succeed to extract helium-3. In a sense, these were silly objections. Of course it was going to arrive and of course it was going to work. If the deployment failed, we would have sent another one. So now, everyone is saying 'Helium-3 is coming, so Earth will build the reactors.' But the terrestrial economy is not that stable. There's no guarantee the Helium-3 will find buyers."

"You mean, because of solar, orbital solar, and wind power?" asked Will.

"No. Wind farms can produce hydrogen, methane, and electricity quite cheaply. Solar panels on houses have made them independent of the grid. Orbital solar installations can provide fairly reliable and steady power by the gigawatt. Everyone knows this already and the argument is that fusion need provide only a few percent of the total, as a backup system, as a primary

system in the winter or where there is very large industrial demand for power, etc. But a few percent of the Earth's electrical output still will require tonnes of Helium-3 per year, so there is enough demand to support Saturn, Uranus, and probably Neptune as well eventually.

"My concern is economic instability. The International Central Bank is continuing to release huge amounts of money into the money supply, so the world dollar has an inflation rate of 15%. It's supposed to be 5% at most. The higher inflation rate means government debt is shrinking and governments can raise their budgets modestly, which looks good, when they are actually cutting their budgets after inflation. Property owners are getting a huge break because they can pay off mortgages in inflated currency. Consumer debt, which was very high after the war, is coming down fast. But banks are losing money and are seriously endangered. People are putting money into property and stocks, which are hedges against inflation, risking the creation of bubbles. Consumers are spending their money instead of saving it because of inflation, so the savings rate is dropping. All that money is stimulating investment, which is good, but the resulting industries are highly automated, so jobs are not being created. People love to invest in space because we're a highly trained population with a cutting edge automated economy. But unemployment on Earth is above 15% in most advanced economies and is 20% in some, with little evidence it will come down soon. The jobs don't exist anymore. How long can this continue? If the central bank stops printing money and inflation comes down, the economy will probably go into reverse, unemployment will go up even more, and social services will have to be cut."

"That would produce huge social turmoil," said Will.

Sirikit nodded. “Exactly. If I were on Saturn, I wouldn’t cut any cords with Mars right now. There’s no guarantee there will be a market for its Helium-3 in three to five years.”

“Interesting,” said Will.

“But regardless, emotion will carry the day,” said Charlie. “Because if you’re over a billion kilometers from anyone else and you’re autonomous, you might as well be sovereign. You can always negotiate subsidies if you need them. Everyone knows Mars has pledged to provide reasonable levels of support. Anyone who wants the prestige of supporting their national image through space exploration will provide support. Why should the residents of the Saturn system vote *not* to be independent?”

“That’s a good point,” said Will. “I think I had better go.”

“I think we had better go to the hospital, too,” said Sirikit. “It’s time.”

“Then off we go!” said Charlie, excited and nervous at the same time.

Esther looked around her prairie ecology cubicle. It was 3.5 meters square and 2.25 meters high, for a total volume of 27 cubic meters, but except for a place where she could stand, it had three levels of prairie grasses, forbs, and accompanying insects. Each tray contained just 5 centimeters of liquid solution and artificial soil; the ceiling overhead (which was often the bottom of the tray above) had light emitting diodes to provide the optimal amount of light.

The fire in early July had caused a deluge that had flooded the top set of trays and drowned the bottom set. The middle set had gotten rather wet, but the carbon dioxide flood that put out the fire had killed 90% of the insects and 60% of the insect species. Over the last two and half months, Esther had been overseeing robotic bug-killing efforts to keep some species under

control while eggs of the extinct species were incubated and the baby bugs released to restore ecological balance. The effort had been nightmarish, but she was beginning to regain control of the ecology.

The sad loss had been the two bird species. The family of larks, which had lived in the grasses and hid from her whenever she entered, had been killed by the CO_2. The ring necked pheasants had lived in a box, where she fed them and daily let them out to forage for themselves in the cubicle. The male had been out when the fire had occurred and had been killed. The female had been in the box, sitting on a clutch of eggs, and had survived. The chicks had been born two weeks later.

Esther opened the box to look in. The mother was used to her looking in, but was always nervous about it. The five chicks were fledglings, developing their wing feathers and eager to eat just about anything vegetative. One jumped in the air and flapped its wings when she opened the box, probably startled by her. Normally it couldn't go very far, but in the low gravity of the cubicle its wings were effective. It flew by her and settled onto the grass, disoriented by its own escape. The mother agitated, began to move around as well.

"Okay, you can come out, too," said Esther, uselessly addressing the bird. She opened the box's main door and the mother hurried out, no doubt glad to be out of the one-square-meter box for the first time in two and a half months. A chick immediately followed.

"I guess you guys are big enough to explore now." Esther reached down and pushed the others out as well. They ran from her hand, then slowed to look at the strange artificial prairie around them.

And just that minute, Esther felt a very powerful contraction. She paused in her work to let it pass. She had had another one 45 minutes earlier and had ignored it because they had been occasional events for the last two sols. But two in 45 minutes, and this one was longer . . .

It was probably time, but she wasn't sure. She looked at the mother pheasant. "You take care of your babies, now, because I think I have to take care of mine," she said, making a note to inform Johann, Director of Ecology, that the pheasants were loose. They would be fine in their prairie cubicle, except to startle visitors. She opened the door and stepped into the central corridor off which were five of their ecologies. She looked around carefully to make sure no insects had come out with her, then headed for the infirmary. She'd call Wicahpi Luta from there.

Esther had the longest wait; her labor lasted eighteen hours. Sirikit's baby was born twelve hours after she reached Mariner Hospital. Two sols later, Esther and Wicahpi-Luta were in their quarters with Miranda when Sirikit and Charlie sent a videomail.

"Hello, old friends!" said Sirikit, sitting on a couch with Charlie and holding up Andrew Maxwell Langlais between them. "Isn't he beautiful? Please send us a video of the three of you, so we can see Miranda! We're so happy, and right now we're even sleeping, because he's sleeping 18 hours a sol. It was a pretty rough labor; not sure I want to go through that again! But he's so precious, it was all worth it.

"The preliminary DNA analysis suggests he has no serious genetic abnormalities, which is a *huge* relief, considering we went to Jupiter and got a bigger dose than we would like. Charlie, especially, has accumulated a lot of exposure. I suppose that means we had better have another kid really soon; no reason to wait for the genetic issues to get worse. I hope Miranda is

okay. How did it go? How are you recovering? I still have five extra kilos. I hope nursing is working out; it's been hard, here, I haven't had much milk yet so we've supplemented with formula. It's . . . well, I'm not sure what else to say, so I'll let Charlie talk." She turned to her husband.

"Well, I should mention the names. I'm not sure why we selected Andrew; I guess because we liked it. Maxwell is a well-known Bahá'í name and Sirikit wanted it, and I liked it, too. My grandfather is calling himself Mars's first great grandfather and he's calling Andrew the first great grandchild born of Mars; true I guess, but since dad was born on Earth, it's not a complete chain of native births! The grandparents are thrilled and want to babysit. We hope that'll continue, because he won't sleep this much and be this portable forever. We're sorry we can't be with you and you can't be here with your parents, because I am sure they're totally thrilled as well."

"I'm planning to go back to work in a week or two," continued Sirikit, "because I need to finish my dissertation. When he's harder to handle and less portable, *then* I'll take some of my maternity leave. I don't know what your arrangement is up there, but since you aren't at Uranus, I suppose the pressure's not too intense. Please send us a videomail so we can see the three of you. We'll be home all day. Tonight we're going to my parents for dinner. Ciao."

The picture faded from the screen. Wicahpi-Luta looked at Esther. "That was really nice. They look so happy!"

"I'm so happy for them. Let's record it right now. You start."

"Okay." Wicahpi-Luta grabbed Miranda from her crib next to their bed and commanded the computer to tape a reply. "Thanks, Siri and Charlie, for the message! We just got it and

thought we'd reply right away. We're thrilled, too; beyond words. The labor was a really anxious time, but above all it was a miraculous time. I still can't believe I'm a father, Esther's a mother, we have a baby; right here, isn't she beautiful? She was almost four kilos. That's one reason we chose the name Miranda; it literally comes from the root for looking at something, but our word 'miracle' comes from it as well. And, of course, one of the moons of Uranus is named Miranda; in fact, it is looking like it'll be our destination. The names of moons have been very common names for newborn girls up here: Miranda, Julia, Cordelia, Cressida, Desdemona, Rosalind, Belinda, Ariel, even Margaret! Francisco, Ferdinand, Caliban, and Stephano have not been equally popular among the names of boys, though." He turned to Esther.

"My turn now. The labor was gruesome. She's been sleeping most of the time since, but so have I. I won't have the energy to work for a few weeks, I think. We do have a fairly relaxed schedule, but the plan is to retain the relaxed schedule even after we arrive; Gandhimohan, who sets the pace, says we'll probably get more done working less, and I think he's right. My ecological cubicle has recovered pretty well, by the way.

"We do miss grandparents; oh, I wish we had some on the trip! They're all hungry for every video we can send. Yes, Miranda is healthy, but we're awaiting the DNA tests. We're living on the *Ouranos* and it's pretty good thanks to the magnetic radiation shielding. She's nursing pretty well, fortunately.

