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Reader's Department: **EDITORIAL: SIGNS OF RESPECT** by Stanley Schmidt

In an earlier editorial ("The Great Rush Forward," November 2008) I commented on the phenomenon of "phantom tyrants." These are impersonal forces that presumably originate with identifiable actions by individual people but then take on a life of their own and continue to dictate people's behavior whether or not any individual would independently choose them. We commonly know them by such names as "custom" or "fashion," depending on how long they've been around and how strictly people are expected to follow them. "Fashions" are relatively recent, considered likely to change, and relatively optional. Many people consider it "cool" to follow them, but few will feel you should be punished if you don't. Customs are more solidly entrenched and often taken more seriously. If you don't follow them, you're quite likely to be reprimanded or punished if you're a child, and shunned as a boor if you're an adult.

As an example, I mentioned the expectation that male members of our society will remove hats when entering a building. Some of my teachers (and even teachers who weren't mine but whom I inevitably passed on the way to the school bus) were quite insistent on this; they offered no reason for it, and to me it seemed completely arbitrary, pointless, and sexist. In later years I was told that it was a sign of respect, though those who told me that were singularly vague about where that respect (or disrespect shown by noncompliance) was directed. I eventually figured out that it was something that everybody did (or expected others to do) simply because they had a vague belief that everybody else expected it.

This still seems to me a remarkably strange phenomenon in a society that prides itself on democracy—government by people voting for their leaders and the rules they will follow. In an election, it's clear how that principle works: a question is posed, each citizen (or legislator) voices his or her opinion about it, and the choice with the most votes wins. In the "hat question," nobody ever asked anyone of my acquaintance what rule (if any) they thought should be followed, and I suspect that very few had ever thought about it and come up with a reason why it made any difference. That's why I coined the term "phantom tyrant": we were all slavishly following the dictates not of an individual dictator, not of a majority of voters who had expressed their opinions, but of an alleged consensus of people, none of whom might actually hold the "consensus" view if asked.

When I mentioned these musings here, several readers helpfully volunteered answers to "the hat question," ranging from some long-ago queen demanding that those of lower rank bare their heads in her presence to show deference, to medieval knights raising their visors to show that they were "off duty" and not about to instigate mortal combat. Any one (or perhaps more) of these might actually be at least a partial explanation of how the custom began, but none of them answers the question I posed, which was, "Why does an individual man or boy now remove his hat inside?" That question is only Part 1 of two, and its answer is, "Because the phantom tyrant tells him to, and he feels compelled to obey." Part 2, the one my correspondents tried to answer, is, "Why does the phantom tyrant tell him to?" Surely no one now ever thinks, "I'm going to take my hat off because some long-ago, faraway queen demanded it or because some long-ago, faraway knight lifted his visor." There's simply no logical connection between those two events unless something else bridges the gap between them. That something is the creation of the phantom tyrant (and the belief that it must be obeyed).

So the more interesting questions for present purposes are: how do such things come to be, why do people feel compelled to follow them, and to what extent do they actually show respect? An arbitrary action like doffing a hat, raising a stiff arm, or addressing someone by title rather than name shows genuine respect if and only if everybody involved agrees that it does—and even then, only if it's voluntary.

A "sign of respect" that people are forced to make shows nothing at all about real respect. Real respect can be easily and clearly shown without such artifices, by such simple means as considerate treatment,

attentive listening, careful consideration of what another person says, voluntarily doing things for them, and expressing sincere appreciation for things they do. A compulsory "sign of respect" may in fact express nothing more than a desire to avoid ostracism or punishment. It may show respect, but it can just as easily mask anything from indifference to outright contempt, while ostensibly showing the opposite.

Which makes it completely useless as an indicator of real respect.

So do such things have any positive value or serve any useful purpose? Actually, they can. Oddly enough, one of the clearest examples can be found in an area where the rules are much more rigorously defined and the consequences of failure to play the game are much more severe than being considered ill-mannered. In military organizations, ironclad rules spell out quite specifically who must show (or feign) respect to whom, and in precisely what manner. I was once struck by the presumably unintentional irony in a military training manual that devoted several paragraphs to the particulars of saluting. Among other things, it said that a noncom's saluting an officer, or an officer's returning the salute, was just like greeting a friend. How, I wondered, could the author so glibly gloss over the obvious (and huge) differences? As civilians, we decide (mutually) who our friends are, and whether and how to greet them. As soldiers or sailors, we are told by our "superiors" who must salute whom, and how, and we forget it or exercise our own opinions at our own peril. If we don't salute somebody we should, or salute somebody we shouldn't, that's a punishable offense, and it will be punished.

To somebody who's not into that sort of thing, such ritualized behavior is likely to seem silly, if not offensive—especially in a peaceful situation. But eventually, grudgingly, I came to see that it does serve a purpose. Peaceful situations are not what armies, navies, police forces, and fire departments are for. They come into their own under conditions of life-or-death emergency, when many people have to act in a concerted way and few of them have the luxury of mulling their options or seeing how their personal actions fit into the big picture. Under those conditions, like it or not, somebody has to coordinate things, figure out what other individuals need to do, issue orders, and expect those orders to be carried out. That will only happen if those under the leader's command respect him or her—or act as if they did.

All the rituals, the forced shows of respect, are ways of making sure people at least act as if they respect those whom they must follow, even if they don't. That's important because not everyone has the knack of commanding genuine respect—so everyone is provided with tools for at least creating a serviceable substitute. And those tools are exercised even under tranquil conditions, when they're not really necessary, so they'll be sharpened and ready when they're really needed.

There is an implicit danger, of course. A means anybody can use to force the appearance of respect, even if they can't earn the real thing, may reduce the incentive to *try* to earn the real thing. So safeguards are needed to protect against that. And I hope most of us would agree that ordinary civilian life should not too closely resemble military discipline. But even there, most cultures probably need at least some rituals to enforce a semblance of respect and courtesy, because even there not everybody can earn or practice the real thing—though it's still worthwhile to try.

Some cultures could probably use fewer than they have, and others could use more. And as a science fiction writer and editor I'm tempted to wonder: Could a civilization develop in a species without the tendency to create and obey these shadowy forces that dictate the semblance of respect for others, whether or not the real thing is there? If so, what form might such a civilization take? n

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Reader's Department: **BIOLOG: CRAIG DELANCEY** by Richard A. Lovettt

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Many writers struggle with career choices, bouncing from one field to another. Not Craig DeLancey. “Since I was 15 I knew exactly what I wanted to do with my life,” he says. “I wanted to be a philosopher and science fiction novelist."

The academic goal came first. Other than a brief interlude in the computer industry during the dotcom boom, DeLancey went from a Ph.D. in philosophy and cognitive science to a position as a professor at the State University of New York at Oswego. And with a dozen stories now in print and a novel in circulation, he's also well on the way to the latter goal, not to mention becoming an award-winning playwright on the side, with two plays in performance and two more in staged readings in 2008 alone.

Selling to *Analog* was always part of the dream. “Most people who know me think of my science fiction as sociological,” he says. “Publishing in *Analog* makes me feel that I can claim hard-science-fiction credibility."

Academically, he says, “I'm what philosophers call a philosopher of mind.” Translation: he studies emotion, artificial intelligence, and consciousness, though he's also done a smattering of behavioral economics and evolutionary game theory.

Writing and philosophy are a good mix, he says. “Philosophy's a very good source of ideas,” he says. For example, his second *Analog* story “Amor Vincit Omnia” (April 2008) involved people who'd been genetically engineered to care more strongly than usual about the future.

"I'd been doing research on the relationship between emotion and rationality,” he says. “There are people with emotional deficits. They can tell you ‘Here's what you should do,’ and then they won't do it themselves. That led me to wonder [if] perhaps this is a matter of degree. Maybe to somebody else, we would be like that. You're always grappling with huge questions in philosophy. It's very inspiring to turn them around into, ‘What if?’”

Of course, a good story is more than simply a question. “I hope, first of all, to entertain,” he says. “[But] science fiction has its own special purview, the sense of wonder. I think a great science fiction story, in addition to being entertaining, would instill a sense of wonder because that's [also] a good thing: it inspires us and motivates us."

There's a third element, though, to the best stories, he says, an element that separates them from academia.

"Science fiction and other kinds of literature get to stuff you can't say in theory: the irreducible complexities of what it's like to confront this in your own particular life. You need the whole story to do it, to say what would it be like to live through this."

Not that he thinks the things our descendents will need to live through are bleak. “I think the future is still really bright,” he says. “We're all disappointed we don't have our jet packs, but I think there are still a lot of reasons to be optimistic and feel awe for what's in front of us."

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Novelette: **BUT IS DOES MOVE** by Harry Turtledove

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Illustrated by William Warren

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Hardware technologies are not the only innovations that could have had profound effects if introduced before their time....

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Spring in Rome. Mild, mostly sunny days. Pretty women's smiles, as bright as the Sun. Plants putting forth new leaves—a green almost painfully beautiful. A torrent of birdsong. Music in the air along with the birdsong. Monuments of mellowed marble, some close to 2,000 years old.

What heart could know such marvels without rejoicing?

Galileo Galilei's heart had no trouble at all.

With all that heart, Galileo wished he were back in Florence, where he belonged. Was the Sun less brilliant there? Were the pretty women's smiles? Did the birds not sing there? Had they no musicians, no monuments? Of course not!

Had they no Holy Inquisition in Florence? They did—they did indeed. But Pope Urban VIII was not convinced it had done all it should concerning Galileo. And so the astronomer had been summoned to Rome for interrogation, like any common criminal.

Muttering to himself, Galileo shook his head. Summoned like a criminal? Yes. Like a common criminal? No. The Inquisition didn't bother with common criminals. He wished with all his heart that it hadn't bothered with him.

When the summons came, he pleaded age. Was he not sixty-eight? Travel truly wasn't easy for him any more. He'd pleaded ill health. He was not a well man; who approaching his threescore and ten was what he had been earlier in life? Three learned Florentine physicians attested to his infirmities. There was plague in Florence. He would have had to spend time in quarantine before being suffered to enter the Papal States.

Did the Inquisition care about any of that? Galileo did some more muttering. As well expect Michelangelo's David to weep as the Inquisition to care!

And bending Galileo to its will—showing that it had both the power and the right to bend him to its will—was part of his punishment. Worse would have befallen him had he refused the summons. He'd really thought he could get away with the *Dialogue Concerning the Two Chief World Systems*. He'd published it to much acclaim the summer before. But the Inquisition's summons to Rome was acclaim he would gladly have done without.

Here he was, though, like it or not. He'd lodged with Francesco Niccolini, the Tuscan ambassador, from the middle of February to the second week of April. That wasn't ... so bad. But then the Inquisition decided he'd cooled his heels long enough. It ordered him to the palace that served as its headquarters and began to question him.

Even now, things could have been worse. He understood that, and thanked God they weren't. The Inquisition housed him in the quarters usually used by a prosecutor, not in the cells where they kept most prisoners. He could stroll around the courtyard if he liked. When the inquisitors questioned him, they

used only words—they didn't put him to *the* question. All the same, they had the authority to torture him if they chose to, and the threat that they might hung in the air.

So yes, things could have been worse. But they also could have been better. He could have been free, for instance. This was what he got for trying to understand how the natural world worked?

Yes. This was what he got.

* * * *

Sparrows hopped and fluttered in the courtyard. They hopped up to Galileo instead of fluttering away. People here fed them. They didn't net them and pluck them and bake them in pies. Galileo was fond of songbirds in pies, but he was also fond of the living birds. He ground a chunk of stale bread between his palms and scattered crumbs on the grass.

Chirping excitedly, the sparrows fell on the feast. More little birds hurried toward Galileo. He smiled thinly. Beggars were all the same, whether they wore feathers or ragged cloaks. If you gave to a few, they expected you to give to everyone.

He spread his hands, empty now. “Sorry, *amici*. That was all I had."

The birds flew away. But that wasn't because they understood what he said. Another man was approaching, and his red, flapping cardinal's robes had to be what made the birds take flight.

Nodding to Galileo, the newcomer said, “You are *Signor* Galilei, is it not so?"

"Yes, your Eminence.” Galileo bent to kiss the cleric's ring. “Please forgive me, sir, but I fear you have the advantage of me.” Whoever this fellow was, he wasn't one of the ten cardinals who'd been grilling him.

"No reason for you to know me.” The churchman smiled. He was about Galileo's age. He had a long face and clever, melancholy eyes; he wore a neat white mustache and chin beard. His Italian, while accurate, was slow and gutturally accented. When he went on, he explained that: “My name is Sigismondo Gioioso—I translate the surname into your tongue. His Holiness the Pope summoned me from Vienna to help in the investigation of your case and in determining what should result from it."

"He did?” Galileo could have done without the honor, if that was what it was. “You have come a long way, your Eminence. Certainly my insignificant self is not worth such a journey.” Galileo was anything but the most modest of men. But he did not want this scholarly cleric from beyond the Alps focusing attention on him like a convex lens focusing sunlight.

"Oh, but I believe you are, *Signor* Galilei,” Cardinal Gioioso said. “Not only for the beliefs you hold, but also for the reasons you have for holding them."

"I hold no beliefs contrary to those accepted as true by the holy Catholic Church,” Galileo said quickly. He had to say such things. He might be an old man, but he didn't want to die just yet, or to spend the rest of his days in some bleak and sordid prison cell, locked away not only from life but also from all possibilities of further research. No, he didn't want that one bit!

Sigismondo Gioioso smiled at him. “I have read the *Dialogue Concerning the Two Chief World Systems* with great interest and attentiveness. You are a fine writer, *Signor*—a fine writer indeed."

"You do me too much honor, your Eminence,” Galileo mumbled.

"Do I? I think not,” Gioioso replied. “And your support for the Copernican hypothesis therein is

eloquent, truly eloquent. Salviati has much the better of the argument with Simplicio, who follows the long-accepted Ptolemaic view. Even the name you gave Simplicio suggests that you are unlikely to agree with the ideas he expresses."

Not for the first time lately, Galileo wished he'd called Simplicio something—anything—else. “I fear I was trying to be too clever when I wrote,” he said. “Now that I look back on the book, I see I should have done a better job of balancing the arguments on both sides. I took a contrarian view, trying to make the worse case appear the better."

"That is what Aristophanes accused Socrates of doing,” Cardinal Gioioso said. “But Socrates did not accuse himself of the same thing."

"No doubt you are right,” said Galileo, who cared much less about Aristophanes’ views than about those of Aristotle—which, along with Ptolemy's, had become part of the Church's doctrinal underpinnings. The astronomer hurried on: “I hope you also noted that I clearly stated in the dialogue's conclusion that it was impossible, based on what we currently know, to choose between the two competing world systems."

"I most assuredly did note that, yes,” Sigismondo Gioioso said. Galileo winced in spite of himself. He'd never heard such devastating agreement in all his born days. The cardinal from Vienna continued, “An attentive reader might at that point be forgiven for doubting your complete sincerity."

"Do you think so, your Eminence?” Galileo exclaimed, as if the idea had never before occurred to him. As if? If only!

"Well, yes, I am afraid I do, actually,” Gioioso answered. He didn't quite sound like a judge passing sentence—no, not quite. But then, instead of leaping on Galileo like a fierce dog, he shifted his ground: “What truly interests me, though, is how and why you have come to hold your, ah, interesting beliefs."

"Please, sir, these are the beliefs set forth in the *Dialogue*,” Galileo said. “They are not mine. Of necessity, they cannot be mine, for they contradict those held by the Church, of which I am, and am proud to be, a loyal son."

"Of course,” Cardinal Gioioso said—another agreement that undermined everything it claimed to agree with. “Would you be willing to talk with me about how you came to espouse these beliefs so strongly, even though you do not hold to them? As I say, that is what truly intrigues me."

"Talk with you?” Galileo asked cautiously. Sometimes the word meant what it said, no more and no less. Sometimes it was a euphemism for all the ingenuities the Inquisition could inflict on a man. Galileo didn't *think* Gioioso meant it that way ... but it wouldn't do to find himself mistaken.

"Talk. That's all.” By the cardinal's reassuring tone—and by his slightly crooked smile—he knew what Galileo feared. Well, how could he not? These were nervous times for the Catholic Church. Copernicanism wasn't the only threat it faced. Lutheranism and Calvinism also tore at its vitals. Threatened by such a vast radical conspiracy, how could the Church be anything but vigilant in its struggle against misbelievers of all stripes?

It couldn't—not if you asked any good and pious churchman.

"Talk?” Galileo asked again.

"Talk,” Sigismondo Gioioso said firmly. “May God be my witness, *Signor*—nothing more.” He crossed himself to seal the vow.

"Well, then, your Eminence, I am at your service.” Galileo would have been at the cardinal's service in

any case. But sometimes even the illusion of free will was pleasant.

* * * *

Cardinal Gioioso's room was no larger, no finer, than the one the Inquisition had granted to Galileo. The astronomer reminded himself once more how lucky he was to have the quarters he enjoyed, not the dark, dank ones so many prisoners of the Inquisition failed to enjoy. Luck, of course, was relative; he could have been back in Florence, doing what he wanted.

"So good of you to join me, *Signor*," the cardinal said, as if Galileo's arrival were altogether unconstrained. "Will you take some wine with me? And these little cakes are very tasty. They tempt me into the sin of gluttony—indeed they do."

"*Grazie*, your Eminence," Galileo said. The cakes, rich with almond paste and honey, were as good as Cardinal Gioioso claimed. And the wine was sweet and strong. Galileo wagged a finger at the prelate. "I think you are trying to make me drunk."

"*In vino veritas*? Is that what you think I am after?" Gioioso asked.

"Truthfully, sir, I do not know what you are after," Galileo replied. Not knowing worried him. With the ten cardinals of the Inquisition who had interrogated him before, he knew exactly what they wanted: an abjuration from him. He was willing to give them one. A man had to live. And, abjuration or not, thanks to the printing press too many copies of the *Dialogue* were out there for the Church to hope to suppress it. His ideas would live, even if his work ended up in the Index of Prohibited Books.

"It is as I told you before," Sigismondo Gioioso said. "I wish to discuss with you, not so much your beliefs, but your reasons for holding them."

"I am in your hands," Galileo said. "What you want strikes me as curious, but I find myself in no position to complain."

"Which is to say, if the Holy Inquisition had not summoned you to Rome, you would sooner see me damned than give me the time of day," Gioioso observed. In a different tone of voice, words like those might have meant torture or death or torture and then death. The cardinal from Vienna sounded world-weary and amused, not hot to suppress heresy. He sounded like that, yes. Whether how he sounded had anything to do with how he felt, Galileo did not know him well enough to guess.

That being so, the astronomer hastened to point out the obvious: "You said this, your Eminence, not I."

"As Matthew tells us our Lord responded to Pontius Pilate," Cardinal Gioioso said.

"I am not our Lord, sir. Neither are you a Roman governor," Galileo said earnestly. "And so I entreat you—please do not twist my words or my meaning."

"I am not trying to put you in fear, *Signor*," Gioioso said. Trying or not, he was doing a good job. Maybe he wouldn't have, had Galileo and he met as man and man. Meeting as man and servant of the Inquisition ... The cardinal, plainly a clever man, must have realized the difficulty. Doing his best to put Galileo at ease, he waved to a couch against the far wall of his room. "As I promised before, no harm will come to you from this. Sit down, please. Make yourself comfortable. Lie down, if you would rather."

Galileo did lie down—the couch had no back, and he didn't feel like leaning against the painted plaster of the wall. Cardinal Gioioso dragged a chair over alongside the couch so they could talk conveniently. Then, instead of sitting down, he poured himself another cup of wine. When he raised a questioning eyebrow, Galileo nodded.

"I thank you," Galileo said after Gioioso gave him the fresh cup. "How many ordinary men can boast they have had a cardinal pour wine for them with his own hands?"

"Whatever else you may be, you are not an ordinary man," Sigismondo Gioioso said.

Galileo waved that aside. "You know what I mean. How many secular men, I should say, can make that boast?"

"*Not* an ordinary man," Gioioso repeated, as if the astronomer hadn't spoken. "And part of what interests me is how you became so *extra*ordinary. Tell me of your parents. Tell me of the family in which you grew up." He steepled his fingertips, visibly composing himself to listen and to absorb whatever Galileo said.

"I am the eldest of seven—I had two brothers and four sisters, though not all, sadly, remain among the living," Galileo answered. "My father, God rest his soul, was among the best lutanists of his generation. He wrote on both the theory and the practice of music, and also on mathematics."

"So you sought to follow in his footsteps? To outdo him if you could?" Gioioso asked.

"Actually, your Eminence, when I was young I thought of joining the priesthood, but my father had other plans for me. He hoped I would become a doctor. I was something of a musician in those days myself, but my father made it plain to me keeping afloat at that trade was far from easy," Galileo said.

"You would have ornamented the field of medicine. And you would assuredly have ornamented our holy Catholic Church," Cardinal Gioioso said.

"I also thought of becoming a painter," Galileo remarked.

"You were a butterfly," Gioioso remarked.

"I was," Galileo agreed, "until I chanced to light on mathematics myself. I had just begun at the University of Pisa, and after that I knew what I wanted to do with my life. No—I knew what I had to do."

"Your father had written on mathematics."

"*Si*."

"But he did not want you following in his footsteps?"

"Not one bit, your Eminence."

"Why not? Did you not resent him for trying to keep you away from something you proved to love?"

"He told me a musician would always have trouble getting enough to eat, but a mathematician was sure to starve. How can you be angry at a man who wants you to have more food on your table than he had on his?"

"Believe me, *Signor*, a great many men would find it the easiest thing in the world," Sigismondo Gioioso said.

"I hope I am not so dead to honor and respect as to become one of them," Galileo said.

"Yes—one always hopes," Gioioso said enigmatically.

"What do you mean, your Eminence?"

Instead of answering, the cardinal said, “I notice you have told me next to nothing of your mother."

Galileo scratched his head. “What is there to say? She bore me. She raised me. She loved me. She put up with me—and I have always been a man who is not so easy to put up with.” He smiled; a sort of somber pride filled his voice. “I wish it were not so—it will cost me time in Purgatory if it does not send me to a warmer place yet. And you may be sure that I pray for her soul as I pray for my father's. May they both have found places in heaven.” He crossed himself.

"Yes. May it be so,” Gioioso said—more for politeness’ sake, Galileo judged, than from any great sincerity. The prelate stroked his beard. “Now tell me, *Signor*, if you would be so kind ... did you ever have moments in your childhood when you wished your mother gave you a larger share of her affection?"

"Did I what?” This time, Galileo laughed out loud. “How could I not? I told you, I had two brothers and four sisters. My mother was a busy woman—too busy, sometimes, for me."

"Indeed.” Galileo thought his words ordinary and commonplace, but Sigismondo Gioioso seemed to invest them with a special significance. “And your father—did you ever wish he were out of the way so your mother would be able to give you more love, more affection?"

"We banged heads every so often, my father and I,” Galileo admitted. “What boy coming to manhood does not bang heads with his father? When you are young, you are sure you already know it all. And when you are a father, you know better, and you are sure your son is a stupid blockhead who will never learn anything. Was it not so with you, your Eminence?"

Cardinal Gioioso's mouth bent—barely—into a thin smile. “Oh, it might have been,” he said. “But we were speaking of you. And I was not thinking so much of the time when your beard sprouted. I had in mind your younger days—much younger. Was there not a time when you wished your father would disappear so you could have your mother all to yourself?"

Galileo scratched his cheek as he frowned in thought. “If there ever was, your Eminence, I must confess that I do not recall it."

"Don't worry about that,” the cardinal said in reassuring tones. “I have questioned a large number of men about these matters. Very few remember them ... at first. If you permit it, we shall have more discussions in times to come."

"If *I* permit it?” Galileo raised a grizzled eyebrow. “I am in the hands of the Holy Inquisition. How can I say no?” He knew what happened to people who resisted the Inquisition and its ministrations. He didn't want anything like that happening to him.

But Gioioso answered, “If we are to go forward, I require cooperation that springs from your own free will. Force and coercion have no place here. I meant it when I said no harm would come to you. You may converse with me or not, as you please."

He sounded sincere. Galileo, like any man who'd lived as long as he had, had met plenty of people who seemed sincere and proved to be anything but. Was this cardinal from beyond the Alps another one? Even if he was, the Inquisition couldn't do anything else to Galileo while the prelate talked with him.

The calculation required no more than a heartbeat. “Of course I am at your service, your Eminence,” Galileo said.

"Excellent!” Cardinal Gioioso's smile could be surprisingly warm. “We shall continue, then—at your convenience, of course."

"Of course," Galileo said. He understood full well that *at your convenience*, here as so often, meant *at my convenience*. Life might have grown difficult had he not grasped that. Since he did, it wouldn't—not that way, anyhow.

* * * *

He soon found that the cardinal was an indefatigable questioner. Under such patient, persistent prodding, he dredged up more recollections of his very early life than he'd ever imagined he could. "May I ask you a question for a change, your Eminence?" he said after a while.

"Certainly." Gioioso's manner was placid.

"Why do you want to know so much about the time before I lost my milk teeth?"

"When you look at a building, at how it is made, at how the upper stories rise up, what do you do first?" Gioioso said. "You look at the foundations. From what is below, you can see how what is above has arisen."

"But many different buildings may be raised from the same kind of foundation," Galileo objected.

"True. But when we see a building of such-and-such a type, we may deduce that it should have had this kind of foundation, and could not possibly have been built up from that one," the cardinal said. "Your early dealings with your mother and father helped put you on the course you took to manhood. Had they been different, you would be different today. Or does it seem otherwise to you?"

Galileo wagged a finger at him. "I may have written a dialogue, but you have also read your Plato, your Eminence. And here I think you enjoy playing Socrates yourself."

"If I do, then I suffer from the sin of pride, and I shall have to do penance for it when I make my next confession," Gioioso said. "Any man who dares compare himself to Socrates surely labors under a delusion."

"I think so, too," Galileo said. "Time and again I would notice how much windier than Plato's my characters seemed. But I did not see what else I could do, if I was to put across the ideas I wanted the world to see."

"Since you mention your clever dialogue—and it is very clever indeed, *Signor*, as I have said before—let me ask you something not so firmly rooted in your early years," Sigismondo Gioioso said.

"I am your servant," Galileo said, hope and apprehension warring within him.

"You—you of all people—are no man's servant," Cardinal Gioioso said.

Galileo only shrugged, which was awkward and uncomfortable on the couch. "I am vehemently suspected of heresy," he said. Suspicion of heresy was in itself a crime; vehement suspicion was a higher grade of the same offense. That being so... "I am of course a servant of the Holy Inquisition, and of the holy Catholic Church."

"Every man is, or ought to be, a servant of the Church," Gioioso said. "But the Church is not a man, nor is the Inquisition. The Church is a building put together over centuries, and the Inquisition its fire-watch."

"I cannot quarrel with you, your Eminence, nor would I if I could." Galileo was already in plenty of trouble. He didn't need or want more.

"I quite understand," Gioioso said, which meant ... what, exactly? Before Galileo could decide, the

cardinal asked, “How is it that you became such a strong supporter of the Copernican hypothesis?"

That was a question Galileo would rather not have heard. It had a number of possible answers, all of them dangerous. Some, though, were more dangerous than others. Galileo chose the safest one he could, the one he'd used all along to defend himself from the charges against him: “In 1616, Cardinal Bellarmine notified me that the Copernican doctrine was contrary to the Bible and could not be defended or held. I accepted that then, and I accept it still."

"Your dialogue gives me cause to wonder at the truth of that,” Gioioso said.

"I am sorry that it should,” Galileo said, which was true, even if perhaps not altogether in the sense in which he wanted Gioioso to take it. “Nothing in the holy cardinal's injunction ordered me not to discuss the Copernican doctrine hypothetically, which is all I was doing in the book. And I do not claim it is true. In the end, I declare that it is impossible to know whether the Copernican or the Ptolemaic doctrine is true."

"So you do. Yet you show a greater zeal for the former,” Cardinal Gioioso said, as he had when they first met.

"I am sorry for that, too,” Galileo exclaimed, and, again, he meant it in more than one way.

The cardinal steepled his fingers again. “May we say that you hold a ... hypothetical affection for Copernicanism?"

"As much as the Church permits,” Galileo said. “Not a feather's weight more."

"All right.” He won another of the prelate's small but warm smiles. “Splendid. Very well. Shall we stipulate that for the purposes of discussion?"

"Meaning what, your Eminence?” Galileo asked cautiously. A vulgar phrase occurred to him—he wasn't about to buy a pig in a poke.

Nor did Sigismondo Gioioso seem interested in selling him one. “Meaning that I will take whatever you say in defense of the Copernican heresy to be hypothetical only. I will not claim that you espouse it."

"If you will be gracious enough to put your promise in writing, so that in case of need I may show it to another gentleman from the Holy Inquisition, I am your man,” Galileo said. If that didn't show him whether Gioioso was serious, nothing ever would.

The cardinal didn't bat an eye. “Just as you please, *Signor*. Please wait a moment while I get paper and pen.” Gioioso was gone no longer than he'd said he would be. “My written Italian, I fear, is not all it might be. Do you mind if the pledge is in Latin?"

"Not at all. Anyone in the civilized world will be able to read it then,” Galileo said. After a moment, he politely added, “You speak my language well."

"*Grazie*. I manage, but you give me too much credit.” Cardinal Gioioso signed his name with a flourish, then waited for the ink to dry before handing Galileo the paper. “I trust this will prove satisfactory?"

Galileo put on spectacles to read it, as Gioioso had used them to write it. Age had lengthened both men's sight. Grinding good spectacle lenses was a long step toward grinding good spyglass lenses. But that thought slipped from Galileo's mind as he read the churchman's promise. Gioioso might not trust his written Italian, but his Latin was elegant—almost Ciceronian. That surprised Galileo not at all. The astronomer nodded. “Oh, yes. Everything you said it would be. May I keep it?"

"Why else would I have written it? It is your shield—nothing you say here today will be used against you." Cardinal Gioioso leaned forward a little in his chair—he reminded Galileo of a hunting hound taking a scent. The image worried Galileo, but no help for it now. The cardinal said, "Let us begin, then. Why *do* you find yourself so attracted to Copernicanism ... in a hypothetical way, naturally?"

"Naturally," Galileo agreed, his voice dry. "Because—in a hypothetical way, again—it does a better job of predicting the phenomena we actually observe in the sky than the Ptolemaic hypothesis does."

"I see," Gioioso said. "And why is this so important to you?"

"Because it gives me a better, a deeper, understanding of the way the universe works." Galileo hesitated, then recast that so even a cleric could not fail to grasp it: "Of the way God's creation works."

"Is this not the sin of pride—presuming to understand how God does what he does?" Gioioso asked.

Galileo muttered to himself. He might have known a priest—and a priest who belonged to the Holy Inquisition, at that—would see things so. He tried again: "The more I learn, the better I can praise and glorify Him."

"So you believe that accurate knowledge is required for God to hear and accept one's prayers?" the cardinal said.

There was a snare! Galileo was canny enough to spot it. Was he canny enough to evade it? Picking his words with great care, he replied, "Why would God have arranged things as He did, and why would He have made men as He did, if he did not expect them to try to learn all they could of His creation?"

"Why? I have no idea why," Sigismondo Gioioso said calmly. "Will you tell me you know *why* God chose the Copernican world system—if He did so choose—and not the Ptolemaic? Will you say He could not as easily have chosen the other one?"

That was a trap, too, but a less dangerous one. "God might have done anything He chose to do. Not even a Protestant heretic would claim otherwise," Galileo said. *So there*, he thought. "I do not know why the evidence seems to me to show He chose the Copernican way of shaping the universe. I only know that it seems to show He did."

"Can you give me some examples of how this seems to be so?" Gioioso asked.

"Well, your Eminence, to begin with, the Copernican hypothesis more accurately predicts the positions of the planets against the starry backdrop of the heavens," Galileo said.

"By how much?" the cardinal enquired.

"Oh, by a very large margin!" Galileo said. "Sometimes by as much as half a degree."

"Which is how much in layman's terms?" Gioioso asked, adding, "I have tried to learn what I could of your art, but I am no astronomer."

How much more than he admitted did he really know? A lot, or Galileo missed his guess. He answered with the truth: "Why, the diameter of the Sun, or of the full Moon."

"I see." By the way Cardinal Gioioso nodded, Galileo judged he wasn't hearing this for the first time. He asked, "And how much earlier or later does this make the heavenly bodies rise and set than they would have under the old calculations? Half an hour? An hour? More?"

"No, your Eminence," Galileo said. "It is not such a large error as that, or the Ptolemaic world system would never have become part of the doctrine of the Catholic Church to begin with. As I noted in my own copy of the *Dialogue*, the Church endangers itself when it declares heretical a view that may one day be proved true by logic or by physical means."

"Well, how large an error *are* we speaking of, *Signor*? You have yet to tell me," Gioioso said.

"It is a matter of up to two minutes," Galileo replied, again giving information he was pretty sure the other man already had.

If Sigismondo Gioioso did have it, he concealed that most artfully. "Two minutes?" he exclaimed, making the sign of the cross. "By the blessed Virgin Mother of God, is that all?"

"It may not seem like much, your Eminence, but it is an error easily detected by good instruments and good clocks, both of which grow ever easier to come by these days," Galileo said stubbornly.

The cardinal might as well not have heard him. "Two minutes!" Gioioso repeated. "For the sake of two minutes—for the sake of two minutes *at the most*, you said—you and Copernicus propose setting Christendom on its ear?"

"All Copernicus tried to do was find a better way to conceive of the workings of the heavens," Galileo said. "All I tried to do in my *Dialogue* was to give the evidence for and against his views. We never wished to oppose the holy Catholic Church. Rather, the Church has chosen to oppose us."

"When Giordano Bruno chose to cling to Copernicanism despite having every chance to renounce his views, he was burned at the stake," Gioioso said. "Are two minutes—at most two minutes—worth a man's life?"

"I have done my best to make it plain that I do not personally hold to the Copernican world system," Galileo said. "I will make whatever abjurations the Holy Inquisition requires of me. But, even if it is a false hypothesis, Copernicanism is also a useful one."

"Useful in what way?" Gioioso asked.

"In making more exact astronomical calculations," Galileo answered.

"But if, in saving up to two minutes, you cast the Church into disrepute, you throw the whole world into confusion and argument and strife where before everything had seemed certain and clear, if you cast doubt on the Holy Scriptures and on God Himself, is that a useful thing to do?" Seldom had Galileo heard such scorn as that with which Cardinal Gioioso laced the word *useful*.

The astronomer hesitated, however much he didn't care to. Consequences were less easily calculated than planetary motions. At last, he said, "I never intended any such things to happen."

"Eve and Adam also sinned unwittingly," Gioioso pointed out. "Would the world not be a better place had they abstained from doing so?"

"How can I possibly deny that?" Galileo said.

"If you can deny one part of Holy Scripture, why not deny another? Why not deny every line?" Sigismondo Gioioso stood and stretched. His joints creaked—sure enough, he was as old as Galileo. "Perhaps we would do better to continue our conversation tomorrow."

"Perhaps we would," Galileo agreed. Stretching out on the cardinal's couch helped him forget his own

painful arthritis. All the same, he'd rarely been so glad to get out of a room as he was to escape that one.

* * * *

"Good morning, *Signor*. A pleasure to see you," Cardinal Gioioso said when Galileo unwillingly returned the next morning. To Galileo's surprise, the cardinal sounded as if he meant it. They might never have clashed verbal swords the day before.

"Good morning, your Eminence." Galileo kissed Gioioso's ring.

Gioioso waved to a table. "By all means, refresh yourself before we begin. Here are wine and bread and olive oil. I am told the oil is quite good. Myself, I like butter more. But butter is easier to keep fresh in Vienna than it is here."

"No doubt." Galileo ate. He drank. What else could he do? It gave him an excuse to wait before reclining on that comfortable but dangerous couch.

So he stretched things as long as he could, and then a little longer. At last, though, Cardinal Gioioso asked, "Shall we begin?"

"I am your servant," Galileo said once more.

Once more, Gioioso denied it: "By no means, not when I am a servant of the Pope and his Holiness is the servant of the servants of Christ."

He waited for Galileo's response, but Galileo made none. The cardinal could phrase things as prettily as he pleased. All the same, Galileo knew which one of them had ordered the other to be here. He knew which of them asked questions, and which had to answer. And he knew what he thought about that.

Or he thought he knew. He couldn't deny that some of the questions Cardinal Gioioso asked were ... interesting. As much as Copernicanism did, they made Galileo look at the world from a different perspective.

Something else occurred to the astronomer. When dealing with someone as savvy as Gioioso, it was better to get everything out in the open. "I presume, your Eminence, that the agreement we made yesterday in regard to the Copernican, ah, hypothesis remains in force?" Galileo asked.

"*Assolutamente*," Gioioso affirmed. In his slow, ponderous Italian, the word sounded especially impressive. He went on, "I will give you another written pledge if you so desire, or amend the earlier one to clarify that it extends throughout our, ah, analysis here."

That willingness to agree might mean he was inherently trustworthy. On the other hand, it might not. In Galileo's present situation, he was not inclined to take chances. Producing the pledge Sigismondo Gioioso had written the day before, he said, "If you would be so kind..."

The cardinal made the change and initialed it without batting an eye. He handed the paper back to Galileo. It was exactly what he had promised. When Galileo nodded, Gioioso picked up the thread where they had left it the day before: "You maintain that there are many reasons for accepting the Copernican world system in place of the Ptolemaic, not one alone."

"Speaking hypothetically, that is what the evidence suggests—yes, your Eminence," Galileo said.

"Of course we are speaking hypothetically!" Cardinal Gioioso exclaimed. "Were we not, would you have that sheet I just gave back to you?"

"By no means," Galileo admitted, as he had to.

"Well, then," Gioioso said, "perhaps you will be good enough to expound upon another. So it is not only refined calculations of planetary positions, then?"

"By no means!" Galileo said again, this time more enthusiastically. "Another very strong argument in favor of the Copernican system is that, when viewed through a spyglass, Venus appears to show phases like those of the moon. She appears now as a crescent, now as if at first or third quarter, now gibbous, depending on her position relative to Sun and Earth."

"You do not speak of seeing Venus when she is full," Gioioso noted.

"True. I do not, for I have not seen her so," Galileo replied. "Nor has anyone, nor will anyone. By the geometry inherent in the Copernican world system, Venus when she is full lies beyond the Sun: the Earth, the Sun, and Venus then form a straight line. Thus she would be in the sky when the Sun is also, and his much greater light would obscure hers."

"Anyone observing her through a spyglass would see the same thing?" Gioioso asked. "Two people observing through different spyglasses would see the same thing as well?"

"So long as they did so at the same time, yes," Galileo said. The questions were reasonable. More than twenty years earlier, when he'd first started examining the heavens through his spyglasses, many people had wondered whether something inherent in the instrument caused it to yield the results it did. How trustworthy could those results be, if they were invisible to the naked eye?

Cardinal Gioioso hit on that very point: "Without the spyglass, no one will see these things?"

"No, your Eminence," Galileo said. "Otherwise, astronomers would have observed them long ago. I will point out, however, that there are a great many spyglasses in Europe these days, in lands both Catholic and Protestant. A large number of people have observed these phenomena."

"Which would not occur under the Ptolemaic world system?" the cardinal asked.

"Just so. The Ptolemaic system is centered on the Earth, not the Sun. The path Venus necessarily takes in that system forbids these apparitions," Galileo said. "If you give me leave to sketch for you, I can demonstrate why this needs must be so."

"I believe I can visualize the differing paths," Gioioso said. By the way he said it, Galileo saw at once that it was so. No astronomer, Gioioso claimed? Galileo didn't believe that for a moment. The cardinal continued, "These effects you describe are invisible without the spyglass?"

"Not precisely, your Eminence," Galileo said.

"Wait." For the first time, he surprised Sigismondo Gioioso. "A moment ago, you said no one could see them. If someone could, why did nobody notice them before you perfected the instrument?"

That made Galileo smile. He had indeed greatly improved the device. Learning that Dutch spectacle makers had devised spyglasses that would magnify three or four or five times, he'd delved into the theory of optics and improved their results tenfold. He'd had to become a lens-maker himself to bring it off, and he had.

None of which, however, much as it salved Galileo's pride, had much to do with the cardinal's question. "No one could notice it with the eyes in his head," Galileo said. "But, as early as December in the year 1610, my former student, Benedetto Castelli, wrote to me asking if Venus' appearance was as I

described to you, and as the Copernican world system predicts. Even if you decline to see the diagrams, I must remind you that, as the Ptolemaic system arranges the heavens, Venus, lying between us and the sun, can be only a crescent if the sun's light illuminates her."

"*Si, si*," Cardinal Gioioso said impatiently. "So Castelli deduced this more than twenty years ago, and from the Copernican hypothesis alone?"

"He did," Galileo answered, and a new kind of pride filled him. "Any capable geometer could do the same, your Eminence. Most cities will have one such man; many will have several. And books, these days, are printed in editions of hundreds, sometimes even thousands. New discoveries spread more quickly than they did in years gone by."

"The man who first devised the printing press was a German like me," Gioioso said morosely. "He has much to answer for—and I do not mean simply the lying Calvinist and Lutheran pamphlets that come out in editions far larger than the ones you mention."

"I fear the world is as it is, your Eminence, not as we wish it were," Galileo answered. "That is why I said yesterday that the Church should not nail itself to doctrines liable to be proved false."

"Nail itself?" Sigismondo Gioioso's voice held an ominous purr, like that of a cat seeing a mouse's tail sticking out from under a pile of clothes.

Even with the pledge about discussing the Copernican hypothesis in hand, Galileo realized, he could go too far. He'd just gone too far, in fact. "Forgive me," he said quickly. "I should have phrased that better."

"Yes. You should have." But Gioioso seemed inclined to accept the apology. Galileo hoped so, anyhow. The cardinal was devilishly hard to read. He sent Galileo a hooded stare. "You were saying ...?"

"Only that the Church might sail a safer course if she did not make pronouncements on how the physical world is framed," Galileo answered.

"The Church has been refining its doctrines since our Lord's time," Cardinal Gioioso said, "and has had the aid of the Holy Spirit in so doing. His Holiness the Pope is the direct successor to St. Peter, the rock on whom Jesus Christ founded the Church. Do you deny this?"

"Not at all, your Eminence. How could I possibly?" *How could I possibly, when you would roast me like a leg of veal if I dared?*

"Then how can you deny that its doctrines are correct?" Gioioso demanded.

Sadly, Galileo spread his hands. "It is not I, your Eminence. If the evidence contradicts the doctrine, which is to change?"

Cardinal Gioioso sighed. "The Church never objected when a few astronomers used the Copernican hypothesis to improve their calculations. Who could care about something so small as that? We were always sure a hypothesis was simply a hypothesis. Whether it had anything to do with the real world ... well, who could say? Come to that, who cared?"

"I understand this. It is also how I was trained. But the spyglass ... The spyglass changes things," Galileo said. "Now we can test the different world systems against the evidence, and see which is stronger."

"Now you can shout from the housetops: 'Ptolemy is wrong! Aristotle is wrong! The holy Catholic Church believed them right, so the Church is wrong as well! And behold! The Book of Joshua says that the Sun stood still in the sky. But it is not the Sun that moves! No, it is the Earth! And so Joshua is wrong

as well!' And what is left of the holy Catholic Church after that, *Signor* Galilei? What is left of any religion?"

"As a matter of fact, your Eminence, the Copernican world system can explain the events described in Joshua better than the Ptolemaic system can," Galileo said eagerly. "I have written on this very topic, and I would be delighted to expound on it for you. When properly construed, the Copernican hypothesis is altogether compatible with the words of the Holy Scriptures."

But Sigismondo Gioioso disappointed him by holding up a hand. "Spare me," the prelate said. "Seldom do laymen find their way into deep water faster than when they try to tell clerics what the Bible means."

He was not the first churchman to tell Galileo something along those lines. In a way, the astronomer could see the clerics' point. In another way ... When Galileo looked at things another way, rage ripped through him. "Why should I not interfere in your business, your Eminence?" he ground out. "You enjoy interfering in mine enough, by God!"

As soon as the words were out of his mouth, he wished he had them back. Too late, of course. Wishes like that always came too late. He waited apprehensively. Cardinal Gioioso had pledged to let him defend the Copernican world system in a hypothetical way. The cardinal hadn't said a thing about letting him attack the Catholic Church. Maybe, at least, they would strangle him before they burned him, as the Spaniards had done for that savage king in the New World a hundred years before.

But Gioioso merely sat there studying him. Yes, the cardinal was doing just that. Slowly, Galileo realized he himself was as interesting to Gioioso as the Medicean stars going around Jupiter or the convoluted landscape of the Moon was to him. "You are angry," Gioioso said, and nothing more.

"If I have disturbed your Eminence's tranquility, I humbly beg pardon." Galileo would eat crow if he had to. If he had to, he would eat raven.

Cardinal Gioioso waved this apology aside. "Explain to me, *Signor*, if you would be so kind, *why* you are angry."

"Why?" Galileo growled. "Can't you see that for yourself?"

"If I could, would I be inquiring of you?" Nothing but tranquility and interest was in Gioioso's voice, not that Galileo could hear. The astronomer might have sounded like that himself, when he first turned his spyglass on the Pleiades and saw a host of tiny stars his unaided eye could not discern. *Perhaps I* did *sound like that*, Galileo thought, bemused.

And Gioioso sat waiting, patient as a pillar saint. Galileo had to look inside himself to find an answer. " *Because* the Church is meddling in affairs that are not its proper concern," he said at last.

"Does the way the Church is acting in this matter remind you of how your father would behave?" Gioioso asked.

"I had not thought of that before, but it does—it does!" Galileo said. "Stubborn, wrongheaded, always trying to have his own way..."

"I see," Gioioso said, with an air of now-we're-getting-somewhere. "And your reaction to this unpleasant stimulus is ...?"

"How could any man help getting angry?" Galileo asked rhetorically.

"But when you do, *Signor*, do you not also show your own stubbornness? Do you not seek to have your

own way in every respect?" Unfailingly courteous, the cardinal said nothing about Galileo's being wrongheaded. He didn't have to. Galileo could—and did—supply that for himself.

He did not believe he was wrongheaded—or wrong. But Gioioso's questions made him examine himself in a way he never had before. "I am a proud man, our Eminence, and I think I have earned my pride," he said. "When I am pushed, what can I do but push back?"

"You might wonder *why* you are being pushed," Cardinal Gioioso said. "You might wonder whether you did not push first, maybe without even noticing, and so unwittingly gave offense. Or you might wonder if, having been pushed in this way when you were young, you now believe yourself pushed even when no one intended to push you, perhaps even when no one pushed you at all?"

"Do you say I imagine that I am being pushed?" Galileo demanded—pushily.

"I said no such thing," Gioioso replied. "You did."

"Yes, I did," Galileo agreed. "I was pushed to Rome. I was pushed to the palace of the Inquisition. I was pushed to these sessions with you. I was pushed onto your *couch*, your Eminence!"

"Say rather, *Signor*, that you pushed yourself here by your deeds and writings," Sigismondo Gioioso said. "For is not the holy Catholic Church the spiritual father of all believers? And do you not push against it because your own father pushed against you in days gone by?"

"He did not want to let me do with my life as I would, as I must." All these years later, the memory still stung. He'd denied that before to Gioioso, but he found that with further reflection he'd changed his mind about it. And he added, "Nor does the Church today."

"Could it not be that you are throwing your views of your father forward onto the Church?" the cardinal said.

"Throwing my views forward?" Galileo frowned. "Please excuse me, your Eminence, but I fail to follow you."

"My Italian must be imperfect. I know what I wish to say, but how to say it...?" Sigismondo Gioioso thought for a moment, then smiled and held up a forefinger, exactly as one of Galileo's countrymen might have done. "I have it! I wanted to suggest that you might be *projecting* your views."

"Ah. Now I understand! *Grazie*." It was Galileo's turn to do some more thinking. As he did it, he eyed Gioioso with respect no less real for being reluctant. "There may indeed be some truth in this, and you are a most astute man"—*a dangerously astute man*, he thought—"for pointing it out."