"I suppose my feelings are mostly . . . I'm overwhelmed by amazement that this has happened. It'll take some time before I adjust. It *is* miraculous, but I'm still a bit numb. It's beginning to hit me, though.

"Not sure what else to say! Let's talk morrowsol. I suspect we'll all have more to say. We've embarked on an eighteen-year project. I suspect we'll be back on Mars about then, and we'll all see each other again, and our children will be able to get acquainted. Ciao."

15.

Independence

Nov. 2079

"So; the deliberation and modification is finished," said Marshall Elliott, looking at his fellow members of the Saturn Council. He glanced at the clock. "It took five hours! I don't know about you, but I'm exhausted!"

"I am, too, but there's a crowd below us in Cathedral Square waiting to hear our decision," noted Ryoko. "From the sound drifting in through the open window, too, it must be pretty good sized."

Tomas Racan walked over and looked down. "A couple hundred people! And more sitting on their balconies, waiting and watching."

"So, are we ready to vote on the Charter of the Commonwealth of Saturn?" asked Marshall. He looked around the room; everyone was nodding.

"I do have one last suggestion," said Iris Geyer over the video connection from Enceladus. "It's pretty simple. Right now it's approaching midnight here, just like at Aurorae; it's late on October 30. But on Earth, it's October 31 pretty much everywhere. I suggest we date the Charter November 1, 2079, and declare it as approved and in effect at midnight tonight. That way, historically, everyone agrees on the day/sol when the new nation was born."

"Good idea," said Marshall. "So moved? . . . Seconded? . . . all in favor? . . . It passes Thanks, Iris. So . . . shall we vote to approve the Charter of the Commonwealth of Saturn."

"Yes," said several people at once.

"All in favor of approving the Charter signify by raising your hands."

All nine of them raised their hands.

“Then it’s done! Ladies and gentlemen: we are now an independent nation!”

“Yeah!” shouted several; others applauded excitedly. They had done it!

“Let’s announce it to the crowd,” said Tomas, gesturing to the balcony.

“Yes,” said Marshall, rising. Then he turned. “No, not up here, above everyone; let’s go down to the square and announce it there.”

“That’s better,” agreed Shiyoko.

The eight of them—Iris was on Enceladus, a million kilometers away, so she went to the main dining area instead—walked down three flights of stairs and stepped out onto the square. Immediately, the crowd turned to them. “Chief Minister Marshall, this is your announcement,” said Sydney.

“I suppose so, but you all come along. We can stand together at the microphone.” Marshall walked across a corner of the square to a low platform where plays and concerts occurred. “Activate the microphone, Ivy,” he said to his automated personal assistant. While he waited for the green light came on, he surveyed the crowd. They were the diehard devotees of independence; that was immediately obvious.

The microphone’s green light came on. He looked at the crowd. “We are now citizens of the free and independent Saturn Commonwealth!”

That’s all he had to say; the crowd erupted with cheers and applause. Marshall and the Council felt the wave of emotion sweep over them and suddenly it hit Marshall as well what they had done. The Council members all turned to each other, excited by the new reality. It was one thing to be immersed in the details of a document; another to feel its import.

The applause and cheers continued for well over a minute and Marshall nodded, smiling, reinforcing the sentiment. Then he resumed. “Tonight, the Saturn Council completed six hours of work revising the Charter. But for the three weeks since the election, we have reviewed the existing charter and the body of laws that flows from it, considered their implications, and brainstormed about the impact of this change in our status. Over 85% of you favored independence in the referendum question we added to the ballot. Our job was to convert that desire into a workable reality.

“The framework of our government requires only minor changes. Paralleling Mars, the former chief executive is now Chief Minister. The powers of the Commonwealth government have also been modified along the lines of the Mars Charter. The legislation the previous Council passed to give representation to Enceladus Borough has been modified slightly to create a path for other future boroughs, and we anticipate that there will be more in the future.

“The geographical or territorial extent of our jurisdiction has also been defined as everything within the ‘Hill Sphere’ of Saturn; in other words, within the gravitational sphere of influence of the planet. We have visited every object over 50 kilometers in diameter in that sphere, save one; our claim to the smaller objects is based on the ‘archipelago principle’ that claiming the major islands of an archipelago extends over the minor ones as well. To reinforce and solidify our claim, we will land an expedition on the last larger moon, Janus, in the next year. We will send an expedition to Tarvos, the largest moon in the Gallic group; we have already visited representatives of the other two groups of distant moons. Of the twenty-three moons inside the orbit of Iapetus, we have already visited fourteen; we will visit the remaining nine in the next three years. To reinforce our claim further, in the next several years we will land

permanent robotic exploring systems on fifteen moons. These systems will include a large robotic roving vehicle with a forty-meter solar mirror mounted on its roof, able to provide six kilowatts of solar electricity; the vehicle will have advanced communications and robot repaid capacity inside them, and will be equipped with smaller rovers able to explore an area and retrieve samples for the larger vehicle's geological analysis laboratory. These exploring systems, which have been under development for several years here and in the jovian system, will provide us with an 'active telepresence,' a way we can project our consciousness via virtual reality to these worlds. Our eventual goal will be have an exploring system on all of our moons. We feel they are a vital part of our claim over the entire system.

"The Council has deliberated at length about the issues of financial autonomy and self sufficiency. As most of you know, the goal of the Helium-3 extraction system is to obtain 1 tonne of He-3 per year for export, worth at least 1 billion redbacks. Half of that income goes to cover the eight-billion redback cost of developing the system, unless Uranus comes on line and contributes an equal amount to cover the initial investment. Half of the rest goes to various energy companies who invested in the Helium-3 company. The remaining quarter is roughly split between Mars and Saturn, and Mars has pledged to repatriate its share to us as well. Our share covers our development costs and a profit. If all goes as planned, we will have at our disposal between 100 and 250 million redbacks per year, which we can use to cover the costs of importing replacement equipment we are unable to manufacture here.

"We commissioned the inventory and fabrication departments to create a list of absolutely essential imports. They found they amount to 50 million redbacks per year, exclusive of transportation costs. In short, we can cover all our necessary costs for survival here once the

Helium-3 system begins to sell product, unless the product's value falls below half; a highly unlikely event. If 250 million redbacks per year are available to us, it means we can launch a half-billion redback expedition from Mars every two years transporting at least 100 people here. Hence our conclusion that independence does not doom us to economic isolation and potentially serious shortages. We certainly cover our basic needs and it appears we will have enough left over to continue our growth.

"Finally, there is the issue of international recognition of our claim over the entire Saturn system. We will pursue and defend the claim vigorously in the courts and we are confident that legal precedents favor us. But we are also prepared to utilize economic means to protect our claim from any unauthorized arrivals. We are not under any legal obligation to sell things to them. We are under a legal and ethical obligation to rescue anyone in distress, but if we do that, we will deport the crew members that have been rescued. Because our infrastructure is so highly developed here, we are confident no one can compete with us without investing a huge sum. Our ten years of development here makes our claim safe.

"So, my fellow citizens, when the clock strikes midnight and November 1st begins, the settlement of the Saturn system enters a new era. To mark that great event, I am declaring tomorrow a holiday: Saturn Day. Schools and work places, except for vital work, will be closed. I hope our artistic community can come together to provide us spontaneous concerts and plays here in the square and our cafeteria and restaurants can offer some special meals. I'm afraid I can't arrange for fireworks, but let us make it a spontaneous celebration. It will be the first of many for our new nation."

Marshall stepped away from the microphone and Cathedral Square erupted in cheers. The other members of the Council joined in. Cheers came from a nearby large screen as well; at some point during Marshall's speech, a live feed from the cafeteria on Enceladus began.

Quite a few people came up to Marshall and the other members of the Council to congratulate them, which started a series of conversations, all to a loud background of singing and even some dancing. It was nearly half an hour before he clock hit midnight and the square erupted in cheers again. But after that, it rapidly quieted down. Marshall walked back to his apartment, where Amy kissed him and congratulated him. "That was a great speech. You sounded like a politician."

"Just what I need! It was a nerd speech, full of details, but that's what a settlement of PhDs expects, I think. I need to call dad."

"Oh, of course. Go ahead. I'm going to bed."

"I'll join you in a few minutes."

Marshall entered his small office and sat at the desk. "Record a videomail to my father, please," he said. The screen in the wall in front of him changed from a three-dimensional "window" view of his favorite landscape on Enceladus—with Saturn and its magnificent rings hanging over a great canyon—and converted into a video recorder. The light turned green, but Marshall ignored it for a few seconds to collect his thoughts. "Hi, dad. If you're following events—I suspect you are—then you know the Saturn Council just announced that it has approved a resolution modifying our Charter and initiating full autonomy—'independence'—as of midnight the beginning of November 1. That time has now passed, so we are now a new, independent nation.

"Cathedral Square overflowed with cheers of joy! Of course, it was full of the diehards, but no one here is opposed to independence, just worried about its implications. So I tried to allay people's fears. I hope you can listen to the speech, which seems to have gone very well.

"I can now understand how you felt the night Mars achieved independence. It's really amazing! It's hard to say what it really means, actually, because we have been running our own affairs for years anyway; we're too far away and too isolated for any other arrangement. But even if nothing changes in practice, sol to sol, everything *feels* different. And for me, things are different, because I am now Chief Minister and I have to worry about foreign relations, especially with China! I'm not sure how to do that, except through the Mariner League for now. Saturn can't easily send an ambassador 1.5 billion kilometers to Earth.