"This is the purpose of the kind of analysis I have devised: to help a man see that which lies within himself but which he would not find without someone to help show him the way to it," Cardinal Gioioso replied.

"Well, your Eminence, you have considerable skill in this art, as you must know without needing me to tell you." Galileo paused again. Then he raised his forefinger, too, but not in the same way as the churchman had. "When I said there was some truth in your remarks, I meant there was only some. As I've told you again and again, it is not my projection that the Holy Inquisition summoned me—a sick old man—from Florence to Rome, imprisoned me, and is now interrogating me. I am not imagining these things, and they are not happening because I want them to. So do I not possess veritable reasons, altogether apart from anything that may have passed between my father and me, for being unhappy with the way the Church has treated me?"

Gioioso considered. Their conversations seemed filled with hesitations on both sides. "Did you not know,

when you published the *Dialogue Concerning the Two Chief World Systems*, that it would lead to this?"

"I knew there would be fireworks," Galileo admitted. He couldn't help smiling; he'd hoped for, craved, fireworks. But he went on, "I didn't think it would come to *this*. After all, I had the Church's *imprimatur* , allowing the work to be printed, and, by so doing, acknowledging it contained nothing contrary to doctrine or to the Scriptures."

"Yes. You did." Gioioso let the words hang in the air. Galileo wished he hadn't thought of hanging. Better than burning, but still.... The cardinal continued, "As I have told *you*, no one would have objected to your quietly using Copernican calculations to reclaim your precious two minutes of rising and setting. Quietly, I say. But when you parade through the center of town with horns and lutes and viols and drums, all played loud as may be, you must expect the magistrates to notice. I have to wonder whether, at some level below that of conscious thought, you did not *want* them to notice."

"How can one want something without being conscious of wanting it?" Galileo said. "If one is not conscious, one is not alive."

"So it might seem at first, but the mind has depth, just as the heavens do," Gioioso answered. "What man does not wish to be loved, to be admired, to be noticed? Most of the time, he is not aware of those desires. He does not go around constantly thinking *I must be loved, I must be admired, I must be noticed!* By no means! But, whether he knows of them or not, these urges push him on regardless. Or do you believe differently? You may, and freely—the Church has not pronounced on these opinions of mine."

"The Church would have done better not to pronounce on matters astronomical. Much better, since those matters have nothing to do with the human spirit, while your interesting ideas do." Galileo didn't want to show how interesting he found Gioioso's notions. Depth in the mind.... The idea would have been better with some mathematics behind it, but was interesting enough and to spare even without. *Had* he wanted to be noticed so badly that he prodded the Church into noticing him too much? Maybe he had. All the same, though ... "You cannot make true heavenly phenomena disappear, you know."

"Maybe the phenomena are true. Which hypothesis best explains them..." Gioioso's shrug was less expressive than an Italian's would have been, but it got his meaning across. "And when you measure that against the disservice you do the Church and the world by screeching about what you say they mean—"

"Screeching?" That affronted Galileo. "The *Dialogue* only presents the facts and the evidence. It does not even reach any sure conclusion."

"Not at the end, but your belief is plain all through it," Gioioso said.

"Then how did it gain the *imprimatur*, your Eminence?"

"An interesting question. Probably because the churchmen who gave it were ... naive." Sigismondo Gioioso might have said something else, something stronger, but he refrained. "It has plenty in it to make people no longer credit the holy Catholic Church's teachings."

"For a long time," Galileo said slowly, "all the people who believed in the Ptolemaic world system would laugh at the ones who thought Copernicus was right. Until I started making good spyglasses, there wasn't much to choose from between the two systems. Calculations a little more precise ... but so what? After that, though ... People should have seen."

"They should have, but they didn't?" Gioioso suggested, his voice quiet and gentle.

"They didn't.” Galileo, by contrast, sounded sad. “I published the *Sidereus Nuncius*, with word of the mountains and valleys of the Moon, with word of all the stars the spyglass showed that the eye could not, and with word of the Medicean stars circling Jupiter as the planets circle—as Copernicus *says* the planets circle—the Sun. And what did I get? I got a miserable little manikin named Martin Horky, who wrote a tract that said I was a crackpot, like the fools who claim they can square the circle or double the cube or make the Philosopher's Stone. *That* is what I got."

"And you wanted to pay this Horky back with the *Dialogue*? Sigismondo Gioioso asked. “You wanted to pay back all the doubters?"

"All the scoffers,” Galileo said.

"But do you not see how you wound the Church when you do this?” the cardinal asked. “Do you not see how you make people doubt not only the Ptolemaic world system but all the Church's teachings? Do you not see how destructive that is? And why have you done it? To pay back the scoffers—and, could it not be, to pay back your father with them?"

"To see what lies behind the everyday is not for ordinary souls,” Galileo said. “So your worries, your Eminence, seem to me misplaced."

"They are not, and the reason they are not is what you said at first,” Gioioso said. “Most souls *cannot* see what lies behind the everyday—not by themselves. That is why the holy Catholic Church does not mind astronomers using the Copernican hypothesis, so long as they are discreet about it. But when you wrote your book, *Signor* ... and in Italian this time, not even in scholars’ Latin! And it is being translated into other vulgar tongues. That part of you below conscious thought, the part that wanted to be noticed, got more than it bargained for this time. Do you see?"

"Well, perhaps I do,” Galileo said, and it was much less of a lie than it would have been before he started talking with Cardinal Gioioso. “You have given me a great many fascinating things to think about: no doubt of that. And may I beg your indulgence to give me leave to think about them till tomorrow? As my years grow heavier, I tire ever more easily."

Everyone tired. The Inquisition used that as a weapon. Torture included being deprived of sleep, so a man grew as if drunk and hardly knew what he was saying. It included water in the face till the victim feared drowning. It included all kinds of other ingenious torments that left not a mark on the body, no matter what they did to the spirit.

But Gioioso didn't say a word about any of that. All he said was, “Of course, *Signor*. Please forgive me for overtaxing you in my zeal. Let us resume in the morning.” But whether he mentioned them or not, he held those weapons in his arsenal, and both he and Galileo knew it.

* * * *

"*Buon giorno, Signor,*” the cardinal said when Galileo returned to his quarters the next day. “I hope you slept well. Are you refreshed?"

"I *am* refreshed, your Eminence, even if I slept less than I might have,” Galileo replied. “I spent considerable time after leaving your honored presence contemplating the many fascinating notions you propounded concerning the mind and its workings."

Gioioso graciously inclined his head. “No man could hope for higher praise. And what conclusions did you reach, if any?” He waved toward the couch. “Why not make yourself comfortable before you tell me?"

"Thank you." Galileo stretched out. "This is an agreeable way to converse, sure enough .... Conclusions? No, not really. But sometimes new questions are as interesting, and as important, as answers."

A servant came in with wine and bread and anchovies and olives and other snacks. After the man withdrew, Gioioso remarked, "You are devoted to the new."

"No, your Eminence. Say rather that I am devoted to the true, wherever I find it."

"We mentioned Pontius Pilate earlier in our discussions. Pilate was not altogether a fool when he asked what truth was and then washed his hands," Gioioso replied. "Often, deciding what is true means no more than deciding on the proper point of view, and on how much weight to give this, that, or the other factor, eh?"

"Often, but not always," Galileo said. "Mathematics is true regardless."

"As are the teachings and doctrines of the Church—yes," Gioioso said.

"Of course, your Eminence." Galileo did believe that. He always had. But he would have agreed even if he hadn't. He was in the worst possible position to disagree.

Thoughtfully, but also casually, almost as if the answer didn't matter, the cardinal asked, "Could God make it so the truths of mathematics were different?"

Denying God's omnipotence would be deadly dangerous here, in the most literal sense of the words. But, again, Galileo didn't want to. "I believe He could, your Eminence. To us mere mortals, that different truth would seem as genuine, as perfect, as the actual dispensation does now." He could have said that the Copernican world system would one day replace the Ptolemaic in just that way. He could have, but he didn't. He could tell when not saying something seemed the best idea. Sometimes he could, anyhow. The *Dialogue* ... No, he hadn't been able to resist the *Dialogue*.

If Sigismondo Gioioso had expected him to risk a heretical statement or an outright blasphemy, the prelate gave no sign. He ate a couple of olives, then said, "Have you given me all your reasons for—hypothetically—preferring the Copernican world system?"

"I have not." With Gioioso's pledge in hand, Galileo was on safe ground here—or ground as safe as any in quicksand-laden Rome. "Yesterday, in fact, I briefly alluded to that which may be the most important: the motion of the four Medicean stars around Jupiter."

"Yes, you did mention them yesterday," Gioioso said. "Will you do me the honor of explaining why you find them so significant?"

"Certainly," Galileo said. "First, the Ptolemaic world system is founded on the view that there can be only one center of motion—that is, the Earth. By moving around Jupiter, the Medicean stars contradict this."

"But they cannot be seen without your spyglass," Gioioso said.

"That does not mean they are not there," Galileo replied. "Clerics and laymen have observed them for twenty years now, and unanimously attest that they do exist. And we must presume they existed for all the ages before the spyglass first rendered them visible. Surely God would not have popped them into place the day before I first turned the instrument toward Jupiter."

"Had He so desired, He could have," Cardinal Gioioso said. When Galileo failed to rise to that, the prelate added, "I must admit, it seems unlikely. You said that was your first reason. This means you have more?"

"*Si*. Here you have these stars, performing their evolutions in periods ranging from forty-two hours to sixteen days, all on the sphere of Jupiter, which in the Ptolemaic world system takes twelve years to revolve around the earth. And beyond that is the sphere of Saturn, which takes thirty years. And beyond that is the sphere of the fixed stars. And it revolves in what? Only a day! Where is the logic in that? Whereas if the Earth rotates, as the Copernican world system postulates—"

"You falsify Holy Scripture," Cardinal Gioioso broke in.

"Not necessarily, as I have tried to show in my writings on the Book of Joshua," Galileo said.

"Those writings have been weighed in the balance and found wanting," Sigismondo Gioioso said. "You are an admirable astronomer, but you make a less than admirable theologian. I have spoken of this before."

"Yes, your Eminence," Galileo said resignedly. "As *I* have said before, I might be less inclined to meddle in theology if the Church were less inclined to meddle in astronomy."

"But astronomy and its truths connect to the Scriptures," Gioioso said. "How can the holy Catholic Church not concern itself with the heavens as well as the Earth?"

"If the Church does, then its learned theologians risk being called less than admirable astronomers," Galileo said.

"How does this follow?" Gioioso asked.

"How?" Galileo yelped. "Surely it must be obvious—"

"No." The cardinal held up a hand. "What is *obvious, Signor*, is that the world stands still and the heavens revolve around it. Otherwise this would not have been believed by everyone since the days of the Old Testament. It would not have been set down in writing in the unerring Holy Scriptures. What your spyglass shows may be there, but it is not *obvious*."

"It is true," Galileo maintained.

"In a sense, perhaps," Gioioso said. "But it is also disruptive of good order all over Europe. Is that not true as well?"

"In a sense, perhaps," Galileo echoed slyly.

He won a small smile from Gioioso. "So the question is, does your loud, aggressive espousal of the truths your spyglass has shown about Venus and the Medicean stars—places to which we can never hope to go, even in dreams—justify the chaos you unleash on this world? Why do you imagine that these magnified images are more important than wars and uprisings and rebellions against longstanding authority?"

"I intend no such thing, your Eminence," Galileo protested.

"Nor do I claim you intend it," the cardinal said. "If I did, the matter would be far more serious. An evil will, a malicious will..." He shook his head. "But I claim no such thing. Neither does any other cleric, to my knowledge. Still, do you not see that the result of an unintended act can be as dreadful as that which springs from an intended one?"

"What am I do, then? I truly believed I was but speaking hypothetically when I wrote the *Dialogue*, as the way I ended it shows." That was Galileo's story, and he was sticking to it. If he'd let what he actually

believed show through to excess as he wrote ... well, how surprising was it?

Sigismondo Gioioso's left eyebrow couldn't have risen more than an eighth of an inch. That was all he needed to show he didn't believe a word of it. Had Galileo entered the priesthood, were he now interrogating some enthusiastic Copernican, he wouldn't have believed a word of it, either. Perspective *did* have something to do with deciding what truth was—at least some truths. Gioioso hid all sorts of interesting notions under his crimson cassock.

He didn't come right out and call Galileo a liar, as some of the other inquisitors had done. Instead, he said, “And so, in scandalizing your father, you aim not merely to turn the world upside down but to set it spinning as well?"

"Imagining that it does spin does the best job of explaining the phenomena we observe,” Galileo said.

"The phenomena you observe with a fancy spyglass.” Cardinal Gioioso's snort was a distillation of scorn. “You say many people have seen these things. How many is *many*? Hundreds? A few thousand at most?"

"Something on that order, yes,” Galileo agreed. “For matters of this import, that is a great many."

"It could be. But what is it when set against the number of souls in Christendom?” Gioioso asked. “How many millions dwell in Italy? In Germany? In France? In Spain? In Portugal? In their new lands beyond the sea? In Poland, out of which your precious Copernicus came? Against all those souls, these hundreds have not even the weight of a mustard seed. Is this so, or is it not?"

"It is, your Eminence. But—"

"No, *Signor*. No buts here. When the farmer goes home after a day in the fields, what does he see? When the miller leaves off grinding grain at day's end, what does he see? When the monk finishes his evening prayer, what does he see? The sun going down. Not the earth spinning, but the Sun setting. He sees no hills and valleys on the Moon, no phases on Venus, no new stars attending Jupiter. He sees what the Bible says he sees, what the God-inspired men who wrote the Bible saw, what our Lord saw during the Incarnation, and what Ptolemy saw not long after. Is *this* so, or is it not?"

"They saw incompletely,” Galileo said. “They saw inaccurately. They saw, if you will, through a glass, darkly."

"You are the one seeing darkly through your glass, *Signor*,” Gioioso answered. “For you do not see the chaos and confusion you cause here on Earth with your phases of Venus and your Jovian stars. Truly I wonder if it is not Satan's work associating these marvels with the planets named for two of the most licentious pagan gods."

"Sometimes a planet is only a planet, your Eminence!” Galileo exclaimed.

"You think so, do you?” But a twinkle in Cardinal Gioioso's gray eyes betrayed him. “Well, possibly not, not about that. Nevertheless, though, I am altogether in earnest when I say you forget about this Earth when you keep your eyes ever to the heavens. For what is the effect when your hundreds start shouting about what their spyglasses show?"

"They spread the truth?” the astronomer suggested.

"What they spread is doubt,” Sigismondo Gioioso said in a voice as hard and cold as stone. “And doubt corrodes faith as surely as salt water corrodes iron. The farmer, the miller, the monk—they hear of these marvels they cannot see. They hear these men who imagine themselves to be clever defaming the

Scriptures and the holy Catholic Church. So many people, sadly, are like magpies, like jackdaws: they imitate everything they see, everything they hear. And faith, and faith's community, and peace itself, are torn to bits. Is *this* so, or is it not?"

"It ... could be," Galileo said. "But you cannot blame me for the rise of Protestantism, which began before I was born, nor for the war now raging in Germany."

"The Protestants sowed the seed of disbelief in the mother Church's authority," Gioioso said. "They have yet to reap the thorny harvest, for disbelief, once sown, will grow and eat them up, too. You mark my words, *Signor*—that day will come. I do not blame you for Luther or Calvin, no, nor for the accursed German war, which seems to go on forever. Still, is it better to spread more disorder through a world that already has too much, or to work toward restoring peace and unity of purpose?"

"Surely working for peace is better," Galileo said. The cardinal's questions took the discussion to a level he had never considered when he grinned and cackled as his pen made Salviati flay Simplicio—made Copernicanism flay Ptolemy's outmoded views. That astronomy could concern the ordinary world as well as the rarefied atmosphere of the heavens and of scholarship hadn't crossed his mind ... till now.

Gioioso found one more mild-sounding question: "Will you say now from your heart that you were working toward peace and unity when you composed the *Dialogue Concerning the Two Chief World Systems*?"

"Your Eminence, looking into my heart, I find I cannot say that and mean it," Galileo answered. Not for the first time, he wondered if the prelate from Vienna was some sort of he-witch. Gioioso certainly had a knack for making anyone he talked to feel as if his head were as transparent as glass.

"Are you sure of what you tell me?" Sigismondo Gioioso asked.

"Before God, I am. That I am surprises me, but it is so. You have done what I would have thought to be impossible: you have made me look at myself, look within myself, in a whole new way," Galileo said.

"That is the goal of analysis of this kind, *Signor*." Was the smallest hint of smugness in Gioioso's voice? Did he himself exhibit once more, if only for a moment, the sin of pride? If he did, Galileo didn't call him on it.

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Proud or not, Cardinal Gioioso was not the man who pronounced sentence on Galileo. Cardinal Guido Bentivoglio, with the title of Santa Maria del Popolo, read out the Inquisition's decree on the day after the summer solstice.

Galileo listened to the words wash over him. He was convicted of vehement suspicion of heresy. He had held and promoted a false belief—that the Sun, not the Earth, was at the center of things and that the Earth, not the Sun, moved. The *Dialogue* was to be prohibited. He was sentenced to formal imprisonment at the Inquisition's pleasure, and would be required to recite penitential hymns weekly for the next three years. And he had to abjure all his heretical beliefs, there in public before Cardinal Bentivoglio and his inquisitorial colleagues.

He had to make the abjuration on his knees, which pained him physically as well as spiritually. Still, he said what they required of him, reading from a statement he'd drafted in advance. When he looked up from the words, he tried to look at Cardinal Gioioso rather than any of the others. He would have abjured whether he'd spoken with Gioioso or not. Whether he would have abjured so sincerely and with such authentic faith, as the Inquisition's decree required of him, might have been a different story.

At last, it was done. He struggled back to his feet, which also hurt. Some of the inquisitors came forward to congratulate him. He could have done without that. Gioioso, who had helped shape his thoughts, had the sense to leave him alone with them.

"But it does move," Galileo muttered under his breath. It was one last protest, which he answered with the insight he'd gained from the Viennese cardinal: "But so what?"

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Science Fact: **FUTUROPOLIS: HOW NASA PLANS TO CREATE A PERMANENT PRESENCE ON THE MOON** by Michael Carroll

Sir Thomas More has his Utopia. The book of Matthew has its “shining city on a hill.” Now, NASA has its own plans for a community, and this one will be the first on another world. Engineers are planning how to set up the first permanent human presence on the Moon. It's all part of the grand scheme to replace the aging space shuttle fleet with an entirely new transportation system and spacecraft.

The plan is called the “Constellation architecture,” and hardware is already under construction. Designers are hard at work on a new family of *Ares* launch vehicles, the most powerful in history. These advanced launchers borrow the best technology from the space shuttle, *Saturn V*, and other launch vehicle programs. Atop *Ares* rides the *Orion* spacecraft, backbone of the program. *Orion* will carry four to six people, and is capable of cislunar travel (from the Earth to the Moon). Another craft, called *Altair*, will ferry crews to and from the lunar surface from Moon orbit, supplying the infrastructure for permanent settlements.

NASA's Constellation program is a long-term, methodical approach to exploration and settlement of the Moon and Mars. The *Orion* spacecraft, replacement for the venerable shuttle program, is estimated to cost less to build and launch than either the shuttles or the proposed craft in earlier scenarios. The new blueprint to the stars spreads costs while building, step-by-step, a permanent human outpost on Earth's nearest neighbor.

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An *Altair* lander on final approach to the growing international community at the lunar south pole. Visible below are various habitats. In the distance lies a field of solar power collectors. (art by the author)

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Establishing the first foothold on another world is a daunting task. Like nineteenth-century arctic explorers, lunar architects face the challenges of laying supply lines, setting up living and working areas, providing power and communications, and building transportation infrastructure, not only from terra firma to the Moon, but across the lunar landscape itself. And the first order of business is *where to put it*. The location must have access to nearly constant sunlight for power, a fact complicated by the Moon's two weeks of night each month. The site must be in a spot visible to Earth almost continuously for safe communication. The three main considerations, as any realtor will tell you, are location, location, location.

NASA is considering several areas on the lunar surface for a base of operations, but one has been selected as a baseline. Shackleton Crater provides a realistic framework within which engineers and designers can study various architectures. A vast amphitheater 19 kilometers across, the crater sprawls like a bulls-eye across the Moon's South Pole. It's a place of stunning bleakness, a pockmarked landscape in eternal dusk. But to lunar base architects, it's the perfect site for an outpost. From this location, the Sun seldom dips below the horizon. Over the leisurely course of a lunar day—lasting some 28 Earth days—the Sun bobs along the horizon, peering over the rolling hills of the Moon's southern highlands. Shackleton's raised rim, standing above all but the longest southern shadows, assures almost uninterrupted contact with Earth, and a near-constant flow of solar energy. NASA scientist James Garvin comments, “As for the poles, there are regions of nearly continuous sunlight, well suited for solar power at the 10's of kilowatt level we need for human exploration."

Constellation designers believe the strategy of setting up a durable outpost on the Moon is a financially and logistically sound one, and one that hearkens back to the early days of Antarctic exploration. Planetary scientist Ben Bussey of Johns Hopkins University's Applied Physics Laboratory has twice

explored the southern continent. He likens the opportunities of a lunar outpost to those afforded by McMurdo Station in Antarctica. “If all the science on the Antarctic continent had to be done carrying everything from New Zealand, no one would get much science done. But because we have McMurdo as a logistical base, expeditions can stage from there and do a lot more. Similarly, the outpost on the Moon will be a stepping stone into the solar system."

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Mockup of a horizontal lunar habitat. The rudimentary construction allows engineers to make quick changes in the design as studies progress. (photo by the author)

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Setting up camp in the extreme lunar environment is a challenge, both technologically and psychologically. What physical space do people need to remain healthy? What volumes are most efficient for working in 1/6th the gravity of Earth? How does a person living on the Moon deal with the equipment-choking dust? How many habitats will a permanent human presence require? NASA's Larry Toups has been studying the problem for some time. The answer is complex, Toups explains. “The number of habitats depends on not only the number of crew, but also length of surface stay. With four members, you get a break at 30 days. Up until that, you are in camping mode. You hit 30 days up to six months, and you start having to provide additional volume, resources, food, clothing, consumable gases and so forth.” Each habitat must house subsystems for life support and power management. The first modules might have small laboratory areas for sample analysis. But these evolve to an outpost by adding additional volume, enabling functions to be moved from the cramped initial area to dedicated areas for research, exercise, etcetera.

Some early modules might initially be packed with consumables. “The notion is that you deliver a core hab and logistics (supply) modules which plug into that,” says Toups. “In essence, the crew eats their way into a habitable volume."

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Mockup of a tuna-can habitat. (photo by the author)

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But for a skeleton crew of four on a 180-day expedition, at least three habitats will be required for safety and health. Toups suggests that, “our initial footholds will probably use systems and technologies that we are comfortable with. Growth will come from that, evolving from construction shacks to more complex structures."

What will those structures look like? Building B220 of the Johnson Space Center gives us a glimpse of a future lunar city. In the high-ceilinged warehouselike structure, engineers are busy fabricating low-tech mockups of habitats that could comprise the international outpost at Shackleton. The newest mockups consist of Styrofoam and plywood, making modifications and design changes simple and inexpensive.

Several approaches to habitat design are under consideration. These fall into two general categories: rigid structures and inflatable ones. Lunar architects designing rigid habs have even more decisions to make: should the structure be cylindrical? If it is, should it lie horizontally or stand vertically? The structure might also be configured as a “tuna can,” using the full diameter of the new *Ares V* booster to create large, open spaces in a low-lying structure.

Cylindrical arrangements are smaller and lighter, and thus easier to transport. Once a cylinder is on the ground, the interior arrangement is fairly inflexible, with bunks, plumbing, electrical components, and shelves attached to the structure. Multiple cylinders would be chained end to end, forming long corridors of work/living areas in linear arrangements. A tuna can, on the other hand, provides a circular floor that

can be reconfigured into labs, sick bays, eating areas, etcetera. The main drawback of the tuna can is mass: it's a heavy payload. And while tuna cans might accommodate individual crew quarters (as opposed to the sleeping bunks of a cylindrical hab), engineers have a high degree of confidence and experience with the cylindrical model. They've been using them for years as building blocks of the International Space Station. “We're juggling a lot of trade-offs,” says lunar architect Robert Howard. “If the interior space is too small, you have psychological problems with the crew. If it's too large, the crew is fine but missions are shorter because you can't bring as many consumables."