"I think I need some general advice, dad. This is very strange, following in your footsteps this way. Who would have thought that would happen! When I was born, Mars had a dozen people and the moon twice that number, and I'm not yet 40. Things are moving fast and I'm not sure anyone knows what it all means. Sirikit's deep into 'solar system economics' and everyone's exploring whole new areas of solar system science, and meanwhile we're discovering Earth-like worlds all over the galaxy. I suppose these are funny examples, but I feel disoriented right now! Running an independent 'country' of less than a thousand people who are claiming a sphere of space a hundred million kilometers across, occupied by a giant planet and 75 significant moons . . . it's dizzying! Anyway, give me a call back when you can and assure me I haven't lost my mind! Bye."

Marshall hit send, not sure whether he had captured his feelings or not. He felt confused about the entire situation but elated that Saturn had made a decision and was now on its own

path. Because any reply from his father would take at least two hours and twenty minutes to arrive, there was no reason to stay up. He told his personal assistant to awake him when the reply arrived and headed for bed.

Marshall's message went by microwave to a satellite at the Titan-Saturn L1 point, where it rode a laser pointed at Mars. The beam was picked up by a communications satellite in aerosynchronous orbit and beamed by microwave to Aurorae's receiver, and Marcomm relayed it to Will Elliott's communicator in a fraction of a second. He was indeed up, watching the live video show Cathedral Square rapidly emptying out of those celebrating. He listened to Marshall's message with a smile and a tear in one eye.

"Marshall, you aren't crazy at all. Tonight is like the birth of a child; it's exciting, giddy, very serious, worrisome, and exhausting all at once. For some people it's more of one emotion, for others more of another, but it is surreal in many ways. Congratulations! I'm sure the Commonwealth of Saturn will be a great success, and I'm sure you will be a great—and historic—first Chief Minister. Mars has set a great pattern that other communities are following, but don't hesitate to depart from it and improve on it. This idea of 'mariner' culture and 'mariner' ways is actually problematic in some ways because we can't be imitators all the time, we have to be innovators.

"You can't believe how proud your mother and I are of you." Will paused a moment because there was a catch of emotion in his voice. "We are proud and confident in your abilities to lead your community. Don't worry about the Chinese; tackle the issues one at a time. That's what your speech did, and it was a really great speech because it laid out everything step by step. The Chinese aren't going to send an ambassador to Saturn and you can't send one to Earth. The

Chinese ambassador here no doubt will be given responsibility over Saturn as well, and the Mariner League can represent you through the Mariner Interests Sections of the Marsian embassies on Earth or directly here. It'll be the same way with Urania, and no doubt with the Neptune settlement as well. That's a function the Mariner League can play. We'll help with the hiring of lawyers, too, to defend your claim, because we have the contacts and this has to be done right."

Just then a message flashed on Will' screen. He paused to read it. "Oh, and I see that Jacquie Collins just issued a statement that the Commonwealth of Mars recognizes the sovereign Commonwealth of Saturn. So you have your first foreign recognition! I'm sure you'll get many more. Jacquie and I were talking yestersol about your probable declaration and she agreed that Mars would work to get countries on Earth to recognize you. I'll go see her morrowsol morning to discuss our steps to obtain recognition. China may be the hold out, but who knows. At other times, China has been our great supporter and the United States was opposed to us. So don't worry; we'll help Saturn."

Esther entered the cafeteria of the *Ouranos* with baby Miranda strapped into a carrier resting against her chest. Wicahpi-Luta was already there and waved to her from their usual table, sitting with Tahirih and Vahid. She walked over and removed the sleeping baby, who woke up and began to cry quietly.

"Ooh, I'll take her!" volunteered Tahirih. She had been very happy to help, since Esther emerged from their quarters with the baby a few weeks ago.

"Sorry I didn't get you any food, but they have the veggie lasagna you like *and* the tilapia with rice that you like," said Wicahpi-Luta.

"Don't worry, I'll get it," said Esther. "Be right back."

She walked over to the buffet line, which wasn't too long; she had arrived right before the peak of hungry people. She grabbed a tray with plate and cutlery as Reverend Varma entered the line right behind her. "Good evening, Esther," he said.

"Good evening, Reverend." Her voice betrayed some nervousness; she had been avoiding him, ever since he had plotted with the Philosophy Club against the Bahá'ís.

"I didn't see you at mass last Sunsol, or two Sunsols before, and Patrick O'Hare told me you hadn't been there at all since Esther was born. I was wondering—"

"It's been a bad time. I've been recuperating. I haven't even started back to work, yet."

"Oh, I'm sure. Such a beautiful, peaceful baby; you really have been blessed. My kids were terrible screamers. Not only did they cry a lot, they kept us awake most of the night, the first year. Miranda has such beautiful features, too. Pretty soon, it'll be time to have her baptized. As you know, the Catholic Church recognizes my baptisms, and Patrick always comes as deacon to distribute the host. We can schedule the ceremony any time that is convenient for you and your friends."

Esther was startled by the sudden change of subject. She was even more startled that she hadn't even thought about the baptism. It suddenly occurred to her that a few of her father's videomails had hinted at the subject, and she had even missed them at the time. She opened her mouth, and words came out that felt very strange.

"Thank you, Reverend Varma, but I don't think Miranda is going to be baptized at this time."

"No?" It was his turn to be startled.

"No."

She moved forward and started putting food on her plate, absorbed in that task so that he wouldn't ask her anything else. He took the hint and moved to another part of the buffet for his dinner.

When she walked back to the table with her tray, she had begun to digest the decision she had very spontaneously and intuitively made. But she decided not to mention it. "So, you're back to work on Monsol?" asked Tahirih.

Esther nodded. "Yes, but just four hours a day. Miranda still sleeps a lot, and I feel pretty recovered now. It should work out fine."

"Good. How's the prairie biome?"

"My colleagues did a great job in my absence. The pheasants are doing well and the plant species continue to recover. I'll be spending most of my time on the extra soybeans, though, to hasten the harvest and maximize its size."

"The shortages have been really annoying," agreed Tahirih.

"It could be much worse, though," said Vahid. "We've had a really good, safe voyage. A little fire really wasn't much of a challenge."

"And the micrometeoroid strike two weeks ago," added Wicahpi-Luta. "A tiny bit of minor damage."

"Well, now we're gearing up to explore the Uranian system," said Tahirih. "And as soon as Uranus Alpha arrived there, I got pregnant."

"Oh, you're pregnant? Congratulations!" exclaimed Esther thrilled. "Right on time, too."

Tahirih nodded. "We put our names in the registry to start in September, and that did it! I'm really dragging around the lab, now. I plan to ask for mornings off, so I can work at a time that's easier."

"Good idea. Morning sickness can be really difficult."

"How's everything going with the deployment?" asked Wicahpi-Luta. "The propulsion team has been busy with orbital adjustments, since we haven't had to do anything with the Urania's engines lately."

"And you guys have done a good job. Most of the satellites are now deployed and we have three landers down, on Miranda, Oberon, and Titania. We're holding off on the other four for a few months to finalize the landing sites."

"Three landers must keep you pretty busy anyway," said Esther. "How's the search for an outpost site?"

"Very well," said Tahirih, with a smile. "We've made a huge amount of progress on the geological history of the three moons, too. It appears they have clues to the mega-impact that turned Uranus on its side in the early days of the solar system, too. It's very exciting."

"That would be an incredible story to uncover," said Esther. "Let me take Miranda back, now."

"You're done eating?"

“Close enough.” Esther took her baby back. Tahirih, Vahid, and Wicahpi-Luta had been alternating as they had finished their meals. “So, what do you Bahá'ís do when a baby is born?”

“Do?” asked Tahirih. “You mean, like baptism? We don’t have a ritual. Some people invite over friends, say some prayers for the baby, and have a meal together. Sometimes people even perform acts of service in the baby’s name.”

“Really? That’s nice.”

“We try to emphasize acts of service, and that’s one way to do it,” said Vahid. “Rituals can become mechanical, but prayers and acts of service can be done as many ways as the cultures and individuals who do them.”

“Then I’d like to come help your children’s class, as my act of service,” said Esther.

“I’ll come, too,” said Wicahpi-Luta.

“What shall we do, as an act of service dedicated to Miranda?” said Tahirih to Vahid.

“Oh please, don’t,” said Esther. “That’s very kind of you.”

“We could help out at day care,” said Tahirih. “They are always short of volunteers, and we should get used to the babies anyway!”

Vahid nodded. “Okay. Good idea.”

Esther smiled, very appreciative of her friends’ attitude. She looked at Wicahpi-Luta. She wanted to tell him they were going to have a devotional program and food for their friends in Miranda’s honor, but she didn’t want to say it then.

“Could I have everyone’s attention?” said Anand over the public address system. They turned to the podium—which was almost overhead in the circular atrium, which circled the ship’s axis—and saw the Commander standing there, waiting. “I have two important

announcements. The first is long awaited. Our landers have explored the three final candidates for the outpost site and we have selected Coriolanus Crater, Miranda. It is a twenty-kilometer crater located slightly north of the moon's equator, gouged out by a nickel-iron impactor. It has the metals we need and currently parts of it are in 24-hour sunlight. Miranda has long been our primary candidate moon because it's the closest of the major moons, so it's well located to support Helium-3 production; also, its orbit is inclined four degrees from the equator, allowing us access to the planet without flying through the rings. Titania and Oberon, which have the most complex interiors and possibly independently evolved bionts, will both have semi-permanently inhabited stations, which will evolve into boroughs as our population grows.

"The second announcement has to do with the recent announcement of the Saturn Commonwealth and their decision to establish an "active telepresence" on as many of their moons as possible. The Urania Council has consulted with our Exploration Department and has decided to do the same. Our Uranus-Alpha probe has brought to the system seven landers and a dozen communications and reconnaissance satellites, all nuclear powered. We have the same on board. The communications and reconnaissance satellites can be modified to function on the thirteen very small moons that orbit inside the orbit of Miranda and can be placed there by geological teams. The dozen outer satellites will be visited by geological teams as well, but they have a lower priority because they all orbit more than four million kilometers from Uranus, and within two years we can build rovers to provide us an active telepresence on them. We anticipate being able to maintain an active telepresence on nearly all the moons within four years. This will actually slow down our exploration of the five major moons somewhat, but political considerations trump science, in this case.

"We have already informed the Chinese Space Agency of these decisions and do not anticipate a backlash. With the arrival of the Uranus-Alpha probe and its powerful laser communications systems straight to us and our even more powerful communications to the inner solar system, the data transmission rate from the existing assets in the system could increase one hundred fold. We are working closely with everyone because we now have the majority of the assets and the overwhelming amount of communications capacity. We anticipate that scientific cooperation will continue at a very high level.

"Thank you, everyone."

Anand stepped away from the podium. "So what's Coriolanus like?" Esther asked Tahirih.

"It'll be a good home for us. There are no areas of seasonal darkness, and Uranus's seasons last a long time; we want to build where there is a day-night cycle so people can go outside regularly. The crater floor is not cut by great cracks and fissures like much of Miranda, so it's a good place to explore by foot or rover. The rim has several significant breaks in it, so we can build roads to the north and south. If we want to tap solar power, we need solar collectors thirty kilometers north of the equator where there is perpetual sunlight for half a Uranian year; a half year later the perpetual sunlight moves to the southern hemisphere, so we would move the collectors thirty kilometers south. If we want to establish solar collectors at the Miranda-Uranus Lagrange-1 point, Coriolanus is in the line of sight."

"I'm glad we finally have a destination," said Wicahpi-Luta. "It's about time."

"It's a psychological turning point," agreed Tahirih.

Carter Levine was late for his appointment. He used his legs and arms to move through the long tunnel as fast as he could, from the PGM extraction facility at the eastern end of Ceres Outpost to the Ceres-1 carrier a kilometer to the west. His arms pulled him forward using the handrails along the sides of the tunnel as fast as he could while his feet occasionally propelled him back off the ground, when Ceres's gravity pulled him down. Mostly, he used his arms, because 3.5% of terrestrial gravity was not a difficult thing to resist.

He flew into the arrival area under Ceres 1 and pulled himself to a halt under the entrance. There was a spiral ramp leading up and he hurried to ascend to the transfer area, where he stepped onto the slowly rotating floor at the hub. He walked toward the edge of the floor and it tilted upward and became a spiral ramp leading toward the outer edge of the cylinder. In the process, he slowly underwent a 90-degree turn. When he exited into Ceres Square—a curved metal surface 50 meters wide and 30 meters long—he was standing at right angles from the Cererian surface and was experiencing half a terrestrial gravity.

The square had a store on one side; other businesses and the Ceres Branch of Martech on the other side, and government offices on the side in between; opposite the government offices the square was open to the rest of the enclosure, which was gardens, orchards, and parkland. Carter entered the government section and went up two flights to his office. Jean Paul Poirier was waiting impatiently in the outer office.

"I'm sorry, Jean Paul. We're having another problem with the fractionation towers and they wanted my expert opinion. It looks like we'll need to shut down and do some extensive cleaning."

"That's too bad. How long?"

"A month each. We'll close them one at a time. We may be able to catch up later because clean towers are more efficient. Come in and sit down." Carter opened the door to his office and pointed to a chair. He sat opposite. "So, you're settled into the Martech labs? How's conversion of the *Piazzi* and the *Bode* going?"

"The offices and labs are quite comfortable, and we're all settled into our housing as well. The *Piazzi* and the *Bode* will take three months each to be re-outfitted for interplanetary flight, but because we have lots of robotic help, it only takes half of us to convert them both. They mostly need new equipment; some of their systems are almost twenty years old! We'll be ready to mount our first expedition—with the *Piazzi*—in February."

"Excellent. How many visits?"

"The navigational program can get us to eight targets in thirty-five months. If we have the delta-v we can add another fifteen months and three or four supplemental targets. They are excellent choices, scientifically. The *Bode* is aiming to launch in May on a four-year mission to the asteroid Triana out beyond Jupiter. As I am sure you know, it's in a solar retrograde orbit and telescopic observations give strong indications that it is a captured extrasolar object."

"Yes, I know about Triana, and it is a scientific goldmine, especially if telescopic observations of extrasolar nebulas and star systems can pin down the likely source. Very exciting. I'm very supportive of the *Bode* expedition. I'm supportive of the *Piazzi* as well, obviously. But I do want to ask you about issues of landing and claiming. Saturn's plan to land on and claim every moon in that world system has shaken up everyone's thinking, and yestersol Urania announced their intention to do the same. We need to make claims as well."

Jean Paul frowned. "In whose name? Mars?"

"I asked our attorney and she recommended we say 'we claim this asteroid in the name of the Borough of Ceres.' In other words, we're adding it to the borough."

"But it isn't part of Ceres. Ceres is a dwarf planet of its own."

"Very true. And Ceres isn't part of the planet Mars, either, but it is part of the Mars Commonwealth. So asteroids can be part of the borough, legally speaking."

"I see." Jean Paul scowled; he was not pleased. "We're scientists, Carter, not politicians. Please remember that."

"I know, Jean Paul, but you are also residents of Ceres, and we are providing the funding for your research. We need research on, and expeditions to, nickel-iron bodies as well as bodies of scientific significance. This is essential for the continued development—even the continued existence—of Ceres borough. Mining companies are planning to launch a variety of missions to asteroids from here in the next few years, and they'll be focusing on the ones with the greatest economic value. We don't want someone to find something with three or four times as much PGM concentration as the impactors we're mining here. They could set up an independent operation and drive us out of business."

"That's highly unlikely. The PGM ratios we have found on meteoroid fragments on Mars indicate that the ataxite body here at Central and the enstatite body at Mahuika are some of the richest sources available."

"I know; I used to run the operation at Uzboi, remember. There were small meteoroid fragments on Mars that were twice as rich, so there's a body out here somewhere that could be the base for a competing operation. That's a serious and legitimate concern for us, Jean Paul. The

new Department of Asteroidal Studies has to help us out. We've already talk about this, and I get the impression you aren't taking this concern seriously enough."

"Carter, there are two bodies on the *Piazzi's* primary expedition and one on the extended expedition that are nickel-iron."

"Good."

"We can only explore so many so fast.'

"I know. But we've also talked about launching more automated probes, and this whole concern about 'active telepresence' has revived my desire to make that a priority. This morning I talked to Adam about manufacturing a modified version of the Firebird system—"

"Why modified? I helped design that system specifically for asteroid exploration."

"It was designed for manufacturing on Phobos, but we have to use steel for the rocket casing, for example. Heavier, so the rocket needs to be longer if we retain the objective of being able to launch five tonnes to a delta-v of 9 kilometers per second. It'll need a heavier robotic refueling system, too. But I think we can manufacture two per year, each equipped with up to ten rovers."

"We can't provide scientific support for many rovers."

"We'll do some of the basic work here and contract out the rest to universities on Earth. That'll keep Ceres at the center of asteroidal exploration and strengthen out claims."

Jean Paul nodded. "Alright. That's a goal we can embrace. We want as much data as possible. But we have some ideas about modifying the basic Prospector 501 system."

"Good. Get them to Martech's Division of Automated Exploration Systems, because they're revising the basic design for us. The design is tried and true and pretty cheap to manufacture, but we have to make them here, so don't propose anything too fancy."

"Okay."

Esther shifted around on the couch and looked at Wicahpi-Luta with a scowl. "I wish you wouldn't do work now. Please watch *The Roundtable* with me."

He looked up from his tablet. "I've been listening, and sometimes looking at the screen. I wouldn't call this work, exactly. Look at the latest pictures of Umbriel! Who would have thought it had cryovolcanoes in the past. Every single major moon has such complex, dynamic, active geology! We're really going to a fascinating place."

"Well, the moons have all gone through orbital resonances with each other in the past, and that causes tidal heating, so they should have been active. I'm not sure why you're considering a Masters in geology. There's an unending series of engineering jobs ahead, like the Lagrange power array."

"If we build it, it will be quite a fascinating project, but a kilowatt of power requires 600 square meters of sunlight at Uranus's distance, so we will need 3 or 4 square kilometers of solar concentrating mirrors to focus the sunlight we need! Even with extremely thin aluminum mirrors, that's a huge task for us. We may be better off sticking to nukes."