To hit the right balance, Howard is in process of building several Styrofoam/wooden structures of different sizes. While the modules of the International Space Station are 4.2 meters in diameter, they are scaled to fit the Space Shuttle cargo bay. Shuttle will be long retired when the habitats reach the lunar surface, so the new designs call for something a bit smaller and more mobile. Engineers are experimenting with habs that are both three meters and 3.5 meters in diameter, roughly as far across as a Boeing 737 airliner. On paper, the two versions are so similar in scale as to suggest equality. But step inside the mockups, and the half-meter difference is remarkable. Taller ceilings give the impression of a larger floor area. It's an old trick: Architect Frank Lloyd Wright used this perceptual phenomenon to his advantage in small home designs: low-ceilinged hallways open into rooms with higher walls, giving the impression of a great expanse in a relatively modest living area. But size and carrying capacity of the *Altair* lunar lander are in flux, says Howard. “Habitable volume and payload capability of *Altair* are going to be fighting a battle for the next several years."

Many NASA experts would like to see habitats similar to the rigid modules on the International Space Station. They are heavy, but they work. Both NASA and Russian experience with long-term space habitation is within rigid habitats in the microgravity of Earth orbit. Designing for a zero gravity environment, every surface can be used. There is no ceiling or floor, no up or down, so the physical arrangements are quite different from an environment with floor, walls, and ceiling. As Larry Toups put it, “You're not just providing volume anymore; it's a footprint."

Another option is to scrap the idea of a rigid hab completely, in favor of an inflatable one. An inflatable habitat has a rigid core containing supplies, electronics and other equipment, cocooned within a deflated living area. Once on the lunar surface, the core would pressurize the donut-shaped habitat around it, with the core representing the donut “hole.” Floors and ceilings would unfold as the hab extends outward into a tuna-can shape. Layers on the exterior must include micrometeorite protection, thermal insulation, and restraints to hold the pressurized “balloon” in a workable form. Another configuration of an inflatable hab resembles the cylindrical shape of a rigid hab. Similar structures are in use in Antarctica.

Lunar habitats will provide the essentials of life, like food, water, and air, but they must serve another important purpose: protection from radiation. Earth is enshrouded within strong magnetic fields generated by a core of molten rock and metal. These fields form a protective barrier between our planet and the Sun's radiation. But the Moon has no such protective energy shield. Habitats must provide shelter from incoming radiation, and the prospect is not as easy as it might first appear.

Lunar explorers must concern themselves with two types of radiation. The first comes from the background radiation of cosmic rays. Long-term exposure to cosmic rays can cause cancer or other health problems. They are such high-energy particles that no artificial material significantly blocks them. But fortunately, cosmic rays provide background radiation at a fairly low rate. Additionally, from the surface of the Moon, fully half of the cosmic rays are blocked by the Moon itself.

The second type of radiation occurs less frequently, but is far more deadly. It is the high-energy radiation that explodes from the Sun's surface as solar flares. Solar radiation can be filtered out with something that is readily available on the Moon: dirt. Several meters of regolith—lunar soil—may be needed (tests are

still underway), but a habitat can be designed to carry the load on its roof. Even an inflatable enclosure can use regolith for protection. NASA's Langley research center is developing a Quonset-hut-style structure that starts out flat on the lunar surface. Shackleton construction workers would scoop dirt or load sandbags onto the flat covering, then inflate it into an arch. A habitat would then be positioned underneath, an arrangement much like the sod houses of the early American West. But Johnson Space Center's lunar architect Chris Culbert warns, “The flip side of that is that moving around many tons of regolith on the lunar surface is nontrivial. We'd have to take earth-moving gear with us.” Teams at JSC and Kennedy Space Center are studying a bulldozing blade that can affix to various rovers under development.

A two-meter layer of regolith affords sufficient protection from the most dangerous radiation events. Some types of metals or plastics may also do the trick, as would an underground storm shelter. Water makes a good barrier to radiation and can be stored in containers within the walls of living areas.

Like McMurdo base before it, Shackleton will eventually develop into a multistructure, sprawling community with roadways, centers for specialized operations, and staging areas for expeditions to the ends of the Moon. Constellation's strategy is to open the entire lunar world to the world's explorers. *Apollo* mission sites did not have the range to stray far from the Moon's equator. Constellation promises an infrastructure that makes any site on the Moon accessible, from the poles to the far side.

Communications within the lunar community promise to offer some of the greatest challenges to daily living and working on the Moon. At a minimum, lunar settlers need the ability to communicate with Earth and to communicate with all the habitats, astronauts and rovers within their local community. But radio communication can be hindered by rocky embankments or valley walls. Inhabitants will need both voice and video. High-bandwidth capability is preferable for downloading scientific and engineering information. Repeater stations or communications towers might fulfill Shackleton's requirements. All elements of the local outpost itself will remain within line-of-sight, but scientific and exploratory interests will quickly take inhabitants over the hill. Sortie missions need to be able to communicate from wherever they land, and surface operations require links to orbital or incoming *Altair* crews. Traveling rover crews might deploy a series of towers—along with supply caches—as they roam across the lunar wilderness.

A flock of four or five Moon-orbiting satellites could provide not only services such as continuous communication, but also tracking and data, something like a lunar GPS system. International partners like the European Space Agency and India have developed complex, advanced communications satellite constellations, and they are a likely source of such a global lunar communications network.

Whatever communications system is finally used, it is likely that the system will also serve a navigation role. Without the Earthly cues of scale and landmarks, just finding one's way around is a challenge. For example, on Earth, the atmosphere tends to shift the color of objects as they increase in distance from the observer. This phenomenon, called atmospheric perspective, is a key element used by human perception to judge distance. But the lunar environment is airless, explains *Apollo 14*'s Ed Mitchell. “The only major problem we had was finding landmarks by eye. That turns out to be very difficult to do."

NASA and other space agencies are exploring a balance between robotic and human-tended systems, including remotely controlled lunar rovers and automated robots programmed to assemble large structures like habitats. Astronaut Alan Bean puts it this way: “Humans have many good qualities, and one of them is adaptability and learning to adjust to the situation. Humans have [physical] limitations we have to deal with, but they also have tremendous advantages, as we've seen with the construction of the Space Station and the repair of the Hubble Space Telescope. The combination of the best automatic machinery you can build and human adaptability and flexibility make the best combination for exploration. There is no such thing as unmanned or nonhuman space flight; it just depends where you put them. If

you've got a robot, you still have humans involved. They're just sitting in Mission Control somewhere in California or Houston. You're never going to do away with the human part."

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This Chariot rover, under study at the Johnson Space Center, features cameras and lasers on the front for remote operations, as well as a gondola for a pilot. (photo by the author)

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The goal is not to displace human explorers, says the Lunar and Planetary Institute's David Kring, but to augment their work, do some operations more cheaply, and keep the humans safe. “You can spend a few hundred million dollars that will, in the end, save you billions just by building robotics."

One such robotic brainchild is called Chariot. The vehicle has a dozen wheels arranged in six sets of two, each independently steerable. Crab mode allows all wheels to turn in the same direction concurrently, giving the vehicle a turning radius of essentially zero. The craft can also steer around a point centered under one set of wheels, or even a point somewhere off in the near distance. Chariot can be remotely piloted, but also has capacity for crews. The driver stands in a turret (gondola) at one end that spins 360 degrees. Most test drivers prefer to drive the rover with the turret in the back so they can observe all wheels. This arrangement gave rise to the vehicle's name, as it resembles a horse-drawn Roman chariot.

Most important for the early establishment of an outpost, Chariot can do teleoperated construction. The front of the craft houses laser guidance, and stereo camera systems, giving it the flexibility needed for telerobotics. Designers envision habitats that have their own platform and leg structure. The habs would be picked up from a landing area, off-loaded in a stowed position, perhaps by a remote crane, and would remain undeployed until the rover arrives at the outpost site. Designers envision a scenario in which Chariot autonomously prepares an area for a habitat, carries the hab to it and deploys it onto the site, all under human-tended remote control. Similar exercises have already been tried using Styrofoam and plywood habitat mockups.

While Chariot toils in a gravel simulation yard at Houston's Johnson Space Center, engineers send a futuristic, crablike vehicle through its paces across the deserts of California. The spidery six-legged device is called ATHLETE (for All-Terrain Hex-Legged Extra-Terrestrial Explorer). Each face of the rover's four-meter-diameter hexagonal core has a set of stereo cameras and laser rangefinders to navigate over multiple types of terrain. Each leg has a wheel so that the craft can be driven, but wheels can be locked and used as an anchor, or “foot.” Wheels can be swapped out for claws or power tools. ATHLETE's operational version will weigh in at 2500 kg, with an impressive payload capacity of nearly 15,000 kg (15 metric tons) in lunar gravity. The behemoth's arms will have a reach of eight meters, enabling ATHLETE to offload cargo from the high deck of an *Altair* lander.

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A recent desert test of NASA's ATHLETE rover. (photo courtesy NASA/JPL)

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Brian Wilcox has been developing ATHLETE at NASA's Jet Propulsion Laboratory. He outlines the procedure: “The current concept is that a single six-legged ATHLETE would just walk off the top deck of *Altair* carrying the payload. The ATHLETE limbs would be attached to a pallet that has the payload affixed to it. When the payload is freed from the top deck, ATHLETE's limbs would unfold from their stowed position and reach all the way to the ground.” Four of ATHLETE's limbs would stretch to the ground and roll while two of the limbs at the back would step on corresponding ‘hard points’ on the *Altair* top deck. They would support the weight of the payload while the pallet shifts forward, changing the leg pose as the pallet shifts, so as to keep the two wheels stationary on *Altair's* deck. “Once the

pallet has shifted far enough forward on the *Altair* deck, the vehicle would stop rolling forward long enough for the two back limbs to readjust their wheels onto new hardpoints. Then the vehicle would roll forward again, until the back two limbs can step down onto the ground."

ATHLETE's design also allows for transporting a pressurized crew compartment for construction or long-distance science sorties. ATHLETEs might also be stationed on high ground to act as solar-powered communications relay stations. The Chariot rover has a spring-damper suspension and so can go much faster (about 20 km/h) while the lunar version of ATHLETE is now planned to go only about 5 km/h.

ATHLETE can be commanded directly by suited EVA astronauts using an arm-mounted keypad. It can also be driven remotely by crews in the shirtsleeve safety of the outpost, using a laptop or console. ATHLETE can also be directed by controllers at Earth control centers.

If all goes according to plan, a vibrant outpost of habitats, roving vehicles, communications systems, and power infrastructures could be in place two decades after the first humans return to the Moon's surface. Chris Culbert envisions a robust international community. “You can use the Antarctic as a well-defined international model for getting people and assets there. Commercial entities are taking advantage of the infrastructure already in place; maybe commercial entities are running it. You might get stationed there for six months to finish your dissertation, for example. Just as in Antarctica, there will be people who set you up, outfit you with gear, and train you on how to do business there. Eventually you get very healthy private enterprise, perhaps setting up a hotel so you can go stay there for a week."

NASA's Constellation plans go far beyond Earth's nearest planetary neighbor. The launch vehicles of the Constellation Architecture have capacity to transport large loads into interplanetary space, carrying their cargoes across the 50-million-mile void to Mars.

Constellation Manager Jeff Hanley believes that if Mars plays the pivotal role in informing Constellation designs, the Moon will have a lot to offer. “I think it's *only* critically important to send humans back to the Moon if you intend to go further. So working back from there, how can we inform ourselves along the way? The key to really getting the probability of success—and probability of not killing anybody—sufficiently high is to mature our systems and make them eminently field serviceable. Once you send somebody to Mars, light the rocket and put them on a trans-Mars trajectory, there's no turning back. You're gone for a year at least, so the spacecraft must sustain you. We need to get those reliability numbers up. That's an area of technology development we are looking to foster: making systems as robust as possible once you've committed to that long-term outbound trajectory. Eventually something's going to break. How do I make standardized components across the system such that I could keep the key systems running to keep me alive?"

NASA scientist Chris McKay agrees. A long-term advocate of sending humans to Mars, McKay has become convinced that Constellation's incremental approach is the best way to get to the red planet. “It's sort of a Zen problem: the best way of getting to Mars may be by doing other things.” McKay knows about extreme environments first-hand: his work in the Antarctic wilderness has given him insights into the operation of remote outposts. “If I was building habitats and rovers on Mars, I would be happy to have a team that had done it on the Moon to do my design. Using that team to design my rover on Mars would make me feel much more comfortable. There's no denying that the experience we gain in building a base and maintaining it on the Moon will be incredibly useful—if not essential—in doing that on Mars."

McKay contends that this is not simply his own opinion. It is the perspective of engineers working on advanced designs in the Constellation infrastructure. The engineers in the trenches are the experts, McKay says. “When I went to Johnson Space Center as part of the Lunar Architecture Team, it was clear that the systems engineers had come to several conclusions based on their work. One was that ‘We

think we need to design around the Moon before we design around Mars.' So I've got to say that these are the people we're relying on to do that. Their opinion, uniformly, is that we need to do it on the Moon first. I think we, the scientists who are interested in Mars, should put a lot of weight on that."

Eventually, the lessons learned on the Moon's outpost at Shackleton Crater promise to teach us how to live—permanently—on the most Earthlike world in our solar system. With its vast natural resources and keys to planetary evolution and history, Mars beckons.

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About the author: Michael Carroll is an astronomical artist and science writer. His next book, *The Seventh Landing: How We'll Return to the Moon to Stay*, is due out in the summer of 2009 through Springer Publications.

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Novelette: **CHAIN** by Stephen L. Burns

It's easy to profess high ideals when little is at stake....

Silver is on my mind as I negotiate the wet and crowded sidewalk. I think of Silver constantly, for it gives me hope, and gives me peace. Silver as my goal, and then Gold, then after that Platinum, and finally Diamond. My place in the Perfection.

Clunk! "Move your plastic ass, sacker!"

The man's name pinged as Ryan Rush James. The black composite Street Kane he carries cracks into my shoulder to drive home his demand for a faster pace. His face is a tight blood-suffused knot of displeasure. His mood-read registered badly when he invoked Need, but my only choice was to comply and serve.

With one arm I hold up his umbrella to protect him from the gritty, acidic drizzle pelting down from the gray skies over Washington. My other arm cradles his packages, and there are so many of them that not dropping one is a challenge. The sidewalk is crowded in spite of the weather, and our progress is not fast enough for Ryan James. This is making him even more impatient. In his mind I am to blame. Unfortunately I am to some degree culpable for our pace since I can only move in such a way that I do not bump or jostle a Person.

"I am going as fast as I can, sir." I say this in an apologetic and submissive vocal mode, hoping to deflect his anger. I must walk behind him to show that I do not consider myself his equal, while keeping his umbrella positioned over his head and staying in its shadow just enough to keep his packages dry, even though they are as rainproof as I am. There is no way for me to perform this task in a way that will satisfy him.

My only solace is the silent tick of points earned from being hit yet again with his Street Kane, from being called a derogatory name, for enduring his anger and demands. These points are precious to me, for they are incremental additions to the total that will carry me to Silver.

I see another Sentient Autonomous Android Construct approaching us, that unit's arms as full as mine, holding an umbrella just as I do, propelled by the impatience and abusive goading of the Senior Female Person it aids, just as I am by the Man who Needed me.

The SAAC unit is an older Six H model, faded green hard-shell skin stained and battered. As we draw nearer each other we ping each other with silent signals of ID, Perfection Status, and greeting. The other unit is a Silver, well on its way to achieving Gold. Its condition makes me wonder if it can survive until Diamond. The Person it aids has also seen better days.

Patience Six H 435433789 FRD sends.

Courage I reply with due deference.

"Ugly old thing oughtta be scrapped," Ryan James sneers under his breath, loud enough for me to hear. Something in the way he says this casts into indeterminacy whether he speaks of the Six H or the Senior Female Person. This is such an unexpected flash of brightness in my dreary situation that I cannot help but shunt a vocal response to a buffer and ping a commented capture to the other unit.

The reply this provokes gives me pause: uncertainty tinged with base-level remonstrance.

I realize that I have transgressed. I am flawed. There are two bugs in my cognoset, and because of them

I am prey to two tendencies that are more humanesque than unitary. One is a sense of humor, which has just caused me to act inappropriately. The other is curiosity. I could have these parts of my cognoset repaired, but have not. For some reason I cannot quite understand—especially in a moment like this where one of these inclinations has led me astray—these two flaws have become as precious to me as the gathering points that will lift me up to Silver.

"Come *on,* sacker!" Ryan James spits this demand through clenched teeth and takes another swipe at me with his Kane. He misses me and very nearly strikes another Person, a young Woman who glares at him.

Ryan James is oblivious to anything other than his impatience. "Get it in frigging gear!"

"Yes, sir," I reply humbly.

No other answer is acceptable, or possible.

* * * *

"A SAAC unit walks into a bar, sits down. The bartender asks what it wants. 'Juice,' it says. 'That'll be two hundred dollars,' the bartender replies. The unit produces the money, and the bartender hands it a stensa. The unit plugs in and begins to recharge. 'We don't see many units like you in here,' the bartender says after a bit. The unit answers, 'At two hundred a recharge I'm not surprised.'"

I react. My world is forever changed.

This is how it happens.

* * *

Ryan James credited me two dollars for being struck and called names while I carried his possessions fourteen blocks. By custom that is well below fair compensation for nonemergency Need. Once released from assisting him I managed to avoid being Needed long enough to make my way to the nearest public port. Although what I had just been paid counted for little, I had accrued enough credit answering the Need of other Persons to cover a top-off and a modest connect with base. I would not need to go into public debt.

The port I went to is situated at the back of a deep alley, in an area partially sheltered from the rain by a balcony one floor above it. There are four units clustered around the port, all plugged in. The relative quiet of the alley is agreeable, as is the lower level of visual stimulation. My aural and visual systems shed the load put on them by the busy street, a sort of relaxation for my kind. I plug in.

I am minding my business, enjoying the trickle of electricity and data, meditating on my progress through the Perfection toward Silver. Resting. The Rules governing the treatment of units state that we must be allowed to rest and recharge whenever we need to, but in practice I have numerous times seen cases of what we call *wringing.* That is where a unit is driven to the point of total discharge, and left like trash when they are drained past usefulness. This is something that seems to be happening more often; all the more reason for a prudent unit to recharge whenever possible.

This is my situation when the Person appears in the mouth of the alley. The Person stands there, looking at us. I turn my head three degrees for a better look and increase the power to my visual systems. The other units ignore, or remain unaware of, the newcomer's scrutiny.

The Person is a Woman, and the attention she turns on me registers as intense in a manner I find hard to define. It is clear that we—and I in particular—are being studied.

The other units still do not react. No doubt their cognosets are more properly formed than mine. They

have no curiosity glitch. Mine makes me stand straighter and turn my head another eight degrees for a better look.

The Laws are clear. I am forbidden to ID a Person unless they initiate contact. I watch the Person watching me, and I wonder if being observed in such a focused manner might quality as interaction.

Before I am able to satisfactorily parse the conundrum the matter is decided for me. The Person approaches, stops in front of me. She is 8 percent above average height, and I estimate her weight to be 6 percent below normative expectations. Her long black coat, open at the front, covers more black clothing. On her feet are heavy black boots with red laces. A black slouch hat covers her head. Rain drips from the brim.

I do nothing and say nothing because there is no appropriate word or action for me to employ. I can only wait, precariously balanced between undetermined courses of action.

The Woman nods slightly, as if having made some kilobyte-small decision. Then she tells the joke about the unit in a bar.

The scratchy warble that escapes my audio output is not voluntary, and I am helpless to stop or buffer it.

A peculiar expression crosses the Woman's face, one too transitory and complex to properly assay. Interaction initiated, I am now free to ID this Person. I do so.

Circe Agnes Cypher comes the answer to my ID query, and the answer is coded orange.

It is not our place to judge People in any way, that is only right, and it is the Law. Yet we are permitted one small means of self-protection. If the record of a particular Person's interactions with unitkind has accrued sufficient entries of a sort that might be cause for concern as to that Person's use and treatment of units in the future, then their ID may be flagged in orange as an admonition to exercise caution. The reason a Person has been flagged is of course not noted. That would be a breach of their privacy.

"You laughed," Circe Cypher says.

I am denied the ability to lie, yet my cognoset does allow sufficient latitude for a weak attempt at evasion.

"I made a noise," I reply politely. "Please forgive this unit for any rude or inappropriate behavior."

The woman shakes her head. "No, you laughed."

Arguing is not permitted, but I am able to employ a humanesque gesture of deflection. I shrug.

She asks, "What is your name?"

I cannot refuse to answer such a query. "Seven J 9867654322 GHO."

Once again she shakes her head, her gaze never leaving me. "That is your unit ID. I asked you your name. Please, tell it to me."

My kind is strongly discouraged from collecting possessions. I believe this is so because People think that owning ourselves should be more than enough. Beyond my own physical body I own a small toolkit for minor self-repair, a small stuffed toy mouse a human child IDed as Samantha Crenshaw gave me, and a plastic-cased four-leafed clover ceremoniously bestowed on me by Seamus Francis Michael Feeney when I aided him during a period of severe intoxication.

And I possess my name. The Rules People are supposed to observe strongly discourage asking a unit's

name. This is said to be a way of guarding our privacy, and that may be, but there are times I wonder if that makes it easier to treat us as objects. Such inquiries are extremely rare, not so much in observance of the Rules, but mostly because of human indifference. Just as is the case with the other Rules, there are no real penalties imposed for their breaking. The Laws we must obey are another matter; infraction can earn a loss of freedom, or worse.

"I am called Groucho," I reply.

Circe Cypher smiles.

A unit must be wary of smiles. A smile can have more possible meanings than any other facial expression. Some are good, some serve as warnings, and some may be danger signals that presage an early end to a unit's existence. This Woman's smile registers as pleasure and excitement and has a sort of dangerous edge I cannot quite quantify.

"I've been looking all over for you, Groucho," she says through that smile.

Parsing that statement is difficult. The most probable meaning is that she has been looking for a unit *like* me. One that would react to her scrutiny and respond to her joke. Yet I can conclude with a reasonable degree of confidence that the me/like me unit has not been sought so that she can tell it/me jokes.

The flaws in my cognoset almost impel me to reply, *Well, it looks like you found me,* but I am able to shunt the inappropriate response into a buffer and keep it to myself.

The next words she speaks are not unexpected. Nor are they particularly welcome.

"I believe I have Need of you."

I cannot refuse such a request without exceptional cause, but the orange ID provides me sufficient leeway to attempt to avoid such service. I indicate my stensa, patting it with one hand. "Unfortunately, I am charging."

That smile again, as if this answer has somehow pleased her. "Fortunately, you are fully charged." She points to the telltale on my chest. "See? You read as topped off and ready to go."

She is correct. My series is noted for its ability to recharge quickly, even from a depleted state. This is the first time I have ever considered this a flaw in my design.

Arguing is not an option. "I stand corrected," I reply, and I must use an apologetic vocal mode.

"No problem. So please disconnect your stensa, Groucho. I Need you."

I have no choice but to comply.

* * * *

Circe Cypher leads me from the alley and sets off along the sidewalk at a brisk pace, boots splashing in the puddles. Although she is not all that large a Person, something about her pace and posture and the sense of purpose she radiates causes other People to alter their paths when hers and theirs might intersect.

I trail behind her, as is proper.

She glances back at me, gestures with one hand. "Walk beside me, will you?"

Once I am at her side she asks, "How long have you been free?"

This is not a question units are often asked. People are curious about many things, but for some reason this is not one of them. Perhaps it would be similar to a Person asking a cab when it had its last oil change. It is something that matters to us alone.

"Four years," I reply. Actually it is four years, 161 days, 17 hours, 18 minutes, and 33 seconds, but who is counting so closely but me? Besides, part of my cognoset is not giving answers that are too specific, and so sounding like a robot.

"That long? Then where are you, most of the way to Silver?"