"Still, it would be better to use solar, or even geothermal if we can tap any, because they're renewable. We don't have access to uranium out here."

"Unfortunately." He put down the tablet and turned to the television program they watched every Thursol night together. Miranda slept peacefully on Esther's lap.

Then Esther's communicator buzzed. She looked at it. "Oh, a video message from mom and dad." She paused the tv show and sent the image to the wall screen.

Greg Harris and Anna Racan Harris, Catholic priest and former nun respectively, appeared on the screen. They were sitting on their couch as well. Both were in their late 60s, but still quite active. "Hi, dear," began Anna. After all her years on Mars, she still spoke with a slight Croatian accent. "How are you? We hope you and Wicahpi-Luta and Miranda are well. The voyage seems to have settled into a routine again. Just a bit over a year to go! You'll be there before you know it!"

"We thought we'd call because Miranda's now almost two months old, and we understand she hasn't been baptized yet," continued Greg. "Patrick emailed me the other sol and naturally he's all worried about her soul. You know Patrick. I told him not to bother you about it because I am sure his personality can rub you the wrong way. For that matter, so can Reverend Varma. What he did with the Philosophy Club to disturb the religious peace on board the *Urania* was uncalled for and inappropriate. I think he may have learned his lesson; I wrote him after the first debate and expressed my concerns. So I hope that's not holding you back. Even though he's Protestant, the church recognizes his baptisms. For that matter, as a deacon, Patrick can baptize Miranda. If you want someone else to do it, even that can be valid, according to the Church Catechism. This is an ancient sacrament that our Lord Himself established for us; it brings grace to Miranda and really to everyone involved. It is quite a privilege to bear children and through baptism we give their spiritual development over to the Lord Jesus Christ.

"So let us know, dear, what you plan to do. We will rest assured as well. Thanks. Ciao."

The screen faded to dark. Esther stared at it.

"I was surprised you didn't make arrangements for Reverend Varma or Patrick to baptize Miranda," said Wicahpi Luta, after a long silence.

"When Varma asked me, I was surprised I hadn't even thought about it. But I told him no. When Patrick asked me a few sols later, I said no again. But I don't know why."

"They're both pretty pushy."

"They are. But that's not it. I . . . just feel it's an outdated thing. You once told me what your parents did when you were born."

"I was there, but obviously, I don't remember! It was not a particular ceremony because dad's Lakota and mom's Maori. They sort of combined elements from both. I think dad did a sweat with a few men beforehand for spiritual preparation and purification, they had some prayers, and offered hospitality."

"It sounds kind of like what the Bahá'ís do."

"Except Tahirih and Vahid do acts of service as well. I like that. Vahid told me when he showed up at daycare they were surprised he actually came because men only volunteer after their babies are born!"

Esther chuckled. "It's the late twenty-first century and many are still chauvinist pigs."

"Well, maybe not that, but I take your point."

"Let's just invite people over, have some prayers and words of wisdom about raising Miranda, and have some food. I think that'd be really beautiful."

"That's fine with me! But what about your parents?"

"I'll just tell them." She turned to the screen. "Please record a reply to the videomail."

A minute later the picture of her parents on the couch reappeared on the screen, followed a moment later by a green light. "Thanks for calling, om and dad. It's good to see you. I wish we could actually sit down and talk, face to face, but that's impossible. The trip has become routine again, except for the excitement about Uranus, which is growing because every sol we deploy another satellite or lander and get an additional flood of data.

"As for Miranda, I'm sorry I've taken so long to make up my mind about what to do about her birth. Nothing has felt right, including going to mass on Sunsols, I'm afraid. So we're not going to baptize her; not now, anyway. Why knows how we'll feel in a few years. We're going to do prayer gathering here, invite friends, give them refreshments, and do acts of service around the community. If you have the chance to do some acts of service on her behalf, also, we'd appreciate it."

16.

Space Race

December 2079

Marshall was so surprised that he decided to play Ambassador Zhao Tao's videomail again. "Greetings, Chief Minister Marshall Elliott; I assume on Saturn you are 'Chief Minister Marshall,' just as your father was 'Chief Minister Will' here on Mars. My government has authorized me to serve as the Chinese ambassador to the Commonwealth of Saturn, whose national sovereignty we recognize over Titan and Enceladus and such other bodies in the Saturn system that the Commonwealth inhabits on a permanent basis. The legal state of sovereignty over the entire Hill Sphere of Saturn must proceed through the courts before we will recognize it; our own international law experts in Beijing doubt such recognition is warranted in any world system. As you may recall, the original treaty granting Mars independent status did not grant it full sovereignty over the Hill Sphere of Mars, although Mars later asserted this right during the U.S.-China War. No one has disputed Mars's control over its Hill Sphere, but it has not been recognized in any court, either.

"As your ambassador—through 'active telepresence,' shall we say—I welcome discussions with you over international collaboration in space. If you choose, you may designate an Ambassador to China who may reside on Earth or Mars. China has no plans at the moment to send an expedition to Saturn; we are concentrating our assets in the jovian system. But considering the many similarities between the jovian and saturnian systems, we anticipate that there are many advantages to the two systems developing common exploration strategies, using

common equipment, and sharing scientific studies. No doubt there are many fruitful ways we can collaborate for the betterment of human civilization and knowledge of its place in the universe.

"I look forward to hearing from you soon about acceptance of my diplomatic credentials and look forward to working with you. Good bye."

The recording faded out. Marshall opened the attached letter again, an official looking document from the Foreign Ministry in Beijing addressed to him as acting Foreign Minister that recognized the sovereign government of the Commonwealth of Saturn. It placed all the same limitations as Zhao's recording had. Also attached was the Letter of Credence officially requesting "agrément" to the appointment of Zhao Tao as ambassador.

Marshall leaned back at his desk a moment, looking out the window at Cathedral Square, pondering this surprising development. He had had warning; the Chinese media had reported the change just minutes before the videomail arrived. Only twenty nations on Earth had recognized the commonwealth of Saturn and getting others to do so was becoming an uphill struggle that promised to take a long time, a lot of his time, and more money than Saturn could afford. Now it was easy.

Marshall turned to an email he had received from his father—as Secretary-General of the Mariner League—two weeks earlier, summarizing all the language and protocol of diplomacy. There were procedures for Saturn to follow, and he had to do it right. But an acknowledgement was fine. He set up his computer to tape a response.

"Good sol, Ambassador Zhao," he began. "You are correct, here on Saturn the proper form of address, as on Mars and in Vietnam, would be the title plus the first name, so I am 'Chief Minister Marshall.'

"The Saturn Commonwealth is grateful to the government of China for extending even a partial recognition of our status as an independent and sovereign nation. It is not impossible for nations to recognize the sovereignty of governments over only part of the territory they claim sovereignty over, as China itself has unhappily experienced in the past. We are sure that further negotiations over the matter will resolve our boundaries to everyone's satisfaction.

"We look forward to working with China on matters of mutual concern, where the exploration of space is concerned. We all seek to extend humanity's presence deeper into the solar system and beyond. We welcome Chinese scientists to come reside here and continue their research. Twelve percent of our population is Chinese and we welcome that percentage to increase. If you have no plans to send an expedition here, please encourage scientists to apply for the slots in the 2083 flight here. We will welcome them.

"I will take your Letter of Credence and the agrément to the Saturn Council and I am sure you will hear positively from us in a few sols. We look forward to working with you and with China to continue the development of the Saturn system, in spite of our claim to full and complete jurisdiction over it. Good bye."

Marshall sent the videomail to Zhao Tao, then copied it to the Council members. "We should discuss this right away; can we meet morrowsol evening at 7 pm for an hour? Sydney, note the ambassador says they aren't planning an expedition here. You may want to reach out to your contacts on the expedition and see whether they'd like to come here anyway. There's plenty of time for them to catch a flight to Mars for the mid 2083 flight here. Maybe we can recruit a few of them. Ciao to everyone."

“This was a lovely gathering, Esther,” said Samantha Augustine, as she stood in the doorway of Esther’s and Wicahpi-Luta’s quarters. “Thank you so much for inviting Marcel and me. It was a great way to celebrate the arrival of Miranda.”

“Thanks, Samantha, I’m grateful you came. Best wishes with your baby, too.”

She smiled. “Thank you. Three months to go! I think we might do something like this after he’s born, too!”

“Definitely,” agreed Marcel, who had been talking to Wicahpi-Luta.

“I like the Bahá'í approach, to pray, provide hospitality, and encourage acts of service,” said Esther. “So practical and loving to others.”

“It is. We’ll do an act of service on Miranda’s behalf,” continued Samantha. “I hadn’t realized you and Wicahpi-Luta has become Bahá'ís.”

“Oh, we haven’t!” replied Esther, surprised. “We’re friends of the Bahá'ís, I guess you could say.”

“Oh. That makes sense. Technically, I’m Protestant and Marcel’s Catholic, but we haven’t done anything religious in years. But service . . . one problem here is that we are essentially organized like a military unit up here, but with elected officers. There aren’t many things we can do for others!”

“I don’t know,” replied Esther. “There isn’t a time, day or night, when the clinic couldn’t use volunteer help, the day care facilities are almost desperate . . . you’d be surprised.”

“Sounds like some service is really needed, then,” said Samantha. “Bye.”