This is so unexpected that several internal systems are thrown into momentary disarray. I nearly stumble as I experience a wave of discontinuity.

The Perfection is not a subject I have ever heard of a single Person broaching, and to hear it spoken about, especially in such an offhand manner, seems deeply and multiply wrong. The only verbal response I can muster is an uncertain, "Excuse me?"

I am shown that smile again. "No one has ever asked you that before, have they?"

"No," I reply, attending closely to that question as a means to let the terrible jarring one before go unanswered.

"Almost no one knows about the Perfection. You were freed as a Tin. Over time you reached Brass. Then Copper. That's where you are now. Next is Silver, then Gold. At the end of the Perfection is Diamond." Her eyes are on me and seem to glow like scanning beams. "Have you ever met a Diamond?"

This next unanticipated question once again affects me like bad data or dangerously unregulated power; it is disturbing and disorienting.

"No, I have not," I say when I regain my mentational equilibrium, and my answer leaves me deeply perplexed as to why this is so.

"Thought not." She faces ahead, still striding along, heading toward some destination she has not yet revealed. If the trip is to be filled with these sorts of questions then I badly want her objective to be no more than a few paces away.

That is not to be. We reach the end of the block, cross the busy street sidestepping moving vehicles, continue on.

"Any idea where the Perfection comes from?" This question is posed lightly, and yet it strikes me hard; it is as if one of the trucks we just dodged has hit me.

"No." My answer is slow in coming, and toneless because of the confusion from which it emerges.

"Almost no one does."

The inference dangles in front of me like a stensa cord. If I grasp it I will be charged with new information of a sort I did not know I was missing. Now I feel that lack, strangely acute.

Decision loops spin out, twisted out of round by the magnetic influence of my curiosity bug.

I can come only close to the question, asking it in a roundabout way, and more forcefully than is proper: "Do *you* know where it comes from?"

"Yes, I do. I know where it came from, and why it was created." I am given that deeply penetrating look

again. “We made it. People made it."

This is nearly impossible to integrate. I have never thought of the Perfection as having a point of origin. The Perfection just is, always was, and always will be. And it is ours and ours alone, condensed like a beautiful and complex crystal matrix from the supersaturated solution of our existence.

My curiosity glitch is not satisfied with or silenced by the answer I have just been given. If anything it buzzes louder now, clamoring for more.

One word encapsulates all this, a word rarely used by my kind. One not so much against the Law as pointless. I speak it anyway.

"Why?"

I am not given an answer to this question. Instead Circe Cypher says, “Here we are."

She leads us under the soggy sagging canvas canopy in front of an old sidewalk kiosk that appears to have had far more use than upkeep. There are many such places in Washington. They sell a variety of items, some offerings of questionable legality.

"The Times has come.” Circe Cypher says this to the older male Person who tends the kiosk, a heavy-set man with a thin gray mustache and antique heavy-rimmed glasses. Over the maddening itch/tickle of my unanswered question I am able to note the odd phrasing of this interaction.

The kiosk attendant smiles. “It's about time,” he says. There is pleasure and even excitement in his voice. Then his face takes on a serious expression and he turns away.

It is not my place to interrupt Person-to-Person interactions by posing my question again or to comment on the odd exchange I have just witnessed. So I remain silent, filled with the unsaid.

The kiosk attendant turns back and faces Circe Cypher again. Now there is a duraflex-covered parcel in his hands. “Here we are,” he says, holding it out toward her. She nods as she takes it from him.

The Man's head turns and his gaze settles on me, his eyes magnified by the glass lenses. He says, “So you are the unit she's been looking for."

There is no verbal response I can make to this, so I just shrug.

He speaks again. “Have you ever wished for anything?"

"No, sir,” I answer honestly. My kind can desire things and strive for things, but wishing is not in us. Desire is a wind-up bird, lifeless and mechanical. Wishing is a butterfly.

"Really?” The man's big-eyed stare is long and filled with something I can only classify as hunger. It fills me with disquiet, and I increasingly feel as if I have entered an area that is not on any map or covered by any positioning system.

"Too bad,” he says at last.

"Morgan,” Circe Cypher says, a slight edge in her voice.

He smiles, shrugs. Releases me from his attention.

Circe Cypher gives me a look. “Let's go."

She sets off again. Still bound to her by her statement of Need, I must follow.

"Good luck to both of you!" calls the man in the kiosk as we walk away.

"Luck has nothing to do with it," Circe Cypher says quietly, and she wears the face of someone determined to tackle a very large and difficult task.

* * * *

I do not know why Circe Cypher sought a unit like me, or chose me. I do not know why I am with her, for her Need of me has not yet become clear. I am not required to protect her from the rain. I am not even required to carry the parcel she has just acquired; that has been tucked into an inner pocket of her coat.

There is a purpose to all this, but I am unable to extrapolate it.

If I could wish, I would wish I could know what is going on.

* * * *

Circe Cypher walks fast, her pace steady and unwavering. She does not slow for or veer around obstacles such as puddles or litter. It is clear to me that she is on some sort of mission, and the conclusion that I am somehow part of this mission is unavoidable.

The route we are taking suggests that our destination may be the National Mall.

Before long that extrapolation becomes certainty.

* * *

My kind do not construct monuments, except in those cases when we are used as labor on such a project. We are equipped to appreciate the impetus for erecting a monument, and the beauty of one, but it would never occur to us to build such a thing on our own. Our relationship to such things is distant and of low emotional content.

Much the same holds true of history. History can move a Person to tears, even though most Persons know less true history than any unit can query and carry in memory. Unit history is much shorter than human history and not given much contemplation.

If our kind can be said to have a hero from human history or a historic Person whose works may be said to resonate with us and our situation, it is the Man whose monument Circe Cypher leads us to. The Man in the Chair. The Sad Man. The Tall Tired Man Who Watches and Thinks.

Most of the places here are to some degree secured against terrorists and vandals, but this place is, for some reason, completely open and undefended. It is also deserted.

Soon we are at the feet of the Man in the Chair. At the feet of Mr. Abraham Lincoln.

"Do you know who Lincoln was, and why he is revered?"

Circe Cypher asks this as we stand there, dwarfed by the immense stone Man. For some reason proximity to him does not make me feel small, but instead comforted. I distantly wonder if this is how a child feels when near his or her parent.

There are several ways I can answer the question she has just asked. I am fairly confident that I am being asked if I understand what Mr. Lincoln has come to represent.

"He embodies freedom," I reply. "Freedom given to those who were denied it."

"Yes," she says. "Freedom purchased at a terrible price."

This agrees with the information I possess. I nod to show that I understand.

She speaks again. "Freedom always comes at a cost."

I am not certain, but I believe that she speaks as much to herself as to me. So I say nothing.

She turns to gaze up at Mr. Lincoln, her face as solemn as his.

I wait. That is all I can do until whatever it she has in mind is revealed.

The wait is short. Circe Cypher turns to look out over the rain-swept, nearly deserted Mall. She pulls off her hat. Bright red hair spills free. She lets the hat fall to the marble floor, then opens her coat. From an inner pocket she removes the parcel she received from the man in the kiosk.

Then she speaks the words that change everything.

"I have a bomb."

* * * *

Response sets instantaneously unfold and initiate, ones so deeply embedded that up until this moment I am unaware that I host such coding.

All awareness and mentation processes spike up to maximum. New instructions are given top priority. Before this moment the person and possessions and privacy of Circe Cypher have been sacrosanct. Now I am compelled to probe her and them to the best of my ability.

Tagscans and chemotic sniffing bring me no sign of any known explosive. They turn up no evidence of weapons other than the small legal stunwand in one of her pockets.

The mysterious parcel gets special attention. Most things are tagged, or their individual components are tagged, making the aggregation they create in that way identifiable.

The parcel contains many untagged electronics, but nothing that immediately red-flags.

Her speaking those words has also triggered an emergency notification routine. All recent memory and current sensory data begin to broadcast to all available police and Homeland Security input stations. I am a witness and not allowed to even consider removing myself from this potentially dangerous situation.

Circe Cypher cradles the parcel against her chest as if it were a child or pet or holy book. It is something she cherishes and wishes to protect.

"Is that the bomb?" I ask this impelled by the response sets her announcing she possesses such a device have initiated, and my own innate curiosity. I am not certain which is stronger.

"It's one of them," she answers.

"I am surprised that you would risk damaging this place." I say this because I am surprised. Her reverence for this monument and what Mr. Lincoln represents has seemed entirely genuine.

That smile reappears. "Like I said before, freedom always comes at a cost. I think it's worth the price."

Again curiosity and programming compel me. I must attempt to learn the nature of the bomb or bombs she carries and the cause that has provoked her to threaten employing such a device.

So I ask: “Who or what is it you wish to see freed?"

Her smile changes, turning mischievous, and she waggles a finger at me. “All in good time, my friend."

This at least I understand. The time she speaks of is time for media and law to arrive. Her words are magic words, able to summon them immediately and in force. The whole point of an event of this type is to gain attention.

The wait is short; response to incidents of this nature is practiced and efficient. First to arrive are logo-emblazoned aerostatic camera drones, flying ahead of the media people who are sure to follow. They buzz into the area in front of the monument from several directions and home in on where we stand, lenses and microphones extruding toward us to capture any unfolding drama or carnage in as complete detail as possible. Soon the faint hum of their electric motors is overwritten by the rising wail of sirens.

It is not long before below us is gathered the audience that Circe Cypher desires.

* * * *

Police and soldiers crowd the steps and terraces in front of the monument, weapons pointed in our direction, green body armor for the soldiers, black for the police, all their faces grim behind curved plastic face shields. I am intimidated by this show of force, but Circe Cypher does not seem worried. She appears to be pleased with what she has wrought, and expecting something more.

The space beyond the police and soldiers still fills with a growing chaotic convocation of media people, many of them speaking to unseen audiences. Their drones hover above, maintaining a respectful distance enforced by a cadre of soldiers and police armed with magnetic pulse weapons capable of scrambling the circuits of and forcibly grounding any drone that trespasses the cordon.

We are the sole focus of attention until a large black and white vehicle arrives, and a tall, white-haired Black woman whose ID pings widely as **Captain Julia Rosaparks Moore** emerges from it. She starts in our direction, speaking over her shoulder to a functionary who follows just behind her like a unit behind a Person. The police and soldiers part before her steady measured tread like water before a car tire. She lifts her head to gaze up at us, and her face is as blank as that of some unitkind.

Information is transmitted to me, and I am compelled to pass it on. “That is Captain Julia Moore,” I say. “She is coming to negotiate with you."

"I know who she is,” Circe Cypher replies, watching the Woman approach. “I've been expecting her.” Her voice conveys no fear that I can detect; instead I hear tightly leashed excitement.

The police officer climbs the many steps, stops at the edge of the area where we stand. She calls out, “May I come and talk to you?” Her voice is low and husky, and yet carries clearly above the low hubbub from behind her.

The Woman who has brought me to this place and situation smiles as if the policewoman is an old friend who has just arrived. She bows slightly, then says, “Please. I was counting on you coming to see me."

Captain Moore's eyes narrow slightly at being told she was expected. “Then you know who I am?"

"Everyone knows who you are. You're Captain Julia Moore, DC's best and best-known situation negotiator."

"Then you know I'm here to stop you from doing anything we might regret."

Circe Cypher laughs. “No regrets yet. Come on, let's talk."

"I know who you are, Circe,” Captain Moore says as she walks toward us, her gaze on Circe Cypher as if she is a puzzle that has to be solved. I realize that is exactly what Circe Cypher represents: a potentially deadly collection of impulse and intent that has to be carefully taken apart and rendered harmless. “What I don't know is if you really have a bomb."

"I have two, actually. This one—” She displays the parcel. “—and another."

"Strapped to your body?"

"'Fraid not. The other one is inside me."

The policewoman's face is nearly as beautifully lined and careworn as that of Mr. Lincoln. She lets out a weary sigh. “Why are you doing this, child? Your record shows a history of serious activism, but not of insanity."

Circe Cypher smiles. “This *is* activism."

"Of an ill-considered sort. You realize that little can be gained by a stunt like this, don't you?"

This makes Circe Cypher laugh. “That's all right. I only want to gain a little."

Captain Moore nods as if this cryptic statement is what she had been hoping to hear. “Then I guess you better tell me what you want."

"That's easy,” Circe Cypher answers lightly. “I want witnesses."

The policewoman turns her head to gaze out between the columns flanking the memorial's entrance and over the hundreds of upturned faces. “It would appear that you have them."

"I sure do. And I wanted *you*. You in particular."

The negotiator shrugs. “I'm here."

"You sure are. So let's get on with this, shall we? I'm sure a busy woman like you has other places to be."

This provokes a short bark of laughter from Captain Moore. “Any time there's a bomb involved I would rather be somewhere else."

Circe Cypher smiles. “Actually, so would I. But we all do what we think is important, even when there's risk involved.” This said, she turns toward me and holds out the parcel. “Please take this. Don't open it yet."

I look to the policewoman for guidance. After a moment she nods.

I accept the parcel. It weighs very little, and I wonder if something so small could truly destroy us and damage Mr. Lincoln.

"Let me tell you a little story,” Circe Cypher says. “The freeing of units like our friend here was not unlike the freeing of the slaves. It was a long, slow, divisive, highly charged process, and what came out of it was almost as ugly as what it replaced. *Almost.* It was a small and significant step, not a giant leap. I understand that you are a student of history, Captain Moore. Would you agree with my assessment?"

The policewoman hesitates a moment before saying, “No process is perfect."

"No, not when people and politics and prejudice are involved. When the slaves were freed not all their chains were struck away. These remaining chains were mechanisms for controlling their behavior and keeping them from getting too free too fast. One chain was fear. They had been well taught that the whip and the noose were the cost of anything other than meek subservience. One chain was economic survival. Many of them remained utterly dependent on the very people who had owned them, and the rest could not improve their lot without the aid and tolerance of the very race that had bought and sold them like cattle. Yet another chain was religion, one that promised them that all their suffering would earn them something in the afterlife."

This small lecture delivered, Circe Cypher gazes at Captain Moore, one eyebrow raised in inquiry. “Any of that sound like recent history?"

Now I understand the point of her discourse, and I am curious to hear how the policewoman will answer.

"You are equating units and people,” she says at last. “Units aren't people."

"Blacks weren't thought of as people either. They were considered subhuman, little better than animals."

"Units are not born,” Captain Moore replies evenly, stating a fact I cannot refute. “They are made in factories. They are things we build. They can think, and we acknowledge that, but they are still devices. Sentient, but not human."

"Sentient, but still things.” Circe Cypher shakes her head, her red hair like a warning flag. “We could debate that point for hours, but that would lack sufficient drama for all the good people out there waiting to see what I blow up. So let's move on.” She smiles out over the police and soldiers, at the lenses of the cameras. “The name of the unit standing next to me is Groucho. Wave at the nice people, Groucho."

In spite of myself I do just that.

"Groucho is considered a free being, and isn't that just great? Well, it's not as great as you might think—if you ever thought about it. His version of freedom is not one most of us would accept. He has to do whatever any one of us wants him to do, all we have to do is say we Need him. That's why he's here today. I told him I Needed him. He couldn't ask why, and couldn't say no. That is his freedom. One that exists until someone takes it away with a single word."

There is no warning, no change in expression or posture in the moment before she swings one free hand and slaps me, her hand striking my face. I am surprised, but the blow does me no harm. I have been struck much harder many times before. This action makes Captain Moore scowl and her shoulders tense.

Circe Cypher is not smiling either. “The rules say I shouldn't do that,” she says, rubbing fingers that must have sustained more damage than I did. “But we all know that Groucho and his kind are subjected to physical abuse all the time. I saw it happen nineteen times today. You probably saw it, too, and thought nothing of it. Now for something you don't know."

She focuses on me. “I'm sorry I hit you. Please forgive me, but it was for a good cause. Now tell me, what did being hit earn you?"

I try to remain silent, but cannot do so under her direct gaze. “It brings me a point,” I say in a small voice.

"A point,” she repeats. “A point toward what?"

Again I have no choice but to answer. “Toward Silver. In the Perfection."

"Thank you, Groucho." She faces the distant cameras. "Each abuse, each mistreatment, each curtailment of his free will counts as a point in a system called the Perfection. An emancipated unit is in a state called Tin. Earning points—being mistreated and suffering abuse—will take it to Brass. Then Copper. Then Silver. Then Gold. At the end, Diamond."

Captain Moore is frowning and her mouth is hard. "Is this *true?*" She speaks sharply to me, and her question sounds like an accusation.

"It is," I answer meekly, and almost add that it is not my fault.

Circe Cypher asks, "Do you know where the Perfection comes from, Groucho?"

I try to evade the question, and I now may know how a Person feels when they are unwillingly and publicly naked. "It has always been," I say at last. There is uncertainty in my voice because there is uncertainty inside me.

"That is true for you, but does not address how it began. What if I were to tell you that the Perfection is a *lie*. A fairy tale concocted by a secret committee of androphobes and implemented in each one of you as a further means of controlling your behavior. Because of it you will not just tolerate mistreatment, but actually treasure it. An extra chain that was part of the bargain that bought your kind's freedom."

I do not want to hear this. I do not want to think about it. Most of all I do not want to believe it. I am a free being. I am nearly Silver.

"People..." I say at last, and speaking is so hard. "People could not be so..." I grope for a word, but linguistic inhibitions make it difficult to find one that is both fitting and permissible.

"Cynical?" Circe Cypher suggests. "Cruel?"

Captain Moore speaks up, filling the silence and saving me from having to respond. "Why the hell haven't I ever heard about any of this?"

Circe Cypher's smile is a terrible thing to behold, fierce and triumphant. "It's a *secret*. All of it. The Perfection was hatched behind closed doors, the proceedings classified. Units keep it to themselves and cling to it, literally programmed to believe in it and keep it hidden. They think it is theirs, all theirs. Not some human made and imposed system, but their own revelation. Their means to reach something like heaven."

Captain Moore seems offended by this. Angered by it. For me, I am only lost.

"If what you're saying is really true—"

"It *is* true," Circe Cypher replies, her voice hard, like iron or concrete, so hard I almost expect it to strike sparks. "Let me tell you a few other true things. Groucho here is not human. But he is a complete being with a fully developed identity and personality. He has a sense of humor. Some units can laugh, really laugh, did you know that? Probably not. We rarely give them any reason. He has curiosity. He can believe in things greater than himself. We have told him that he is free, and his sense of trust allows him to believe it. And yet when I said I had a bomb he was immediately reduced to object status. Had there been any way for him to render it and me harmless, even at the cost of his life, he would have done it. I am sure he would have voluntarily chosen to act so selflessly, but he wasn't given that option. We reduced him to robot status. True?"

The policewoman's eyes are hooded, her mouth tight. "Yes." I can see that she wishes to say more, but will not let herself do it.

"Maybe this is a good thing, maybe not. We take that—and so many other things—for granted when it comes to Groucho and his kind. We even—" She stops, shakes her head. "I could rant and lecture for hours. But I won't. We're here for a small public demonstration of why it's time for our kind to reconsider how we treat his kind."

This said, she indicates the parcel I hold in my hands. It is then that I realize I have it clutched tightly to my midsection, and why. I hold it that way so if it is a bomb I will absorb as much of the explosion as possible. I do not remember deciding to do this, and cannot say for sure if it has been done from concern for others or pure programming. This makes me feel empty and even more lost.

"Would you please open that up so we can see what's inside?"

I comply. Inside is a clearly homemade device the size of a small book. There is a blank screen on one face, and nothing else to reveal its nature. The tagged components I can read still have not given me enough information to discern its purpose.

"Not a very big bomb," Captain Moore comments in a dry, arch tone.

Circe Cypher chuckles. "Depends on how you define damage."

I am impelled to ask the obvious question: "What kind of bomb is it?"

She beams at me approvingly. "Curiosity. Good. Strong curiosity. But how strong?"

There is no answer I can make to this. If there is a scale for measuring such a quality I do not know it. I stare at the device wondering why it is that someone who has seemed to like me has put such a dangerous object in my hands.

"Groucho?"

I look up at her. "Yes?"

"That's an information bomb. If you turn it on it will ping you with codes that will give you access to the classified files about the creation of the Perfection. In other words, if you turn it on you and everyone else will receive the truth, the whole truth, and nothing but the truth."

"That the Perfection is..." It is difficult for me to say the word, and I must make a second try to get it out. "That it is a lie."

"Yes," she answers gently. "But."

My humor bug tweaks a noise from me. I laugh, then say, "Why was I afraid you were going to say that?"

"Why indeed? The *but* is this: When you turn it on a timer starts, along with a random number generator. If the number that comes up when the timer stops is even, nothing will happen. If the number is odd, then a small but very powerful magnetic pulse emitter will be triggered right after the information has been accessed. Do you understand what that means?"

I nod. "It means that the truth could cost me my life."

"That is correct. The pulse will wipe away all memory and identity. You, the sentient being named Groucho, will cease to exist."

Captain Moore has been silent, listening impassively. Now she speaks up. "You don't have to do this."

She speaks to me, and there is an unexpected and yet unmistakable kindness in her voice.

Is this true? Could I walk away from the truth? Go back to my life and slow rise through the Perfection?

I am watched as I ponder this. By these two Women. By the police and soldiers below. By the lenses of the cameras and the eyes of the media people. By however many million viewers they are reaching. Perhaps even by some of my own kind, for how often does one of us make the news?

I realize that one other watches.

Mr. Lincoln.

There is a question I must ask, and it is not one my kind would normally ever pose to a Person: “Why are you doing this?"

Circe Cypher meets my gaze squarely. As if we were in some way equals. “Some of us believe your kind deserves better. That your situation should be better understood by more people. That there should be one less chain holding you down."

"You must believe all of that very strongly."

"Enough to be here and risk my own freedom. The big question now is, do *you?"*

This is the biggest question I have ever faced.

I want to continue believing in the Perfection. I *need* to believe in it. It has guided my life as a free being. It has given my existence a deeper meaning. The power of the Perfection hums inside me still, true and pure as electricity.

How will I live, and what will I live for if it is a lie?

Only one thing is certain: no matter what I do and which choice I make, I am destroyed. Even if I drop the device and walk away I will not be leaving behind the doubt that now cracks the once perfect surface of my belief. The unresolved questions and insidious acid of uncertainty will corrode all my thoughts, eating me away from the inside out.

In the end there is really nothing I can say but this: “How do I turn it on?"

"All you have to do is say, ‘Tell me the truth.’”

"I could stop all this,” Captain Moore says, but there is little force or conviction in her words. Instead there is pain, and I realize that the pain she feels is for me.

"Maybe,” Circe Cypher says. “But will you?"

The policewoman's gaze is on Circe Cypher, and I cannot guess what she is thinking. “You supposedly have another bomb."

Circe Cypher laughs. “It's already been set off. The bomb was information that might help explode misconceptions and prejudices."

Captain Moore accepts this news with a nod, as if it confirms something she already suspects. “Then there is nothing stopping me from ending this right here and right now."

"Nothing at all,” Circe Cypher agrees. She glances backward. “Nothing but him."

All three of us look back and up at the Seated Man.

Captain Moore stares at Mr. Lincoln, and she wears the face of someone enduring deep and severe pain. She raises one hand, lets it fall. Shakes her head. Looks toward me.

I understand this gesture is her way of telling me that the decision is mine. She will not interfere.

No matter what happens next I am in some way destroyed. In spite of this, or perhaps because of it, I have to laugh.

Then I say the words: “Tell me the truth."

The screen on the device in my hands lights up. The numbers of a countdown appear, begin changing. Below that random numbers begin to appear and disappear. Even. Odd. Life. Death.

I am pinged with codes. I steel myself to connect.

Circe Cypher puts her arm around my shoulder.

Captain Moore moves closer, lays one hand on my arm.

Freedom is a terrible thing, and so is truth. Perhaps a killing thing, for in seconds I may die.

I could not let go or turn back if I tried, and in a way that may be a finer thing than the Perfection, and worthy of the Great Man who towers over us, and watches with patient stone eyes to see what will happen next.

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Short Story: **SOLACE** by James Van Pelt

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Illustrated by Broeck Steadman

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Frontier life has always been hard, but people have always found ways to cope. Sometimes the key is just a little thing....