“Ciao,” replied Esther, waving as Samantha and Marcel left. They were the last ones; they had invited over a dozen, including Tahirh and Vahid. She closed the door and looked at the left over cake. “That was fun.”

“It was,” agreed Wicahpi-Luta. “I think my ancestors would have been pleased. Everyone participated in a very simple ceremony.”

“She’s definitely Miranda now!” Esther reached into the crib and scooped up her baby and kissed her. Wicahpi-Luta smiled and kissed Esther instead.

“I love you,” he said.

“I love you, too. It’s interesting that Samantha thought we were Bahá'ís.”

“She may be more correct than she knows. I have great respect for the Bahá'ís. Bahá'u'lláh may have been a great prophet.”

“Come to think of it, I agree. But I don’t feel ready to join, or anything like that.”

“Me, too. Not yet, anyway.”

Jacquie Collins was late. “I apologize,” she said, as she entered the conference room where the Neptune Commission was meeting. “This is yet another building—or wing—of Martech, and I have never been here. I should have relied on my communicator’s navigator.”

“It’s a beautiful addition, and as you can see, it has a pretty courtyard,” said Helmut, pointing out the window. They could see the tops of palm trees, lush vines climbing the wall opposite, and a ceiling of Kevlar and straight-chain polyethylene with a meter of clear ice sandwiched between the layers.

“It is beautiful; a lovely setting for the Neptune Commission. So: what’s the evidence?”

"We were just reviewing it, and Will just gave us even more," replied Mercedes Patel, Director of the Neptune Project. "As you know, two weeks ago the Chinese announced that they were postponing their plans to send a caravel-class vehicle to Saturn. It was supposed to be full of atmospheric scientists, it would stop at Jupiter—the planets are well aligned for that right now—pick up a few atmospheric and icy moon experts, and continue on to Saturn, where they would join the existing settlement but would continue their research separately, at least for a time. Everyone has suspected that support for their own Helium-3 mining effort was the long-term motive, and efforts to fund a Helium-3 extraction system had begun in a very public way. The government created a private/public partnership to fund the effort and it began to make progress with its funding and its design goals.

"Then they postponed the Saturn mission, but they are continuing to seek funding for their Helium-3 system, and according to the Marsian embassy in Beijing, the design for the system is still under development. We're talking about a project that was announced to cost 10 billion redbacks, and that is now estimated to cost 12 billion because of overruns. That's a lot of money to spend, with no destination."

"And we're sure they can't deploy the system in Jupiter's atmosphere?" asked Jacquie.

Jimmy Khan shook his head. "With our gaseous core technology, it's possible; our new engines have a specific impulse of 5,000 seconds. But with advanced solid core nuclear engines, the exhaust velocity is way too low. Anything dropped into the jovian atmosphere can never be propelled back out."

"So, they could approach us for gaseous core." Jacquie considered that. "We might want to offer it to them, as a political gesture. Their scientists on Deimos contributed extensively to it, after all. And Neptune's the only other source left."

"Exactly," said Will. "When Ambassador Zhao called Chief Minister Marshall and told him the trip to Saturn was off, Marshall called the director of Saturn science and suggested that she call her colleague in Beijing and encourage them to come anyway. They have all replied that it is not possible at this time, and one of them said that she was already busy with a new project."

"Suspicious," said Jimmy. "Then we heard from someone who is on the Chinese station in low Earth orbit that the caravel being outfitted for the Saturn mission is still being outfitted, but that the mission clearly has changed because the hydroponics they are installing are much more robust."

"As would be necessary if you're going to Neptune," said Jacquie. "How quickly could they get there?"

"The Saturn launch window would have opened in another few months," said Jimmy. "Uranus is almost 180 degrees around the sun, so the launch window won't open for six more months. If they use a solid core nuke and dive into Earth's gravitational field from L1, they could get to Neptune in maybe three years. I doubt they can do it much less because they'll need a lot of hydrogen to slow down at the other end. They'd be going too fast for aerobraking."

"So, based on our current plans, they'll get to Neptune about the time we send our settlement," said Jacquie.

"A bit sooner," replied Jimmy.

"And we can't move up the launch three years, I'm sure."

"That's impossible," agreed Mercedes. "We have started to make crew selections and have a few dozen people admitted, plus another hundred under serious consideration. The new plan replaces two of the three corvets with a partially completed carrier-100. Just the part of the carrier closest to the corvet would be completed. It would include ample housing and lab space. Some of the rest of the carrier would be agricultural, but it would be relatively unshielded from cosmic radiation, unless the magnetic bubble can be expanded. It would, however, provide enormous interior open space. The flight time would be three years, so a departure in January 2083 would produce an arrival in January 2086. We really cannot depart thirteen months from now, in January 2081. There's no time to create a community and see who doesn't fit in. The carrier would have to be completed during the flight, so everyone would be crowded together."

"We'd have to look at our hydrogen supply, too, because that's a huge demand on it," said Jimmy. "The immigration from Earth starts in a few months and returning those vehicles to Earth will drain down our hydrogen supply significantly."

"And in February we will launch three vehicles to deep space; one to Jupiter, one to Saturn, and one to Uranus," added Will. "They have to go very fast, so that will drain down the hydrogen supply on Phobos as well."

"This is a very bad time to contemplate a huge mission," said Jacquie. She shook her head. "We can't send Neptune-1 early, that's clear."

"No, but we could send a scout mission," replied Mercedes. "The Chinese appear to be sending one caravel only. That's 50 personnel, maybe 65 if they use the new hydroponic technology."

"With a Helium-3 system?" Jacquie frowned. "They must be planning just an advance exploration mission."

"We think so," agreed Jimmy.

"And it's risky," added Will. "That's a long way to send one caravel by itself, without redundancy and no possibility of rescue."

"And based on the launch time, I take it Neptune is nowhere near the other outer planets," said Jacquie. "So there are no potential stops on the way."

"Correct," said Mercedes. "Which makes us wonder whether we could send the two caravels we had originally planned to send with the three corvets in 2083. This was to be a mission with five vehicles; three to settle, two for exploration. Then we replaced two corvets with a carrier-100 design. But we always needed the caravels to get around the system. We could send two, plus substantial supplies, with a crew of about 100, and that we could do in thirteen months."

"Ah!" said Jacquie. "With the carrier and a corvet following later with the Helium-3."

"Exactly. Send them out fast to make the claim," said Mercedes. "The launch window from Earth opens in late September or early October, depending on your delta-v. The launch window opens from Mars three months later; late December or early January. We can't launch before they do, if they are determined. But we can definitely get to Neptune first because two caravels with supplies will mass 600 or 700 tonnes, total. With two advanced gaseous core engines, we can push them to Neptune in two years."

"*Two*?" said Jacquie, startled.

Jimmy nodded. “Two years. That requires an average velocity of 76 kilometers per second! But gas core has an exhaust velocity of 50 kilometers per second and Mars is moving at 19 kilometers per second, so 1,200 tonnes of liquid hydrogen can do it. Actually, that’s about how much you need to slow down at Neptune, so you need a bit over 3,300 tonnes of liquid hydrogen to accelerate yourself and your deceleration fuel; 5,500 tonnes altogether.”

Jacquie raised an eyebrow. “They’ll have great radiation protection. Aerobraking?”

“Only in an emergency, if an accident causes them to lose a substantial amount of hydrogen,” replied Mercedes. “They can’t aerobrake at 76 kilometers per second, it’d crush and incinerate the vehicle. Twenty kilometers per second might be possible.”

“Okay,” said Jacquie. “The next question is, why would we do this. It’ll cost us more. Not a lot more, since the same number of people and vehicles will be going, but we will have to rush the first mission’s preparations. If there’s an accident, it will be a huge embarrassment. The Helium-3 Company certainly will appreciate our rush to make the claim; it’ll secure their monopoly. But that looks like a brazen act that endangers lives for material gain.”

“That’s not the reason,” replied Mercedes. “The reason is that the Chinese are not spreading the mariner way. *They’re* the ones conducting the brazen act of sending one caravel on a three to four year mission to a very distant planet, just to beat us to it. We have invited them to participate many times in our multinational expedition and they have refused. Their set up of the jovian system was colonial and we had to send settlers there to change the situation. They are now trying to overwhelm our settlers with more settlers and they’ve had to accept our system of governance there. We want to set up Neptunia as a free and equal partner in the solar system economy. We’re sending a thousand people; it’s a huge expedition! It’ll arrive with all the

institutions they need and with an economic mainstay. The Chinese are trying to mess that up and we have stake in preserving it."

Jacquie considered the argument. "Alright. I'll buy that. Their plans are secret. There's the possibility that if we announce our change of plans, they'll cancel their plans and deny they ever had them."

"Yes, that would be ideal," said Helmut. "Then we wouldn't have anyone disputing the claim to the Neptunian system. But we can't afford to cancel ours as well because they get one launch window every terrestrial year, so another one will come along in September 2081. We won't get another one until December 2082."

"I understand," said Jacquie. "I can see why you were so urgent about me meeting with you. This is a big decision. And it all hinges on being sure there's a secret project to beat us."

"Exactly," said Mercedes. "But we are all convinced."

"We are," echoed Will.

"So am I," said Jacquie. She nodded. "Alright, we'll do it. How quickly can you select the crew?"