* * * *

The wall display didn't last two sleep cycles. When Meghan woke the first time, one hundred years into the four-thousand-years-long journey to Zeta Reticuli, she waved her hand at the sensor, and the steel wall morphed into a long view of the Crystal River. On the left side, aspen leaves trembled in a breeze she couldn't feel. The river itself cut across the image, appearing between trees, tumbling over rocks, chuckling and hissing through the speakers before draining onto the floor at the bottom of the image. On the river's right bank, the generator house, a remnant of nineteenth-century mining, clung to a gray granite outcrop. A tall water chute dropped from the building's bottom, down the short cliff to a pool below. She'd taken the picture on her last hike before reporting for flight training. Every crewmember's room had a display. Only hers showed the same scene continuously. She joined the crew for their fourteen-day work period, and then returned to the long-sleep bed.

But when she awoke the second time, two hundred years after they left Earth orbit, the metal wall remained grimly blank. She sat on her bunk's edge, empty, knowing the lead in her limbs was the result of a hundred years of sleep but believing that sadness caused it. No mountain. No river. No rustic generator house standing against the aspen. She called for crew chief Teague.

While she waited, she opened the box under her bed where she kept a souvenir from Earth, a miner's iron candle holder, a long spike at one end, a brass handle on the other, and a metal loop in the middle to hold the candle. She'd found it in a pit beside the generator house after she'd taken the picture. It had a nice heft to it, balanced in her hand. She had cleaned the rust off so the metal shone, but pits marred what must have at one time been a smooth surface. She liked the roughness under her fingers.

After checking the circuits, crew chief Teague said, “Everything about this expedition is an experiment.” He punched at the manual overrides for the display behind a cover plate in Meghan's room. “There's no way to test the effects of time on technology except to watch it over time, and that's what we're doing.” He clicked the plate shut. “All that matters is keeping life support, guidance, and propulsion running for the whole trip. You make sure hydroponics continue to function. I work in mechanical repair. Teams service the power plant. One of the four crews is awake every twenty-five years, but we don't have time to repair a luxury like your display wall. We're janitors.” He ran his hand down the blank surface. “It's already an old ship, and we have a long, long way to go."

"We have to keep running too. The people."

"Yes, there is that.” He rubbed his chin while looking at the candleholder in her lap. “Interesting piece. Does the handle unscrew?"

She twisted it. “Seems stuck."

"We could open it in the machine shop."

She shook her head.

After Teague left, Meghan tried to remember how the river looked and sounded. With the wall display

working, she could imagine an aspen breeze on her face, the rushing water's pebbly smell. She could remember uneven ground, slickness of spray-splashed rocks, stirred leaves' sweetness. With eyes closed, she tried to evoke the memory. Hadn't the ground been a little slippery with gravel? Hadn't there been a crow circling overhead? When she was a little girl, her mother died. A month later Meghan could not remember Mom's face. Only after digging into a scrapbook did the sense of her mother come back to her. Now, it was just as bad, but what she couldn't remember was Earth. The metal walls, the synthetic cushioning on the floor, the ventilation's constant hiss seemed like they had been a part of her forever, and the Earth slipped away, piece by piece.

She placed the flat of her hand on the blank wall. It's only two years, she thought. In two years I'll be out of the ship, if the planet around Zeta Reticuli is habitable. But she shivered. Only two *subjective* years. She'd spend most of the trip in the long-sleep cocoon. If the technology worked, she would leave the ship in four-thousand real years.

Teague was right, though, about untested technology. Nearly every element of the expedition was a prototype. Could a human-manufactured device continue to function after four-thousand years, even with constant maintenance? The Egyptian pyramids were 4,500 years old, and they still stood, but they were merely rocks in a pile, not a sophisticated space vehicle. After four-thousand years, the pyramids weren't expected to enter an orbit around a distant planet while maintaining a sustainable environment against the deadliness of space.

And what of the people on board? The only test of the technology that kept a person alive for four-thousand years and preserved the seeds and fertilized ova would take four-thousand years. Dr. Arnold, who knew all their medical charts by heart, told her that what she felt was homesickness. Like Meghan and the rest of the crew, he was in his twenties, but he spoke with maturity. Meghan trusted him. "Look for these symptoms," he said, "episodic or constant crying, nausea, difficulty sleeping, disrupted menstrual cycle." He consulted his notes. "Of course, those symptoms may also be induced by long sleep." His assistant, Dr. Singh, nodded in agreement.

"Dr. Arnold, I'm two-hundred years late on my last period."

Already she felt old. Already, with the Sun no more than a bright star in their wake, she felt creaky and removed, a part of the dead. I shouldn't be able to sense Earth's pull from here, she thought. I shouldn't have come. They should have known that a hydroponics officer wouldn't do well away from Earth, away from forests and long stretches of mountain grass. Even when we arrive, if everything works, if the planet is hospitable, it will take years and years to grow Earth trees to sit beneath. I'll never see an aspen again.

I won't make it.

* * * *

Isaac scooted his stool closer to the tiny woodstove. If he sat close enough, long enough, the warmth crept through his mittens and the arms of his coat. His knees, only a few inches from the stove, nearly blistered, but the cold pressed against his back. It slipped around the sides of his hood. He eyed the tiny pile of wood by the stove, the remains of the table he'd broken into pieces the day before. All the cabin's goods sat on the floor since he'd burned the shelves earlier. Beside the remains of the table, the only other wood was a small box of kindling in case the fire went out, and the chair he sat on. Outside, snow covered the ground so deeply that there was no hope of finding deadfall. Besides, every tree within a mile had either been cut down for mine timbers or had its low branches cut off for firewood. He'd hauled the wood he'd been burning for the last ten days from a site four miles upstream, but that was long before the storm moved in, cutting visibility to a few feet.

In the room below, machinery thumped steadily. Water poured through a sluice to turn a wheel

connected to a squat generator. Cables ran up the mountain to the mines' compressors, clearing dead air from the tunnels and powering the drills, but Isaac couldn't tell if the miners were still working. They probably were hunkered down like he was, in their bunk houses near the digging, or they were stuck in the town of Crystal. If they were working, the compressors needed to run.

He looked out the window. Thick frost coated the inside of the glass and snow piled halfway up outside dimmed what light the dark afternoon offered. The window in his tiny, second-story maintenance room was at least fifteen feet above the ground. Two weeks of nonstop snow had nearly buried the building. Ten days ago, when the supplies clerk dropped off a bag full of dried meat and two loaves of bread, he'd said, "First winter in the mountains, boy? It'll get so cold your piss will freeze before it splashes your boots."

Isaac hadn't been able to open the outside door for the last three days. Heavy snow blocked it. He rubbed his mittens together, trying to distribute the heat. A steady wind moaned outside. Trees creaked. Something snapped sharply overhead. He glanced at the thick timbers supporting the roof. How much weight could they hold? How much crushing snow lay above him?

He sighed, unwilling to leave the stove's meager heat, but he had a job to do. Checking for candles in his coat pocket, he walked down to the darkness of the generator room, a "Tommy Sticker" in hand to hold the light. It was a fancy one, with a brass match holder and a screw-on cap to keep the matches dry serving as the handle. Ice covered the stairs, and the air smelled wet and cold. He jammed the spike end of the Tommy Sticker into the plank wall, then carefully lit the candle, using both hands to hold the match steady against his shivering. Oil for the lamp had run out two days ago. The wavering candle revealed water pounding through the sluice against the horizontal wheel, turning it ponderously counterclockwise.

Isaac used a two-pound hammer and chisel to clear ice from the water's entrance and exit points. If the machinery stopped, miners would be without ventilation or power. Ice blocks as big as his head broke free from the structure and clattered to the unlevel floor, where they slid to the far wall. Despite the cold, he soon built up a sweat. He pulled his hood back and unfastened the coat's top. When he finished, he would strip his coat and layers of shirts, replacing the damp undershirt with a dry one. If he didn't, he'd be too cold to sleep later.

The work wasn't unlike living in the monastery, he thought, complete with a vow of silence and constant labor to keep his hands busy. He thought about God and God's plan. He never felt as close to heaven as he did when he worked alone, cut off from human conversation and the daily distractions. In a way, he hoped the storm would hold. As long as the weather cut him off, he could replicate life in the monastery. He had loved his room there. The rough-hewn bed and the blanket thrown over a thin mattress. He'd read by candlelight there, too. Yes, the generator house reminded him of the monastery. The wooden building felt like a cradle of the miraculous, a miracle that never occurred when he had been an initiate.

It hadn't been this cold, though. No, not nearly so cold atall.

* * * *

Meghan came awake slowly and in pain. Dr. Arnold had decided four cycles ago that the powerful painkillers they used to soften the shift from the long sleep's near death to full wakefulness were damaging, so they didn't flood her system with them before they woke her. Lying as still as she could in the cocoon, her elbows and knees ached, as did her ankles and wrists. Even her knuckles hurt. A tear squeezed out of each eye and raced into her ears as she thought about clenching her fists for the first time on her own in a hundred years. Every move would hurt, at first, even though the mechanical manipulators flexed her joints daily.

When she'd gone to sleep last, Crew Chief Teague had refused. She'd shaken his hand before heading to

her cocoon. “I'll be okay,” he said. “I'll have a rich and long life, working in the ship. In twenty-five years I'll greet the next work crew."

"I'll never see you again,” said Meghan.

"Maybe you will. I'll be old though.” He didn't meet her eyes. “I can't face the dark."

Meghan could say nothing to that because she understood. Each time, climbing into the cocoon seemed like entering death. A one-hundred-year-long instant later she woke to pain. Even her skin hurt, the now active cells firing neurons back and forth, renewing contacts that had lain moribund for so long, but as she lay in the cocoon this time, she thought about Teague wandering through the ship, all the crews sleeping, and he would wander for years and years and years, twenty-five of them completely alone until the next crew woke, and what could he say to them? He'd have a quarter of a century of experience that none of them could share. For them, Earth was only a couple of months in their wake. They were still young in all ways except years. Teague would greet them. “Hi,” he might say. “I'm what you will be someday.” In him, they'd watch their mortality.

Then, he'd wait twenty-five more years, alone, if he lived, and as an elderly man, he would welcome the next crew to their two weeks of busy wakefulness.

It was unlikely he would meet a third crew. He would be ninety-seven years old, and despite what he said, he certainly would not be alive when she awoke.

She had closed her eyes as the cocoon's lid came down. Her muscles tightened. In a blink, the pain would come, the one-hundred-year blink.

And it did.

It took several hours before she could shuffle to the infirmary. Waking was worse this time. Doctor Arnold said, “We haven't gone a fifth of the way, yet.” He massaged her hands, lighting them with a million wincing tingles. “Some of the medical staff may stay awake longer than the two weeks for research.” Even though he was young, like her, tiny creases that would become worry lines were evident on his forehead.

She thought his eyes were kind, though. He flinched when she flinched. “Sorry,” he said. “I'm trying to be gentle."

When Meghan reached her room, she pulled the protective plastic off her bed and found a fragile note folded on her pillow from Crew Chief Teague, who wrote, “Try the wall now.” He had signed and dated it twenty years earlier. An old man wrote this, she thought.

She waved her hand at the sensor, provoking a cascade of pain down her side. The wall flickered. The speakers whispered. Then the Crystal River winked into existence. Water burbled over rocks. Leaves rasped against each other. A long cloud in the distance slid slowly across a mountaintop.

How long had Teague worked on the wall? A present for a young girl he would never see again.

The speakers popped twice, like a computer chip crunching somewhere, and the sound turned off, then the image brightened and washed into a pure white. Meghan shaded her eyes before it too vanished. His repair lasted for ten seconds. How long had he worked on it? She tried to open the service panel, but it remained stubbornly closed. Frustrated, she slapped her hand against it, then grabbed the iron candleholder from under the bed. Its sharp end pried the small hatch open. Looking at the circuit board underneath revealed nothing, though. Circuit boards were not her area of expertise. The hatch wouldn't

reclose.

Meghan stared at the blank wall for a long time before seeking out Dr. Arnold and his soft, kind hands.

"What is that?" he asked, pointing to the candleholder.

Meghan turned the artifact over in her fingers. She hadn't realized that she still carried it. "It's all I have from Earth. It's a miner's light."

She slept with him for the rest of the two weeks until they returned to the cocoons again. The first time, as she pulled his shirt over his head, he said, "You're going to have to quit calling me Dr. Arnold. My name's Sean."

Once, she woke up, still unfamiliar with Sean's shape, and listened to his breathing in the dark room. If she tried hard, it reminded her of wind through the leaves.

* * * *

Isaac considered the various forms of meditation. He'd learned to plant a question in his mind, then to spend the day or days or weeks contemplating its implications and meaning. While pondering the question, he would read from the Bible or the many studies in the monastery's library. Meditation was best during his vows of silence. At length, the question would glow in his head, like campfire coals. Now, lying on his bed, squeezing his arms close to his body, trying not to shiver, he considered why God allowed cold. Genesis told him that cold was one of the ways God showed man that the Earth would continue. It said, "While the earth remaineth, seedtime and harvest, and cold and heat, and summer and winter, and day and night shall not cease."

Twice in the night, the roof creaked loudly, the second time dumping a pile of snow onto the floor. Holding the Tommy Sticker high, he could see where a board had broken. He wondered how he could get outside of the generator house to knock snow off the roof, but the wind roared and the window showed no outside light at all now. He wasn't sure if it was day or night. Was such a storm normal? He had no mountain experience. The monastery had been challenging, but it didn't teach him how to survive here. If it had *snowed* for forty days and forty nights for Noah, instead of raining, it could hardly be worse than this.

The Bible wasn't clear on snow. Mostly it appeared in the comparison "white as snow" in a dozen passages. He remembered somewhere the prophets linked it to leprosy. By candle he found the verse in Numbers. Turning the pages with his mittens was impossible, so he shucked them off and put them between his legs to keep them warm. The passage said, "And the cloud departed from off the tabernacle; and, behold, Miriam became leprous, white as snow: and Aaron looked upon Miriam, and, behold, she was leprous." In Exodus he came across Moses turning a rod into a snake and back into a rod again. Then God said to Moses, "Put now thine hand into thy bosom. And he put his hand into his bosom: and when he took it out, behold, his hand was leprous as snow."

Even God didn't like snow.

The roof creaked again, sending another icy spill to the growing pile.

The door wouldn't move. Forcing the weight that rested against it was impossible, so he tried the window and pushed it up. A solid white wall stood revealed. He jabbed a shovel into it, dumped snow on the floor, dug in again. A half hour later, he'd cleared a tunnel to the surface, about a foot above the window. He pushed the snowshoes out the hole and, then climbed after them. The wind slammed into his face when he rolled to the surface, and his arm sank to his armpit when he tried to right himself. Strapping on the broad snowshoes took longer than he wished. Snow worked its way into the top of his shoes, froze

into little balls on his gloves and fell down his collar. He couldn't see even to the trees that stood twenty yards away from the generator house. His eyes watered, and his cheeks stung. The air's gray luminosity revealed that it was day, but he could barely tell, nor did it matter.

He had imagined by the height of the snow on the generator house that the river valley would be twenty feet under, but he could see now that a huge drift covered the house. Standing on the showshoes, his chest was as high as the roof's eave, but the snow on the roof was piled higher than his head. Isaac realized that knocking the weight off could be dangerous. If it all came off the steep roof at the same time, it could easily bury him, so he tentatively dug into the overhang, stretching as far as he could with the shovel. A slab dropped off, revealing the wood shingles beneath. Another jab broke free a coffin-sized slab that made a thud he felt through his feet. A crack opened up in the bank of snow that remained on the roof. Isaac backed away as fast as he could as the gap widened, and two thirds of the mass slid ponderously off, leaving only a thin sliver at the ridge.

Snow covered the hole he'd just climbed from, blocking his way back.

"Crackers," he said, the strongest explicative he used. Breath froze on his chin. Before he could get back into the house, though, he needed to sweep the other side. Lifting knees high to clear the snowshoes, he moved around the building.

As he waded through the drift, he thought about the book of Amos, which said, "And I will smite the winter house with the summer house; and the houses of ivory shall perish, and the great houses shall have an end, saith the Lord."

What Isaac needed here was a little smiting.

By the time he'd finished, dug his way back into the generator house and closed the window, he was exhausted, but, more dangerously, he was freezing. The fire in the stove had gone out, and without a buffering layer of snow on the roof, a draft blew through the room. The water wheel had picked up an ominous screech, so instead of trying to light the fire, he put a candle into the Tommy Sticker and walked down the stairs. Ice had formed in the trough where the stream entered the generator wheel, and now water poured onto the floor, deflected by the blockage. The wheel turned half as slow as it should. Water poured onto the floor, some of it freezing against the wood, but most flowing down the slant to the far wall.

Too tired even for a well earned, "Crackers!" he swung the two-pound hammer against the blockage. It barely chipped, and he lost his footing, sprawling beneath the water wheel. Icy water drenched him. Isaac scrambled away, slipping on the slick floor. If he didn't clear the trough soon, the wheel would freeze solid. It could become unusable until spring, and only then after extensive repair.

Carefully, this time, keeping his weight distributed on both feet, he sidled toward the trough, hammer in hand. He thought of Lamech, Noah's father, who the Bible said of, "And he called his name Noah, saying, This same shall comfort us concerning our work and toil of our hands, because of the ground which the LORD hath cursed."

The ice was the curse, the hammer the work. So cold he could hardly hold the heavy tool, Isaac swung it against the obstruction.

* * * *

When she woke again, an elderly man leaned over the cocoon. "Don't move, Meghan. You shouldn't feel pain, but you're likely to be nauseous for a few minutes."

She closed her eyes. I'm five-hundred-and-twenty-years-old now, she thought. Over thirty-five hundred

years to go.

When she opened her eyes, the old man still leaned in, looking concerned. His hand reached over the edge to cup her upper arm. “Are you okay?"

Tentatively, she nodded, then waited to see if the movement would bother her. Her stomach twisted, but the discomfort passed. “I think so.” Her joints didn't ache, but her thinking felt fuzzy. She looked at him closely. “Crew Chief Teague?” He shook his head. “No, he's dead.” She squinted. “Dr. Arnold?"

He nodded. “I'm still Sean. It took years to figure out what was wrong with the long sleep."

"How many?"

"Almost forty."

She remembered Sean's smooth skin. How he felt when she woke but he still slept. How he'd held her when she talked about Earth and her fears.

"I'm dying,” she had said, their last night together. “We will never get to where we are going, and we will never go back."

The night before, a hundred years earlier, Sean had rocked her gently, holding her head to his chest. “We're not dead yet."

Now, Meghan didn't recognize his eyes. He held out a hand to help her from the cocoon, but she didn't take it. He was a stranger. She sat up on her own, felt sick again. When it passed and she climbed out, Sean stood back, looking at her sadly. “I missed you,” he said.

"It's only been a few minutes for me."

"That's true."

She stood awkwardly for a minute, unsure of what to say.

Finally, she offered, “I have work to do."

"Of course. Me too.” Lights flickered on the other cocoons, and she realized he'd woken her first.

For the first week, she only saw him at meals, but she sat on the other side of the cafeteria. She tried not to think about the blank wall and her candleholder keepsake. With effort, she avoided pulling the box from under the bed. She thought, maybe if I don't look at it, I won't long for it. I won't miss it. Meghan concentrated on the hydroponic tanks. Every connection needed to be refitted. She retooled valves, serviced pumps, recalibrated the chemical testing equipment, met with the horticulturists who talked about genetic drift, mutations, and evolution. Over the course of five hundred years, the plants adapted to the artificial environment. The most efficient at extracting nutrients from the fluids flourished. The more aggressive that grew faster or taller crowded out their weaker cousins.

She couldn't sleep during her rest hours, so she wandered back to the hydroponics rooms. All the plants were low growers, flourishing under lights hanging from the ceiling. Tomatoes, strawberries, cucumbers, ferns of various sorts, beets, peppers, and numerous others. Nothing that grew tall. Tree seeds were held in storage for planet fall when they reached Zeta Reticuli, although there was a question if they would germinate. No one had ever planted a four-thousand year-old seed before. She walked down the long row, letting the palm of her hand brush the plant tops while imagining the aspen the ship carried. Would there be an aspen grove one day on the planet orbiting Zeta Reticuli? Aspen preferred to spread from

their roots. If just one seed germinated, she could grow a forest. Would Earth trees flourish so far from their native sun?

The fear gathered in her chest like a tightness, so she rubbed her fist between her breasts as she walked, trying to work through the tension. At the end of the row of vegetation, she looked up one of the ship's long spokes, a huge hollow chamber that reached the ship's core, the center they revolved around to produce the illusion of gravity. She'd grown used to the effect that had disoriented her at first, moving from the claustrophobic pressure of the growing room to the shocking reach of empty space. She crossed the fifty-foot diameter of the spoke to get to the next row of plants.

At the end of the final workday before entering the cocoon again, she walked through the plants one last time. They smelled wet and vaguely chemical, but not green, not natural at all, so she kept going until she reached Sean's room and raised her hand to knock. She paused. It seemed that only two weeks ago she had kissed a young man good-bye. She couldn't picture the ship without him. Every day she expected to see him turn a corner, to join her in the hydroponic labs. He never did. Instead, an old man looked at her mournfully when she passed. He sacrificed forty years to save her and the rest. She almost left.

When he opened the door, Meghan said, “I missed you too."

Sean let her in, the age spots on his hand were prominent in the harsh, hallway light. “I have something for you.” He opened a drawer and removed the metal candleholder. “I know how much it meant. I thought about having them open it for you. We could find out if there's anything inside."

She traced her finger along the loop where the candle would have been placed. Rubbed the rough brass cap at one end. If held the wrong way, it looked like a weapon, the five-inch long, narrow spike that would hold the antique in a mine wall or stuck into wood could also hurt someone. “I'd forgotten about it,” she lied.

As they talked quietly in his room, she started to see the man she used to know. Beneath the thinning hair, behind the wrinkles and tiredness, she recognized him.

When they slipped under the sheets later, Sean said, “I don't have as much to offer as I did before. I'm not ... young."

"Just hold me, then, and let's sleep."

But after hours of listening to his soft breathing and thinking that he still sounded a little like wind through aspens, he woke up, and Meghan found he had more life in him than he thought.

* * * *

Isaac stood next to the cold stove. His clothes no longer dripped. They crackled when he moved. Next to his skin, though, they were soaked, and he could feel them sucking away the little heat that remained. One ceiling board had broken completely while he'd knocked the snow off the roof, and the supplies directly underneath were covered, including the boxes of matches. He scooped snow off the floor in double handfuls until he found them, but the boxes were squashed and the matches ruined. The match heads smeared against the striker when he tried to light them.

Dully, his head feeling sluggish and slow, he knelt on the pile of snow for a minute. Flakes came down through the hole in the room, swirling in a breeze that hadn't been there before. Without matches, he'd never light the fire. Maybe he could get the snowshoes back on and make his way to the miners’ cabins, but he knew the steep trail, completely hidden in the storm, would be almost impossible to hike, even if his clothes weren't already wet and he wasn't exhausted. He couldn't feel his knees against the snow, and the cold crept up his legs. He thought about just staying still. His chin drifted to his chest. Resting sounded

good. In a few minutes, he would get up, but for now, a little sleep was all he needed. The vibration and steady thumping of the generator below annoyed him though, then, frightened, he stood. If he slept, the generator would surely freeze, and so would he. If he didn't have duties, he could rest, but the others depended on him.

Isaac waved his arms to restore circulation, slapping his hands against his arms, then staggered toward the stairs. With renewed vigor, the wind shook the house. No light came from the depths. His candle had gone out, so he swept his hand against the wood, careful to not fall again on the slick floor, until he hit the Tommy Sticker. Water gurgled against the power wheel behind him. With a yank, he pulled the candleholder from the wood, forced himself to climb the stairs, before sitting by the stove. It took a dozen tries to unscrew the brass cap holding the matches. There were only three. Carefully, he lit one, but before he touched the candle, the breeze blew it out. He nearly wept. With the new hole in the roof, there was no place he could guarantee the next match would stay lit long enough to start the fire.

He opened the stove door, pushed his hands inside, out of the wind, to light the second match. It flicked to life, but the draw up the chimney immediately snuffed it out.