"Two months for most of them, three or four for the entire complement," replied Mercedes. "Most of the supplies are routine and readily available, or can be hauled from Earth during the upcoming opposition. The gaseous core nukes that will make possible the largest immigration to Mars in history will be back here by then and we'll be able to select from the entire inventory. Marcraft will have plenty of time to replace them before the 2082 immigration. There's plenty of time to accumulate 5,000 tonnes of liquid hydrogen on Phobos. Training can occur at the north pole of Phobos, which will be in permanent shade by next summer and thus

will be as cold as the moons of Neptune. The crew will arrive at Neptune just a few months after the Neptune-0 probe we sent last year with communications satellites and surface rovers, so they will be able to speed up the preliminary reconnaissance of the system."

"Good," said Jacquie. "Then let's do it. I'll work on the financing and the diplomacy. I want a report twice a week about progress and challenges."

Marshall slowly drove the ranger through the airlock and out into Titan's smoggy orange cold. Willie sat next to him, staring out the windshield in fascination. It was not his first time outside the outpost—his science class had gone out once two months ago, and in fourth grade they had gone out once as well. But this was the first time he had gone out with his dad, and they were going to go for a hike.

"This is called Settlement Creek," said Marshall, as he steered the vehicle down a broad, flat expanse of fresh ice covered by crushed stony meteorite "gravel." "This valley used to be fifteen meters deeper, but as we melted our first caverns we poured the meltwater here and it froze solid almost instantly. Now the water is disposed of elsewhere because we filled this valley up so much."

"How long has it taken Titan's bedrock to accumulate so much meteorite?" asked Willie, looking at a rocky streak in the eroded valley side.

"Billions of years. The crust hasn't been renewed so much, except at the few cryovolcanoes, like the Likoma volcanic complex where we're going. That rocky streak represents a spot where the crust eroded down, accumulated a layer of meteorite 'lag' deposit,

then ice ‘sediment’ was deposited on top by some temporary methane stream, and over time the ice chunks fused together. A lot the crust is like that.”

“Billions of years,” said Willie, who was ten and trying to contemplate the number.

They passed several big cliffs where the ancient methane creek—now long dried up—had cut back the ice-bedrock. Then the canyon began to open up into a narrow valley. In a few kilometers they reached the edge of the highland area and the road descended an ancient alluvial fan and turned to proceed up the Acheron river valley. “We can’t hike here,” explained Marshall. “This flood plain is the right at the ‘water table’ but the water here is liquid methane. This level is the lowest we can excavate our caverns, too; the floor of Cathedral is just twenty meters above the methane table. The ground here is wet and squishy, and you don’t want to try hiking on it. Your boots could leak liquid methane and your feet would freeze solid almost instantly. We’ve done a little exploring here, but either using a robotic body in virtual reality, or with the mini-helicopter.”

“And the big dark areas are tholin deposits?”

“Yes. You can see lag deposits of meteorite all over the place too, left when methane floods poured through here. The deposits with nickel-iron are the most important. One of them is over there.” He pointed to a pit a kilometer away where a robotic miner was at work.

“And there are no more floods now?”

“Once every thousand years or so. The late diluvial period ended a hundred million years ago. The Acheron does have methane flows in it every few months near the spring and autumnal equinoxes when we get some rain.”

They drove up the valley along the edge, where the road cut through dry sediments. In ten kilometers the road rose and turned west. They passed several huge dunes. “And we can’t climb them?”

Marshall shook his head. “The stuff’s too loose. You can get stuck in it or cryogenic grains can get through cracks in your clothing. Not only can they give you frostbite, they’ll release methane and sometimes a little ammonia into your suit, which is nasty stuff to breathe, even in small quantities.”

Willie watched the dune roll by. Puffs of wind tumbled a few grains off the top and made little eddies of tholin and ice dust. “A really dangerous place,” he mumbled, sounding a little frightened.

“It is, but we’re safe. The ranger is driving itself, so it won’t stray off the road. We’re going to an area of Likoma where there are some workers, so there’s rescue capability if we have trouble.”

“How often has there been trouble?”

Marshall paused to think about the answer and figure out what to say. “We have about one incident a year. No one has died, but one person lost parts of two fingers. I almost lost a toe to frostbite the sol we landed here; a boot heater malfunctioned.”

“Did it hurt?”

“Yes, for a few weeks until it healed.”

They continued up the road in silence. Liquid water had been poured on the ground to freeze a hard, smooth pavement, into which grooves had been cut before the ice had fully hardened to concrete-like hardness. The result was an excellent but quite cheap road surface.

Where the road didn't have to wind around old cinder cones and cryovolcanic vents, the rover speeded up to 75 kilometers per hour.

Soon they reached the crest of a long ridge. Huge wind turbines lazily rotated in the slow but steady breeze blowing from the east. Paralleling the road was a power cable that carried their electrical output straight across the plateau and a series of deep valleys to the outpost. They drove ten kilometers down the ridge, passing a wind turbine every 200 meters, until they stopped and pulled off the road. "This is the best place to get out and go for a hike," Marshall said. "You sure you want to do this?"

"Oh, definitely. I want to see and feel the place, dad."

"Okay." Marshall was reluctant. But the boy had a suit his size, and it was highly automated; it would take care of Willie just fine as long as he didn't fall into a pond of methane, and up on the ridge there was no methane anywhere to fall into. Marshall glanced at the weather radar as he picked up Willie's suit and began to help him climb into it. There was no methane rain anywhere within a thousand kilometers of them that sol.

Willie started putting on his heavy, insulated, electrically heated boots. The insulated overalls, two centimeters thick and foamy, zipped onto the boots and electrical leads were connected; the overalls went all the way up to his armpits and were secured with suspenders. Then a heavy insulated coat went on his arms and reached all the way down to his waist. It was zipped on securely and attached to the overalls so there was no way air could circulate between them. A life support backpack went on next, and was attached to the suit's electrical system and to air intakes in the collar. A transparent helmet was securely snapped in place on top, then

Willie put on heavy heated mittens. Marshall checked everything, then donned his own suit as well.

"I'm getting hot!"

"The suits can keep you cool inside the ranger, but it's a stain for them. Let's go outside." Marshall pointed to the airlock in the rear passenger side of the ranger and they both squeezed inside.

It took a few minutes for a nitrogen flush to evacuate all the oxygen, so that it wouldn't mix—possibly explosively—with Titan's methane-rich air. Finally the light over the outer door turned green and Marshall opened it. They stepped out onto the surface of Titan.

Ice "sand" crunched under their feet. Willie looked down at the ground, wanting to touch it but not daring to. Then he looked up and saw the ghostly orb of Saturn and the small intense brightness of the sun in the western sky.

"Wow! The sun is bright!" He stared at it.

"Be careful looking at it for too long. It's a lot brighter than the artificial 'suns' shining from the ceiling of Cathedral Enclosure. But you can't look at the sun at all, from the Earth. It's so bright, it's intensely painful."

"Really!"

"Titan's smog absorbs some of the light, too, especially the ultraviolet that can damage your eyes. The sun at Earth is 100 times brighter than it is here, before the atmosphere does its blocking."

“Wow.” Willie turned to Saturn, a big, ghostly yellowing smudge shining faintly through the orange overcast. “Saturn looks so much better when it’s projected onto the ceiling in Cathedral!”

“That projection is what it looks like above Titan’s atmosphere. You can barely see any atmospheric cloud belts, through the haze. You also can’t see the rings because we orbit right above them and they are very thin. The image we project onto Cathedral’s ceiling is taken from ‘north’ of the rings, so that you can see them.”

“I see.” Willie squinted at Saturn to see whether he could see any of the rings, but he couldn’t. Marshall looked around to see whether he could spot any moons, but they were too hard to see during the day, faint sun or not.

“Let’s walk,” suggested Marshall. “There’s a trail right here that runs down the side of the ridge and into a ravine. It gives a good view of the layers of rock this hill is made of.”

“Okay. Can we stop at the wind turbine?” Willie pointed to a 120-meter tall nickel-steel mast and the huge blades slowly turning in the light Titanian breeze.

“Sure.” They walked over to the base of the mast, which was a small skyscraper in a way, four meters in diameter. “Titan can have some pretty strong winds, so these towers have to be strong. That makes them pretty expensive to build, even with robotic labor. But they can make all the power we need. The electricity flows back to the outpost on that cable, there, where any surplus is used to electrolyze water in to hydrogen and oxygen.”

“And where are the thermal generators?”

Marshall pointed south. “We have three wells in the Likoma complex that go down a kilometer, where it is warm enough to boil liquid methane. The expanding gas comes up, turns a

turbine, cools, liquefies again, and flows back down. The thermal generators are steady; the wind is not."

Marshall tapped the wind turbine's mast, which was so big and thick it made no sound. Then they turned to the hiking trail.

It was well marked and ran along the crest a few hundred meters, then turned down a slip depression in the side, which soon funneled into a little canyon with a flat floor and cliff-like sides. The bedrock was a fascinating mix of colors: white or smoky gray where it was relatively pure water ice; brown where the ice was mixed with stony meteorite or chondrite, or shiny and metallic where nickel-iron fragments dominated; black and tarry where there were pure layers of tholin, which resembled coal seams; yellow to orange to brown where increasing quantities of tholins mixed with the ice. Titan's crust had been melted, flowed like the water that most of it was, and redeposited frequently over 4.5 billion years. It was impossible to tell, from the outcrops, how old that portion of the crust was, but Marshall explained that there were various geochronological techniques that had provided a date for the ridge and the canyon of about one hundred million years. It was a span of time Marshall himself couldn't fathom, let alone his ten year old son.