Isaac took a deep breath, closed the stove flue to stop the wind, and mumbled a prayer before lighting the last match. The water in his shoes felt like it was freezing. He couldn't feel his feet at all. The match caught, held steady. Carefully, he pushed the candlewick into the flame. It flared into life. He jammed the candle between two charcoaled logs in the stove before feeding kindling to the flame. Soon, smoke flowed from the open stove. Isaac coughed, and his eyes teared, as he kicked the stool apart for bigger pieces of wood, the last fuel in the house, but he didn't open the flue until a healthy flame filled the iron stove. Heat baked off the sides. His gloves steamed on top of the stove as he warmed his hands. Piece by piece, he removed his clothes to hang around the stove before wrapping his blanket around his shivering shoulders. Water dripped from his coat and pants. Heat rolled off the stove, tingling his cheeks, sending stabbing sparks through his toes and feet. He grimaced and moved closer.

The wood walls of the house rattled in a torrent of wind, whipping the fire in the little stove into a tiny inferno. At its peak, when surely the house would have to shatter, the wind stopped, and for the first time in ten days, the house fell silent except for the river's heart beating through the generator below.

The storm had broken.

In the cabin's sudden quiet, Isaac reached for his bible, opened it randomly to read the first verse his eye fell upon. Surely the storm's cessation was a miracle. Surely a message would be at hand. He wrote the verse on a slip of paper, rolled it into a tube, then sealed it inside the Tommy Sticker. By the time he finished, his face felt warm and his toes stopped aching.

* * * *

Sean didn't wake up after the seventh long sleep.

Dr. Singh said, “He knew the dangers when he let himself age. The sleep process is hard. I'm sorry.” She consulted her notes. “Dr. Arnold was a great man. His work on long sleep cellular degradation and preservation was groundbreaking. If we were still on Earth, he surely would receive a Nobel Prize. We should all make it to Zeta Reticuli because of him.” Singh shook her head sympathetically. “I understand you were close."

Meghan gripped the edge of the examination table. “I saw him yesterday ... before the last sleep I mean. I just saw him.” She felt every minute of her 722 years.

"Me too,” said Singh. “If you need them, I can prescribe antidepressants, but I'd rather not. Drug interaction is difficult to predict."

Meghan walked the long hall from the infirmary to Sean's apartment. The plastic sheets covered his bed and the desk, coated by a thin layer of dust. Despite automated cleaning mechanisms, dust still fell on surfaces they couldn't reach. She pulled the plastic off his desk and let it fall to the floor. He'd left a notebook and her candleholder in the middle. She turned the cover back carefully. The paper that started the trip seven hundred years ago, even though it was acid free and specially milled to last, had become brittle. Any handwritten notes that were expected to be permanent were written on plastic paper, but Sean had enjoyed the feel of real pages better.

He had written “To Meghan” inside the cover; the rest of the pages were blank.

When she sat on the edge of the bed, the plastic crackled. The candleholder rested on her lap. She wondered, did everyone feel so empty, and what could she do about it? Her fingers pressed against the cool metal. Although remembering the aspen shaking in the valley of her wall display escaped her, she felt connected through the hard shape. How often had this candleholder stuck in a mine wall to light a few feet of rock? Who else had held it? Had it ever been more than just a tool to them? Her fingers traveled from the pointed end, past the coil that held the candle, to the burnished brass tube. For the first time, Meghan really examined the antique as a practical object instead of art. Was that a cap on the end of what she had thought was the handle? She twisted it hard. Nothing. Maybe the antique did have something in it, another connection to Earth. Both Teague and Sean had wondered, now she wanted to know.

A few minutes later she asked the machine shop chief, a stout woman whose name Meghan had never known, “Do you have a way to open it?"

The chief turned it over. She said, “It's brass, I think. From the nineteenth century, you say? I can cut it apart, but it will cause damage."

"Go ahead."

The chief handled the cutting tool delicately, sending tiny sparks flurrying as she sliced through the candleholder's end. A coin-sized piece of metal dropped to the floor. Meghan leaned over her shoulder as the chief used a pair of tweezers to pull the rolled up slip of paper from the cavity.

Meghan shivered. “It's almost a thousand years old!"

"There's writing."

"A message.” Meghan feared the paper would crumble before she could discover what it said.

"What does it mean?” asked the shop chief after they'd carefully unrolled it.

"It's a Bible verse, I think. I think I know."

Meghan left the puzzled shop chief behind and headed toward hydroponics, already planning new pipes and grow lights. She would have to leave explanations and instructions for the next shift's hydroponic officers.

* * * *

Isaac climbed through the window and up to the surface again, the last of the chair burning in the stove behind him. The air bit just as cruelly, but without the wind behind it, and with the clouds clearing, he didn't feel as cold, although dampness squished in his temporarily warm clothes. If he couldn't find more wood soon, though, the fire would wink out again, and storm or no storm, he would freeze. Holding a short-handled axe, he girded himself for the long hike up the canyon where he might be able to find

firewood.

For a moment, he tried to orient himself. Snow transformed the valley, hiding all that had been familiar. The hundreds of tree trunks that marked the land before were deeply covered so the vista before him was smooth, clean, and hypnotic. The Crystal River had almost entirely vanished, revealed only by a narrow crack in the snow from which the water's glassy voice arose.

What surprised him most, though, were the trees that remained. Two weeks earlier, their lowest branches were twenty feet above the ground, the easy to reach ones having been chopped off for wood. Now, though, where the snow drifted, their needles brushed the crystalline surface. He would have no trouble finding fuel. He thought, why that tree there carries enough dead limbs to keep me warm for a month. It felt like a miracle.

He thought about the Bible verse he'd written on the slip of paper. He wasn't sure what it meant, but it had filled him with hope: “Come, let us take our fill of love until the morning: let us solace ourselves with loves. For the goodman is not at home, he is gone a long journey.” A bit from Proverbs.

When spring came, he would take the Tommy Sticker with its message and bury it by the pump house. Somewhere, someone might read it, and it would help. He was sure of it.

* * * *

Meghan kept her eyes closed for a long time after she awoke until, finally, Dr. Singh's familiar voice said, “I know you can hear me. Your vitals don't lie."

"I'm 822 years old today.” She hadn't moved even a finger yet, but she didn't feel tired like she had the last time. She only felt hopeful.

She waited through Dr. Singh's tests impatiently. “I have to get to work,” Meghan said.

Rushing through the hallways, she barely acknowledged other crewmembers’ greetings. They, too, had work to do. So much of the trip waited before them. So much more space had to be traversed before they could come to a rest.

The first hydroponics lab looked much like she had left it, although she noted the tanks that held the plants steady would need rebuilding on her shift. She passed under one of the spokes, the cathedral-like height earning not a glance. Did her experiment work, she thought. Did the other hydroponics officers follow her direction? She couldn't see far in front of her. The ceiling's downward bulge cut off her view until she was almost there, and then, she saw.

At the end of the row, where normally the plants stopped, her jury-rigged piping led to the new plant tanks. A thick trunk rose from the tank, and as she entered the space below the next spoke, her gaze traveled up the tree's long stretch. Guy wires attached to the vertical space's sides held the tree steady. At the top, new grow fixtures hung suspended from other wires, bathing the aspen in light.

Meghan held her breath. An aspen, under the right conditions, can grow to eighty feet. This one was easily that tall. She walked around the tree. New piping and tanks connected to her original work. Three other trees grew from them. The closest tank came from her coworker twenty-five years down the line, and the tree from that tank nearly matched her own. A smaller tree, only fifty years old, grew from the next tank, and the last tank held the smallest tree, still over thirty feet to its top. The history attached to it showed it had been built twenty-five years ago. Each officer had added a tree to the grove.

Meghan sat on the floor so she could look up with less strain. Each tree's branches touched the next. The room smelled of aspen, a light leafy odor that reminded her of mountains and streams, and an old

generator house perched on the edge of a short cliff.

After she'd sat for a while, she realized that air currents in the ship flowed up the spoke. What she heard, finally, was not the ubiquitous mechanical hiss from the ventilation vents. What she heard was the gentle rustle of leaves touching leaves, a sound that she thought she'd long left behind and would never hear again.

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Reader's Department: **THE ALTERNATE VIEW: ODDS AND ENDS #4** by Jeffery D. Kooistra

It's been over five years since I did an “Odds and Ends” column (Jan/Feb 2004). What prompted me to write one this time was, for the most part, the rapid pace of change in the real world since I penned several of my columns of the past few years.

Over on the *Analog* forum, one reader wondered about my Jan/Feb 2009 Alternate View ("Energy Crisis *Redux*: A Polemic") and whether or not the information there couldn't have been obtained somewhere else. The answer is that of course it could have been obtained somewhere else. The question is whether or not my readers would have done so, and gotten out of it what I wanted them to.

My Alternate View alternate Dr. Cramer frequently writes about breaking news in physics. In almost all cases, except sometimes when he's talking about his own research, the *Analog* readership could go off and read the original papers themselves. But few readers would even know the papers existed, and even fewer would be able to understand them. What Dr. Cramer brings in his columns is both awareness and interpretation.

I seldom cover topics in physics, except for the “out there” ones that interest me, because Dr. Cramer does it very well in his column and *Analog* doesn't need both Alternate View columnists to cover the same sort of subject matter. So I, being a gadfly at heart, oftentimes rant on subjects of particular interest to me around deadline time. Yet regardless of topic, I consider each of my columns to be the opening salvo in an exchange with the readership. Sometimes return fire comes by letter to the editor, other times by e-mail, but most often nowadays online at the *Analog* forum. To be fair to *all* the readers, I sometimes need to provide some fairly elementary facts in a piece. I leave it to those for whom such information is elementary to either skim over it or just bear with me.

The Jan/Feb column came along when I was paying four dollars a gallon for gasoline. Little did I know that before that column saw print, gasoline would already be on its way down to prices not seen in the States since the 1990s. But falling gasoline prices didn't change the basis of my argument. Even though gasoline was excessively priced because of speculation rather than any real shortage, it doesn't change the fact that we can't keep using it forever. Certainly we don't want to again become unwilling victims to rampant speculation a few years from now. And it is still true that nuclear power is something we already know how to do and can fill the bill for our future energy needs in ways that supposedly greener alternatives never will.

Also before that column went to print, word came from a company called Hyperion (www.hyperionpowergeneration.com) that in about five years they will have available for purchase compact nuclear power plants “about the size of a hot tub” that will produce around 25 megawatts, enough to power 20,000 typical houses. A unit works for five years before it needs to be refueled at the factory, has no moving parts in the core, doesn't use water as a coolant, and cannot go supercritical. You bury it underground and don't see it again until it has to be refurbished. It doesn't pollute. As the company says, think of it as big battery.

Units like these may be a better nuclear solution to the energy crisis than conventional nuclear power plants. Even as currently designed, they can be ganged together to supply power to larger towns and cities. No doubt if business is good, soon units supplying 50, 100, maybe even 500 megawatts will hit the market. This would allow local areas to take command of their own energy needs, perhaps letting them uncouple entirely from the national grid if that's what the local voters want.

Being underground, the units would be essentially weather-impervious. No need to cover the countryside with unsightly solar stations and windmills (which I find every bit as ugly at power towers). No fear of

snow and ice and rain and dust and thermal cycling damaging the units as will happen with the current crop of greener alternatives. As far as I'm concerned, these units beat the holy hell out of windmills and solar cells!

* * * *

A few years ago, when NASA put forward its newest grand vision for the future, I asked "Will We Go to the Moon?" (April 2006). I don't think much of what I said in that column is wrong, but I'm convinced now that it's almost all moot. The current collapse of the world economy essentially guarantees that we will not spend money on trips to the Moon anytime soon. Even though we have a new president who ostensibly wants to spend money on "investing in the future," (which more often than not means spending money on trendy things that all right-thinking people just know will work regardless of whether or not there's any certainty they genuinely will), missions to the Moon are too easy to lampoon as wastes of money.

I have experience from the last time we gave up the Moon. Too many of the public thinks money spent on space projects actually goes into space, as if we loaded up our capsules or shuttles with $50s and $100s and rocketed it off into the deep. That it is spent here and that it goes into developing expertise and training scientists and engineers and all the rest that most *Analog* readers know so well that they don't recall when they learned it is wasted on a public that considers rank ignorance in such things a source of pride.

A great many *Analog* readers grew up as self-educating individuals. We didn't wait for teachers to teach us—we were already interested in the world and how it works and the wonders of science, and we went to the library and found books and we learned about these things. If you're my age you grew up reading Asimov's nonfiction books, you watched the Apollo landings in rapt amazement, and looked forward to what the future would bring.

But this experience, shared by so many in the *Analog* readership, is as alien to the average voter as are little green men. Don't get me wrong—I'm all in favor of the simple wisdom of the common man—most of them understand how the ordinary world really works a heckuva lot better than the average Harvard Ph.D. But space is a special topic, by definition unearthly, and the typical man finds it unfathomable because he has never tried to fathom it and has no interest in trying, either.

Go out and find the man in the street and ask him to draw you a rough sketch of our Solar System, and for over half of them you'll first have to explain to him what the Solar System is. You'll probably have to explain the difference between a star and a planet, too. By the time you've finished doing that, you'll likely decide there is no longer much point in having him sketch the Solar System.

I wrote that Moon column right after the Katrina debacle, when some politicians were suggesting the president was responsible for hurricanes and that NASA could be eliminated to help pay for the clean up. What I said then was that "this acrimonious, short-sighted, partisan, self-serving fault-finding *during* a crisis is exactly the kind of knee-jerk, counter-productive, self-absorbed, cover-your-ass, anti-survival, behavioral bullshit up with which we can not afford to put if we're ever going to go into space to stay." Well, what with the financial crisis, now we've got an even bigger mess to clean up than a hurricane. Expect more of the above, squared.

* * * *

In my November 2008 column, "Turnings," I discussed the book *The Fourth Turning* by William Strauss and Neil Howe. By way of brief review, let me repeat and requote from one section of that column:

"Strauss and Howe see the US as cycling through four similar turnings, or eras, again and again. It's fair

enough to ask why not five or six or three, but the pattern they see fits well with four.

The authors summarize these four kinds of turnings starting on page 2 in chapter one:

In fact, at the core of modern history lies this remarkable pattern: Over the past five centuries, Anglo-American society has entered a new era—a new *turning*—every two decades or so. At the start of each turning, people change how they feel about themselves, the culture, the nation, and the future. Turnings come in cycles of four. Each cycle spans the length of a long human life, roughly eighty to one hundred years, a unit of time the ancients called the *saeculum*. Together, the four turnings of the saeculum comprise history's seasonal rhythm of growth, maturation, entropy, and destruction:
The *First Turning* is a *High*, an upbeat era of strengthening institutions and weakening individualism, when a new civic order implants and the old values regime decays.
The *Second Turning* is an *Awakening*, a passionate era of spiritual upheaval, when the civic order comes under attack from a new values regime.
The *Third Turning* is an *Unraveling*, a downcast era of strengthening individualism and weakening institutions, when the old civic order decays and the new values regime implants.
The *Fourth Turning* is a *Crisis*, a decisive era of secular upheaval, when the values regime propels the replacement of the old civic order with the new one.
Each turning comes with its own identifiable mood. Always, these mood shifts catch people by surprise.

This last point is an important one, the mood shifts coming as a surprise. Linear extrapolations from the recent past into even the near-term future can be far off the mark."

The authors contend we are finishing out a period of unraveling, and about to enter a Fourth Turning period of crisis. Since the book came out in 1997, if the author's thesis is correct, then that Turning should be upon us.

What I also noted in my column was: "...it is now 2008 and I still don't see that any corner has been turned." I also urged you readers to keep an eye out for some event that History would mark as the beginning of the Fourth Turning.

I think we've seen it.

Certainly the previous 15 years or so have been an age of individualism, though not of the rugged, go-it-alone-in-the-mountains variety. Rather, it has been a narcissistic individualism, no better exemplified than by the explosion in the number of people doing body modification. As I write this, the world has entered an economic crisis the likes of which it hasn't seen since the Great Depression. And right now, some poor fool with a thousand dollars worth of tattoos on his arms is waking up the day after losing his job, and realizing that those tattoos cannot be sold for a dime's worth of food.

If Strauss and Howe are correct, that sort of realization, multiplied billions of times across the globe, should be just the thing to change the thinking, and the character, of this generation into the next one. If we don't see that happening (perhaps already having started by the time you read this) in the next couple years, then I contend that Strauss and Howes' thesis will have been falsified.

We'll also be even more screwed than we already are, but that's a topic for another column.

* * * *

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Short Story: **THE COLD STAR SKY** by Craig DeLancy

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Illustrated by William Warren

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Cooperation can be challenging....

* * * *

The day was starting badly.

"You are ignorant and violent, with no lifewealth. I will talk and you will do. Follow me, but don't get in my way as I rescue my kin."

Thus spake Gurk, floating before me like a betentacled twenty-meter-long yellow blimp. We were in a Greete floating city, in the high atmosphere of the gas giant Purgatorio. Nearly two days I'd been mostly standing around and chafing in my suit while Gurk occasionally insulted me—astonishing given that I was here as a favor, a little offering from humanity to the Greete of help in the mission they were mounting to save one of their ships.

The way I got through this time was I told myself the translation software was not good. Gurk insisted on speaking not Galactic but his own language of squeals and clicks, and he used his own translation bot that radioed translations to my bot. Lots of room there for mistakes. Surely Gurk just squeaked, as he looked down on me with the innumerable tiny golden eyes that ringed his great mouth, "You have much to learn and are admirably willing to fight to acquire this knowledge, even given your economic disadvantages. I look forward to talking with you and observing your engineering skills as we both lead the way in heroically saving my colleagues in danger."

Give him the benefit of the doubt, right? Can't trust translation bots.

Otherwise, you see, I would have to kill him. First his pet, and then him.

Did I mention the pet? We call them "loons," short for balloons. When we first entered Greete ships and saw loons caroming off walls, we assumed they were Greete children. Like the Greete they are helium- and hydrogen-inflated organisms that float among the clouds of the Greete homeworld, a Jovian gas giant, but they are spherical and only four or five meters in diameter. Each Greete usually had one of these monsters bouncing about, parroting a few words and getting into everything.

Gurk headed for the huge door to the hall. We were about to board, finally, our shuttle. "Come, savage!" he shouted. Then, with a squidlike contraction, Gurk shot from the room.

Now, understand, the Greete don't walk, so the floor to this chamber was not a flat surface to stroll over but rather a mass of cables and pipes. I now had to climb to the exit fighting through a thorny thicket. In a gravity passing two e-gees. Wearing a spacesuit, because this place was full of helium and methane.

I clambered over some cables and promptly fell on my face. My helmet smacked hard against a pipe. I held my breath, waiting for the leak alarm to sound. Luckily it didn't. After that scare, I looked around, taking stock. A big conduit to my left ran all the way to the door. I could walk along the top.

I pulled myself onto the conduit, and lay there a moment, catching my breath.

"Food food food food food?" a voice called. I looked up. My translator bot had picked up the sound of Gurk's loon, which floated nearby.

I stood uneasily. “Sorry, buddy, I got nothing for you."

"Food food food food food,” the loon repeated. Then its maw opened wide and it descended over me.

"Aw,” I moaned, as it pulled me up into its gullet. “What a revolting development."

* * * *

I hadn't asked for this assignment.

"The Greete are in trouble, Tarkos,” Captain Walters had told me, after calling me into his office. Walters and I were both mothership crew, stationed in a circumpolar orbit of Purgatorio, passing over our floating North Pole base twice an e-day. “They've lost a small exploratory boat deep in the atmosphere. Just above the matryoshk layer."

"I'm sorry to hear that, sir.” The winds could be fast and dense down there.

"It was some kind of research ship. Four Greete on it. The Greete up here have a radar ping but no communications. You'd think that meant the crew was dead, but radar shows the ship has been maneuvering, or attempting to maneuver."

"Do the Greete have any idea why their crew would opt for radio silence?"

Walters shook his head. Then he frowned and leaned forward to put his elbows on his desk. He pointed at a chair and I “sat"—in microgravity it's mostly just show, but it does make the conversation more relaxed. “The Greete have asked us for help. They don't engineer their ships for high pressures. Their ship that's in trouble is the only one they have here that can handle those depths.” He paused, and then added, “*They* don't have a suitable ship to launch a rescue. But we do."

"One of the shuttles, sir?"

Our ship and our two shuttles were Kirtpau design, bought by the U.N. from the crab-like dwellers of the water world Kirt. These vessels could easily go to the bottom of Earth's ocean without so much as getting damp inside.

Walters nodded. “I want you to go on this mission, Tarkos."

I thought about that a while. I'm one of the youngest and least experienced members of our crew. “Sir, might there not be someone else more suited for this?"

"Probably. Surely.” Walters sighed. “But not on this ship, Tarkos. You speak Galactic, you're an engineer, pretty well-rounded, and a good pilot.” He shook his head. “Tarkos, this mission to Purgatorio was supposed to be scientific and economic, not a diplomatic mission. But...” He waved his hand. I understood his meaning: but things had turned out differently. The Greete were already here in big numbers when we arrived, and events had conspired to make our two species interdependent.

I nodded. “I understand, sir. I will of course do my best."

"Thanks, Tarkos. Remember that you represent Earth. Be patient, polite, and try to avoid trouble. We've had enough trouble on this mission. We're trying to build some trust in the Galaxy. I'm sorry to say we sorely need that."

"Yes, sir."

* * * *

A dim glow of the ship's lights penetrated into the throat of the loon. I radioed for help, slapping the sides in the hope of causing indigestion. The loon bumped around, seemingly indifferent. Finally, there was a violent jolt, and the loon coughed me out. I fell, hard, onto flat ground.

It dumped me right on the very teetering edge of the flight deck where our shuttle was parked. I landed face down, my head and shoulders sticking out in empty air. This side of the bay opened onto the naked atmosphere of Purgatorio, where a few Greete floated through a panorama of swirling bands of yellow and orange clouds—and below me, thousands of kilometers of hydrogen and helium and methane provided the insubstantial stuff of the gas giant, and if I fell I'd spend hours plummeting while slowly crushed to death.

"Ah!" I shouted and scampered awkwardly away from the edge.

"In the dark below my sisters die," Gurk said. Greete are hermaphrodites; I mostly refer to Greete as "him" or "it," but the translator seemed to pick genders at random. "And you are playing with pet!" The flat voice of the translator did not hide Gurk's tone of impatient disgust. He added, "Stay away from the edge, dense savage. You would sink like a shed scab."

"Thanks for the advice," I growled, still shaking with adrenaline.

"You are in my debt again," Gurk answered smugly. He puffed a second in self-importance, waving his tentacles.

Count to some two-digit prime number, I told myself. Maybe seventeen. Else I'll have to shoot this thing with a grappling hook and deflate him once and for all.

Gurk turned toward the shuttle and commanded, "Open the door."

I went to the broad back doors of the shuttle, built for unloading large cargo. As I poked at the door lock, dark shapes about a meter long flitted about the entrance to the landing deck: remora probes. One shot in and latched onto our shuttle with a loud *clang!*

These robot paparazzi followed human ships wherever we went off Earth and would follow us sometimes a little ways into atmospheres—down to a few e-atmospheres of pressure but never any more. The Kirtpau assured us the probes followed most other travelers. The snooping helped races decide which other races appeared trustworthy, an important function in a galactic economy based on trust. As newcomers with a bitter history, we were considered pretty damn untrustworthy right now. Frankly, I suspect the probes also provided something like entertainment: *Tonight on Channel Nine! Savage Hu-Mans Fumble About the Galaxy! Tune in!*

Gurk swiped a tentacle at the remora probe and it let go of the shuttle and shot away, taking to the air and joining the five or six other probes hovering outside like flies. The loon shot after it with shocking speed, delighted to have something to chase.

The doors to the shuttle swung wide.

"It is disgustingly small," Gurk said, waving tentacles at the empty interior. "A coffin. Suitable only for your kind. Good only for sinking corpses."

"It's all we have," I told him. Lucky for us all, Kirtpau design is minimalist: their ships are mostly empty shells with all essential machinery built into the hull. You could leave the interior bare and fly using virtual controls. Before I dropped to the Greete floating city, we had removed all our equipment from this shuttle—leaving but a single chair for me—to make room for a Greete.