Finally after half an hour they emerged from the canyon onto the floor of a river valley. A lazy trickle of methane-ethane mixture flowed down the creek bed in the center. They stopped and threw ice "stones" into the liquid and watched them make a splash. They turned and walked up the valley a ways until there was a trail that headed up a gentle break in the steep edge. They followed it back up to the wind turbine and their rover.

They stood, looking south over the bright white cones of the cryovolcanoes and north toward the grays and browns of the Acheron river valley. “It’s beautiful,” Willie finally said.

“It really is,” agreed Marshall. “And it is very different than Earth or Mars. Earth has browns, but it is very green, because of the trees, bushes, and grass that grows almost everywhere. Mars is barren like Titan, but the ground is rusty red, cinnamon, orangey sometimes, gray, and brown. At the poles of Earth and Mars there are huge deposits of snow and ice, but they are ancient, so they tend to be cleaner.”

“Here, the rock is mostly ice!”

“Exactly, but not on Earth or Mars.”

“I love Titan.” Willie thought about what he said, then added, “But I want to see Mars, some time, and maybe Earth.”

“You should see both. Especially Earth, because it is our home world, our cradle. There, you can breathe the air and walk around without any protective clothes. The ocean is an amazing thing to see; water with waves all the way to the horizon! Three quarters of Earth is ocean.”

“You went to Earth for university.”

“Yes, that’s something we can’t provide here; not very well, anyway. My dad and mom wanted me to go to Earth because Mars was small at that time—maybe three times bigger than Titan—and Martech couldn’t provide an undergraduate education, either. It can now, but the options on Earth are still better. Who knows, you might end up on Neptune or exploring Pluto and the other worlds out there. Or you could end up on Mercury, for all we know!”

“Or living in California.” Willie had become fascinated by California, lately.

"Or California." Marshall said it, but not enthusiastically; he didn't want his kids settling on turbulent, dangerous, decadent Earth. "I remember dad and I went out for a walk once, and we talked, and he said 'who knows, maybe you'll go to Titan.' And here we are!"

Willie laughed at that. "Maybe I'll go to Pluto, then."

"We'll see. Let's head home."

Willie nodded and they walked back to the rover. It took a while to go inside; the air in the airlock had to be purged while the outsides of their suits were warmed up, to make sure no "dirt" had liquid methane on it. Once inside, they removed their suits and enjoyed the warm air.

"Even through the suit, I could feel the cold," Willie said.

"It's a good warning. Any exposed flesh will freeze solid in seconds. This place can kill you very easily and in many ways. That's true of Mars, too. If we want to stay alive, we have to take bubbles of Earth with us."

"Unless we use virtual reality."

"True, and in another decade or so, artificial bodies that can function well in Titan's cold will be possible. At that point our bodies will stay inside while our consciousness frolics outside!"

Willie nodded at that. They could see a group of robotic bodies working on one of the wind turbines; one worker inside the outpost was coordinating all of them at once. Marshall saw his communicator light up with an urgent news item. He pushed an icon on the screen, read the item, and smiled. "Mars is going to Neptune late next year."

"Really?"

"I heard about the possibility a week ago. The Chinese redirected their planned Saturn expedition to go to Neptune instead, to claim the system for themselves, so they could have control over a source of Helium-3. Mars found out. They've decided to launch a much faster expedition to the system instead, to get there first."

"Will they beat the Chinese?"

"Definitely, and they're launching a bigger expedition. The Chinese won't be happy, but maybe they'll agree to a compromise of some sort. We want space to be a place of cooperation. I suspect, after this, they'll agree."

"Why?"

"Because Neptune is the last unclaimed source of Helium-3, and that's the big resource everyone wants. It's probably the last great space race."

"Really? Wow!"

"Well, now that I think about it more, I suppose there will always be space races," said Marshall.

Plot Summary

June 2078: Second anniversary for Esther and Wicahpi-Luta

April 2079: Two caravels leave Earth for Ceres with 300 on board; arrive October

May 2079: Titan-1 starts to rotate; von Braun re-outfitted for space flight

June 28, 2079: Saturn-4 arrives at Saturn; Ceres completes Carrier-100-1 for Swift, launches it to Earth with 90,000 tonnes LOX/LH2; arrives June 2080

Oct. 2079: Charlie and Sirikit's baby born; Willie goes outside for first time; 300 reach Ceres

Jan/Feb 2080: Phobos-2 pressurized and spun; Phobos 1 set up for move-in

Fall/Late 2080: Carrier-100-2 departs Ceres for Phobos, then Venus in the spring of 2081, arriving late 2081. Venus gets home rule, early 2082, with 600 people (300 arrive on Carrier-100-2 from Phobos)

Summer (late?) 2081: Carrier-100-3 departs for Earth with 400,000 tonnes of water (or liquid hydrogen?; goal: 50,000 tonnes/yr by 2081); arrives early 2083

2082: Lunar mass driver completed

Mar.-June 2078: 9,000 leave Earth for Mars (opposition, April 27) (pop. 33,000)

May 2078: *Barnard* returns to Mars

Late? 2078: Cassini-Dawes metal road completed

Summer 2078: metal road completed Meridiani-Thymiamata-Kalgoorlie

Aug. 2078: Venus gets third asteroid

Late summer 2078: Carrier 1 turntable, pressure envelope completed

Dec.? 2078: Carrier 1 finished enough for Cererian population to start moving in.

March 2080: launch window, Mars to Jupiter (and on to Saturn and Uranus)

Some time in 2080: Metal highway and pipeline will stretch, Uzboi to Cassini

Opposition 21: April 27, 2078

Autumnal Equinox: July 29, 2078

Dust Storm Season begins: Sept. 20, 2078

Dust Storm Season ends: Feb. 15, 2079

Vernal Equinox: May 30, 2079

June 20, 2079: Earth and Ceres at opposition

Autumnal Equinox: June 15, 2080

Opposition 22: June 16, 2080

Dust Storm Season begins: Aug. 7, 2080

Sept. 30, 2080: Earth and Ceres at opposition

Dust Storm Season ends: Jan. 2, 2081

Mars-Ceres opposition: 2081.031 = Jan. 11, 2081

Vernal Equinox: April 16, 2081

Autumnal Equinox: May 3, 2082

Dust Storm Season begins: June 24, 2082

Opposition 23: Sept. 1, 2082

Dust Storm Season ends: Nov. 19, 2082

Vernal Equinox: Mar. 4, 2083

Autumnal Equinox: Mar. 20, 2084

Mars-Ceres opposition: 2084.209 = March 17, 2084

Dust Storm Season begins: May 11, 2084

Dust Storm Season ends: Oct. 6, 2084

Opposition 24: Nov. 10, 2084

Vernal Equinox: Jan. 19, 2085

Autumnal Equinox: Feb. 6, 2086

Dust Storm Season begins: March 28, 2086

Dust Storm Season ends: Aug. 23, 2086

Vernal Equinox: Dec. 7, 2086

Opposition 25: Dec. 7, 2086

Mars-Ceres opposition: May 31, 2087

Autumnal Equinox: Dec. 24, 2087

Dust Storm Season begins: Feb. 15, 2088

Dust Storm Season ends: July 10, 2088

Vernal Equinox: Oct. 24, 2088

Opposition 26: Jan. 31, 2089

Autumnal Equinox: Nov. 10, 2089

Dust Storm Season begins: Jan. 1, 2090

Dust Storm Season ends: May 27, 2090

Vernal Equinox: Sept. 11, 2090

Opposition 27: March 6, 2091

Autumnal Equinox: Sept. 28, 2091

Dust Storm Season begins: Dec. 19, 2091

Dust Storm Season ends: May 14, 2092

Vernal Equinox: July 29, 2092

Opposition 28: April 11, 2093

Autumnal Equinox: Aug. 15, 2093

Dust Storm Season begins: Oct. 6, 2093

Dust Storm Season ends: Feb. 28, 2094

Vernal Equinox: June 16, 2094

Opposition 29: May 26, 2095

Autumnal Equinox: July 3, 2095

Dust Storm Season begins: Aug. 25, 2095

Dust Storm Season ends: Jan. 20, 2096

Vernal Equinox: May 3, 2096

Autumnal Equinox: May 20, 2097

Dust Storm Season begins: July 11, 2097

Opposition 30: July 31, 2097

Dust Storm Season ends: Dec. 5, 2097

Vernal Equinox: Mar. 21, 2098

Autumnal Equinox: Apr. 7, 2099

Dust Storm Season begins: May 29, 2099

Opposition 31: Oct. 18, 2099

Dust Storm Season ends: Oct. 23, 2099

Vernal Equinox: Feb. 6, 2100

Autumnal Equinox: Feb. 23, 2101

Dust Storm Season begins: Apr. 14, 2101

Dust Storm Season ends: Sept. 9, 2101

Titan northern spring equinox: Aug. 11, 2009; (+29 yr 5 mo 17 days); Jan. 28, 2039; July 14, 2068; Dec. 31, 2097. Northern summer solstice is late Feb. 2077

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