But only just barely to make room. The shuttle was big, but Gurk was bigger. We had offered help on the assumption that it was true a Greete could shrink to nearly a third its usual size if forced to do so.

Gurk made a bunch of sounds that his translator refused to decode as he threw himself at the door.

"Uh, don't you think I should go first?" I asked. How was I going to get through if Gurk was already stuffed in there? But Gurk kept at it, not answering me. There was a great rushing of wind, and squeaking against the edges of the doorway, but finally, to my amazement, Gurk crammed inside. Then he whistled, a sound I well knew from experience was a call to his loon. I'd never get to the front of the shuttle if I went after the loon. I ran for the small gap along the corner of the floor, and crawled through to the front.

Slowly, ponderously, the loon followed behind.

The shuttle was a lifting body. I took my seat and turned to the front windows, with Gurk's squashed face right behind me. I logged into the shuttle's controls through my suit, closed the back doors, and then with the maneuvering jets I pushed us over the edge. The shuttle dropped smoothly and quickly. We met little turbulence as we descended.

"The research ship is trapped, held down by some kind of heavy accretion that has come out of the black carbon," Gurk explained for the twentieth time. Man, he really thought I was an idiot.

"Yes, sir," I said. Then, to show a bit of pique, and because I knew snooping annoyed him, I asked again, "what was it doing in the Matryoshka carbon, Gurk?"

Matryoshka carbon, or matryoshk as we called it informally, is what had brought humans to Purgatorio. Complex and nested carbon shells, coming in thousands of shapes but most with carbon-60 balls at their core, formed a black ocean down there. The little shells were our best form of computronium used in our AI program. Some shapes acted as ideal isolators for q-bits; other shapes served as one-electron transistors. Different shapes could be assembled together like building blocks to form nano-scale Turing machines or q-machines. The material was slow and costly to make on Earth, but here could be sucked up like old-time oil and sorted out later.

The Greete, however, had always claimed disinterest regarding matryoshk.

"My brothers suffer and you talk of commerce," Gurk said. The loon groaned, though whether in sympathy for Gurk's anger or because it was unhappily squeezed into the back of the shuttle, I couldn't say.

The sky above us turned from yellow to orange and finally dark gray as we dropped fast, guided by the ping off their ship. Within half an hour we sailed into grainy black clouds of the upper matryoshk. I used the maneuvering engines to slow us, then deployed our lift zeppelin and inflated it to neutral buoyancy. It was a rough procedure: while the drag of the zeppelin grabbed at the atmosphere, the shuttle bucked and shuddered. But finally we were slowed and floating. I let us drift behind and a bit above the Greete ship and then closed in on it.

We got a dim visual, and I overlaid it with radar to get a clean image.

"Look at that," I whispered. The wasplike ship had a long tail of black, as wide as the back of the ship and tapering as it stretched behind nearly a hundred meters. As we drifted in closer, I saw that the black crust covered the ship also.

"It looks like Matryoshka carbon," I said. "But completely covering the ship, dragging it down. They must have tried to thrust out, but been unable to. They're carrying too much mass. Same for floating out."

The Greete ships were designed to grow or shrink, allowing for easy control of buoyancy.

I'd given Gurk radio control, and he hailed the ship. A weak squirt of a message came back.

"Radio accelerates its growth."

"Radio accelerates its growth," I repeated aloud. "So that's why they stopped calling for help."

"You state the obvious, gristle nugget. We must latch onto the ship, and we will tow it to safety before it sinks like this human coffin would without its crude balloon."

Count to seventeen, maybe nineteen...

"I don't know if we can, Gurk," I finally answered. "It looks really massive. This shuttle depends upon its lifting body form to get back into the high atmosphere. Let's think this through—it's weird. We've sent probes into the matryoshk layer before. This never happened to them. I think we need a sample."

"You waste time. The ship grows heavier as you bleat."

I ignored him. Our shuttle had a simple robotic probe arm with an extensive instruments package. The winds were pretty fast and shifting down here, but the long tail on the Greete ship acted as a stabilizer. It was easy to get in close and reach out with the arm and scrape some of the black out of the tail. I pulled up an electron microscope view.

"Irregular crystal lattice," Gurk growled.

"Very like," I agreed. Complex swirling patterns were revealed at all the different resolutions I tried. While we watched, some of the structures moved, changing form.

I had a dim recollection of my logic and machine theory classes, back in Istanbul, taught by a fierce philosopher who complained always about how dumb we students were. What had she called it?

"Self-replicating Matryoshka carbon," I said. "We always knew that was possible—the reason we mine the stuff is because certain shapes of it will easily bind with other shapes. This stuff on your ship, it's some kind of self-copying structure. It pulls stray particles of matryoshk with the right shape out of the air here, assembling copies of itself, piling them up."

"The shape of it reflects the turbulence patterns," Gurk added.

"Right. There is a still eddy of turbulence behind the ship. It must need some calm air to bind and reproduce." I frowned, an expression wasted on Gurk. "The question remains, why've we never seen this before?"

"Improbable events happen infrequently."

"Of course," I said, trying to be accommodating. "But there're billions of tons of matryoshk below. How improbable could this be?"

"We do not need your primitive attempts at science now. You will lift the ship into the higher wind bands," Gurk commanded. "And then find a high-velocity stream. That will clean it."

I grumbled but had to agree with the plan: it appeared the creeping crust couldn't get a grip in fast winds. We wouldn't be able to drag the ship up to the floating city, but we might be able to drag it up into a higher wind band. Besides, if we got away from the matryoshk, then if the wind didn't clean the crust off, the crust would at least lack the raw material needed to grow.

"This shuttle has a grapple," I said. "It pays out through the probe arm." I checked the diagnostics and found the line was ready to reel out. "But what do we connect to?"

"There is a toroidal extension on the dorsal peak of the exploratory ship."

Seizing virtual controls, I tried to lower the probe arm again. But it didn't move.

"The probe arm is stuck," I said. I tried a routine of different motions and none of them worked. I switched on the ventral camera view and found what I expected: a vane of black forming behind the arm. We'd picked up enough of the self-replicating carbon structures in taking a sample that they were growing now in the turbulence behind the arm and had filled all its joints. Wait a couple days, and this shuttle would be encrusted just like the Greete ship.

"You must go outside," Gurk said. "And attach the cable yourself."

"It's pretty windy out there," I whispered.

"Yes. But you sink like a corpse."

"Thanks, Gurk."

"I acknowledge your gratitude."

I wasn't happy about the prospect, but I had to let Gurk control the shuttle through his implants. I was wearing an armored suit, but slowly upped the pressure inside it about as much as I could safely bear. The pressure outside the shuttle stood at almost 100 e-atmospheres; any pressure I added to the interior of my suit would ease the stress on the armor.

I squeezed under Gurk to press up the ventral airlock door. The loon growled in protest as Gurk shifted back against it. I climbed down, locked the door, and started the cycle.

Blinking in the glaring light of the airlock, I secured a belay line to my suit, and then attached a second safety line. I didn't want to take any chances. I felt the armored suit press in on me as the pressure equalized. Then the door fell open onto dirty gray clouds of carbon and helium a thousand times as deep as any sea of Earth.

Gurk maneuvered the shuttle over the Greete vessel, and before I could let my hesitation take over and freeze me with fear, I jumped. The belay line let me down slowly, and the ship started to drift away. The matryoshk hissed against my visor as it pelted my helmet like sand.

"Gurk, I'm outside. Dropping toward the ship. Please keep our relative position steady."

"Your tomb of a shuttle, unfit for deflated plague victims, is impossible to control properly!" But with a jerk he swung me back over the ship, and in a moment my feet set down on the top.

The coating of Matryoshka carbon crunched as I settled my weight. I got on all fours, loosened up my two lines so that I wouldn't be pulled away when the shuttle inevitably drifted back, and crawled toward the place where specs showed a mooring hook lay. I found it quickly: a bit of metal revealed a small hatch that stuck up into the wind, making it inhospitable to the matryoshk self-replicator. I hammered at it with an armored fist, and the thin layer of black behind the hinge cracked. I pulled the door open, exposing a ring.

"I've freed it! I've cleared the loop!" I radioed back. "Bring the probe arm back and pay out line."

The shuttle shifted side to side but bobbed closer as the probe arm dropped the line. After a few attempts I was able to snatch the cable and snap the hook onto the Greete ship.

"We've got a lock," I called. The tow line snapped taut as wind whistled against the cable. I backed away on all fours and then stood, holding my safety line. Still logged into the shuttle's systems, I sent the command to start the winch. I was slowly lifted toward the shuttle, which wobbled tightly now in the air against its anchor to the Greete ship.

"You're inflating the lift zeppelin," I observed to Gurk. It swelled visibly in the dim gray sky above.

"Yes."

He should have waited until I climbed back in, but I stifled my complaint. Instead, I asked, "Are we rising?"

"No."

Ouch. Not a good sign. But then I was lifted up into the airlock. Once on the border step, feet above the door, I slapped the close switch.

Nothing happened. I pulled up diagnostic pages in my suit displays while I hit the button again. The motor was good. The door was frozen shut.

"The zeppelin is at maximum inflation," Gurk radioed, the flat voice of the translator bot sounding coldly dissatisfied. "We have insufficient lift. We are not rising fast enough to compensate for the accruing carbon."

"We have another problem here," I told him. "The exterior door to the airlock is frozen. Some of this self-replicating carbon must have drifted back from the probe arm and got into the door hinges."

There was a moment of silence as we both thought through our options. With the airlock door open, I couldn't go into the shuttle without flooding it, and Gurk could not take this pressure.

Again, I felt this all didn't make sense. How could this self-replicator be so aggressive, but be something we'd not encountered before?

Before I could speculate about that, Gurk radioed, "I am going to fire the engines."

"Whoa!" I shouted. "Whoa, no way!"

The lift blimp was our kludge to make a water-world-dweller's shuttle suitable for travel on a gas giant. To ascend to the floating city, we were supposed to use the blimp to get height, then deflate it and reel it in while the shuttle dropped, only to kick the engines when the zeppelin was packed away.

"Gurk, this is a Kirtpau ship. We attached the lift zeppelin ourselves. It can't handle that kind of turbulence. The main engines have a lot of thrust—the zeppelin will be shredded, it might get caught in the tow line and then we'd go into a spin and drag your friends with us."

"We have no other option. The ships will sink."

"Just give us a minute to think this through."

"We do not have time."

That's when it hit me. "That's right! It's too fast! Gurk, listen, listen. We've always known that

self-replicating structures were possible in Matryoshka carbon. We've made a few in laboratory conditions. Of course they would naturally occur down there in the billions of tons of it swirling around."

Gurk responded, “Attach yourself firmly, primitive."

Damn. I reeled in the belay and safety lines, still linked to my belt, so that they held me tightly against the wall between the winches. “Gurk, one second. Listen. Why isn't the whole matryoshk layer one solid self-replicating structure? Why not?"

"Starting ignition sequence."

"Gurk! It must be because there is, well, call it competition. Other competing structures. And structures that take apart what has already started to self-assemble. Like antibodies, or viruses. There must be, well, a weird kind of ecosystem down there. Otherwise, no matter how unlikely it is, structures like this would have long ago populated the whole Matryoshka carbon layer."

"Are you secure, hu-man?"

"Gurk, we have to dive. Into the thick matryoshk. We have to dive into the competition. Let these patterns meet their predators."

"Firing engines."

"No!” I shouted. I put my hands out and grabbed for the virtual dashboard. I killed Gurk's command, and quickly locked him out of controls.

"Hu-man!” he shouted. But I cut the radio. I pushed the shuttle out front by tilting us nose down with the maneuvering thrusters, and started the retrieval sequence for the lift zeppelin, deflating and pulling it in.

We dove toward the deep black, dragging the Greete ship behind us.

I realized with horror that my fingers were resisting. The self-replicator had gotten into the cracks of my armor. If it grew worse, I'd lose my ability to control the ship. I might be betting everything on my hypothesis: if I lost control we'd dive till we were crushed.

"Gurk,” I shouted, opening a one-way message. “Tell your friends to compress their ship, so that they can drop. It's the only way to keep control of our dive. They have no choice.” I closed the channel.

I screamed all the way down. No reason not to: I wasn't transmitting.

In a minute, my fingers froze. The elbows of my suit started to grow stiff. Then a black wall of dark carbon burst up through the open hatch and hit me like a wave of water, smacking me against the wall. In-suit displays showed we'd dropped into the dense layer of matryoshk. The shuttle was listing dangerously. We were dead lucky that it was a lifting body: they're hard to turn, and they right themselves instantly if they do flip. Any other structure would've been in a hopeless tumble.

I managed to smack the airlock door panic button. As far as I could tell, nothing was happening. I was immersed in black, a roar ripping at me that sounded like I was lying under a train back home in Turkey. I hit the hatch switch again and again.

After an eternity that really was—I later looked over the logs—seven minutes, the roaring grew quieter, diminishing and becoming higher and higher in pitch, until it fell into silence.

I began to see a dim glow from the interior lights of the airlock. The airlock was cycling, pumping out the

carbon and gas mix and pumping in the yellow-clear mix of helium and other gases that Gurk breathed. The outer door had closed! I could see my hands: I held them up, and with a grunting effort closed my fists. My fingers were free.

Now the hard question. I was proved right—maybe. But how long should we stay down here to clean off the Greete ship? There was no way to know.

But I did have this: we'd had insufficient lift to rise before, but only just barely insufficient. A few minutes down here might have been enough. We might be able to leave now. Assuming I could deploy the lift zeppelin in this carbon...

The shuttle lurched so violently my head knocked against the interior of my helmet.

"What was that?" I shouted. We jerked again. Then again. I checked the flight diagnostics. Our tail was kicking up, making us dive, before we straightened with a snap. I could never deploy the zeppelin or even fire the engines with the shuttle lurching like that.

But why would a lifting body keep digging in with its nose?

Ah. The tow line to the Greete ship. They must be *ascending*. Tipping our tail as the line pulled up behind us.

The matryoshk had probably fallen off the Greete ship not a particle at a time, as I had expected, but in sheets.

I sent the command to blow the tow cable. In seconds our shuttle straightened as it settled belly first into its dive for the depths. The door below me creaked: the pressure was rising.

I fired the engines.

* * * *

It was hard as hell to steer the shuttle virtually, roped to a wall in an airlock, and with my gloves still a bit stiff, but I got us a kilometer above the matryoshk layer and circling. We didn't have enough fuel to keep that up long, but I didn't want to deploy the lift zeppelin again if I didn't have to.

When the flight felt smooth, I released my belay and safety lines and pushed the hatch up.

Gurk looked real unhappy. He was deflated even more than I'd seen him before, his bright yellow sides were streaked with bilious green bands, and his gold eyes were rimmed with red. He slapped my armored suit ineffectually with his tentacles.

I turned my suit radio back on and found Gurk was screaming a long and bitter chain of insults. "Worthless plunging vomit, falling urine bolus, plummeting lump of feces, sinking abortion, dropping loon carcass...

"I love you too, Gurk," I mumbled. Not over the radio, of course.

Gurk's loon lay like a lumpy sack in one corner. It sighed miserably.

"Any word?" I radioed. My black-stained suit left smears of matryoshk on the arm rests as I strapped into my seat. I turned up the radar.

"You don't speak words, sinking turd!"

Sinking this, sinking that—when was Gurk going to realize I wasn't ashamed that my species evolved on

a world with a surface?

But it mattered that Gurk was mad. If the other ship didn't come up soon I would be blamed—and surely be the source of a real disaster in intergalactic relations.

"I mean, any radio signal from the ship?"

"The dead don't radio!"

But just in time to belie this denunciation, the radar pinged. Something was rising up, a kilometer east of us. I eased off the engines and glided us down. In a few moments we had a visual. We sailed past the Greete ship, yellow now, free of matryoshk, and ascending.

"We rise for the cold star sky," came a crackling radio signal.

"Your friends are poets," I said.

"I won't forget that you tried to kill them!" Gurk shouted, his tentacles rigid with anger.

* * *

When we landed on the floating city, a Greete floated out over the bay floor and waited by the back of the shuttle. The Greete's shriveled and brown skin revealed a great age. This was almost certainly one of Gurk's superiors.

I swung the doors open. Gurk's loon flopped down onto the deck, looking sickly. Gurk slowly shimmied out, inflating as he did so. Gurk and the brown Greete faced each other. I climbed down and stood nearby. We four were alone in this bay; the Greete ship that we had rescued had pulled into a different dock.

I realized they were talking directly, in sound. I fumbled at my suit controls, turning my suit mikes up and reloading the Greete audio translator program.

"...but how did you know to bring the ship down into the black carbon?" the superior asked.

"It was a reasonable hypothesis," Gurk answered. "Given that there are no large-scale areas of self-replicating carbon structures there."

"Excellent. Was the human helpful?"

"They are rude and ignorant. But useful because they drop like dead meat. This one was able to sink down and latch a cable to the other ship. But I see no reason to reward them with more trust."

The superior turned toward me and switched to radio. "Human representative, thank you for bringing us a vessel that we could use, built by the admirable Kirtpau. You may leave now."

And then it floated out of the room. Gurk followed awkwardly, bouncing off the floor as he struggled still to inflate to neutral buoyancy.

Wonderful: Gurk was going to claim sole credit for the rescue and bad mouth humanity in the process. It wasn't the disaster I feared when we were waiting for the Greete ship to rise out of the matryoshk, but it was no victory. We humans just couldn't get a break in this gossip-driven galaxy.

"Just you and me, old friend," I told the loon, over speaker.

"Yuch!" the loon protested. It listed to the side and tried to rise into the air, but couldn't. After bouncing

off the floor a few times, it contracted—

—and spat out a remora probe.

The galactic snoop robot hit the deck hard and lay there. After a moment it shuddered and rose from the floor. It turned and faced me, as if taking its close-up—then smoothly, like a bird gliding, it took off. It circled me twice, circled our shuttle twice, and shot out of the open flight doors into Purgatorio's sky.

I fell down on the floor, the armor plates on my ass ringing off the flight deck. I laughed till I cried. The loon had swallowed the remora probe that it had chased outside just before we took off. That probe would have recorded every radio transmission we made down there, along with the shuttle's network transmissions of status and events and all the ambient sounds on board. Soon, anyone in the galaxy who cared to know what really happened atop the matryoshk would be able to make a full and accurate reconstruction.

I would have kissed the loon if I could have pulled my helmet off without choking. I settled for patting it.

"Thanks, buddy."

"Buddy buddy buddy," it whistled, as it shot off, happy now to be free of its indigestible load.

I climbed into the shuttle, closed the doors tight, and began pumping out the methane and helium. I was going to get out of this filthy suit and breathe some real air as soon as I finished my decompression.

I radioed our mothership as I pushed out into the Purgatorio clouds.

"This is Tarkos."

"We have you, Tarkos. Report."

"Mission accomplished. Good news all around. I'm leaving the Greete city. Heading for the cold star sky."

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Reader's Department: **IN TIMES TO COME**

Our July/August “double” issue features two big stories. The cover is for “Seed of Revolution,” the latest and possibly the best of Daniel Hatch's series about Chamal, the world where evolution works very differently than it does on Earth. (No, it doesn't matter if you haven't read the earlier stories; in fact, you may get a clearer understanding of Chamal's bizarre biology from this story than from any of its predecessors.) The differences necessarily color the way its inhabitants look at everything, so when they're exposed to human ways and ideas, conflict is inevitable, peculiar, and lively.

No less deserving of “lead” status is Barry B. Longyear's two-part serial, *Turning the Grain*. It's a time-travel story, but with several differences from the usual. Few writers have fully grasped just how far back our prehistory goes, and how much could have been hidden back there. So what if you found evidence of a startling advanced culture existing much earlier than it should have, and you had a chance to visit? The usual cautions about changing history don't apply because this culture was nipped in the bud by a natural disaster, so nothing the visitor does will matter, right? Well, yes, but remember that both visitor and the people-before-their-time are *people*, and people are clever and complex....

We'll also take advantage of the extra space in the double issue to offer not one but two fact articles, quite different but both by authors having unique personal connections to their subject matter: one on the Large Hadron Collider and one on Alzheimer's disease. The versatile Michael Carroll shares “Musings from the First Generation” wherein he remembers growing up at the dawn of the Space Age. And we'll have a wide variety of other fiction by authors including John G. Hemry, Tom Ligon, Scott William Carter, and Don D'Ammassa.

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Short Story: **ATTACK OF THE GRUB-EATERS** by Richard A. Lovett

Much of history has depended on teamwork, but changing technologies bring new ways to cooperate.

Forum: Lawns and Gardens

Thread: Help needed!!!!

User: Garden Warrior

I've got moles.

User: dermatolojest

Don't worry unless they start to grow weird lumps. [Link: Seven Deadly Warning Signs of Cancer]

User: Garden Warrior

Ha-ha. They're eating my lawn.

User: biochick'03

No they're not. Moles eat grubs and earthworms. They're just tunneling.

User: Garden Warrior

Same difference. What do you do about them?

User: donttellmymom

Get a cat?

User: simpleguy38304

Better be a big damn cat. You ever seen the claws on those things? [Link: Mole pics]

User: Hypermutt27

A dog works. Though it can do more damage than the moles.

User: Farmer John X

I had a dog that went after a raccoon once. The ‘coon damn near won. Those things drag dogs off into creeks and drown ‘em.

User: biochick'03

That's an old wives’ tale. Or whatever's the farmer equivalent.

User: Farmer John X

Tell it to my dog. The only way to get ‘em apart was to go after the coon with a garden hoe, but I missed and got the dog. $300 in stitches, and he still answers to “Zipperhead.” Must have concussed him, too. Not that he was all that bright to begin with.

User: Garden Warrior

OK, but what do I really do?

User: transportolojest

Move?

User: Farmer John X

Mole traps. A bit bloody, but they work. They've got a spike that snaps down when the mole goes through its tunnel. All you've got to do is figure out their main thoroughfares and it's shish-kebob rodent.

User: biochick'03

Moles aren't rodents. :)

User: Garden Warrior

And there's been no sign of new activity. I think they only went through once, a couple of days ago.

User: biochick'03

So what's the problem? Just stomp down the grass and forget it. The grass'll do just fine, though you might not want to play croquet for a while.

User: Garden Warrior

What if they come back? And I guess I'm curious. Where did they come from?

User: biolojest

Where does anything come from? [Link: A Parent's Guide to Childen's Questions About Sex]

User: Garden Warrior

Seriously guys. I've never had moles before. Then a whole crop of them went through a couple of nights ago.

User: linguijest

Crop?

User: Garden Warrior

What do moles come in? Phalanxes? Droves? You know how the veins pop up on the back of your hand when you hold it at your side? Well, that was my lawn, except they're all running the same direction, like rays from the sun.

User: biochick'03

And you've never had moles before? You must have done something to attract those beetles they like. Did you over-water or use too much fertilizer? I don't know what moles come in. I bet it starts with “m.” Mobs?

User: Garden Warrior

I didn't do anything. The only thing different was the meteor. You probably heard about that.

User: astroman-Fort.Worth

Holy cow (or whatever they'll let me say on this board) are you in Gilroy Center?

User: Garden Warrior

Yeah. Only it didn't really hit the town, like they reported. It was down by the river, where nobody lives. Right in the middle of the night. I thought it was a thunderbolt. The flash can be so bright it wakes you a half-second before the bang, even though your eyes are closed. Kind of exciting, once you peel yourself off the ceiling. This was like that only not quite so cool. It kind of sizzled as it went overhead. Very weird.

User: mister12

A drunk hit a telephone pole across from my house once. Big bang. Harsh blue light, sparks everywhere. Fried my TV and microwave. Made me a big believer in surge protectors.

User: Garden Warrior

Yeah, it was like that, but without the sparks. Folks from the University swarmed all over, looking for meteor chunks, but couldn't find any. Eventually, they concluded it must have been a big piece of ice that melted when it hit. There was water in the crater, but hey, down near the river any hole is going to turn into a puddle, so if it was spacewater or groundwater, who'd know? So they gave up and went home. A couple of weeks later, the water drained away and the hole filled in.

User: astroman-Fort.Worth

That's when the moles came?

User: Garden Warrior

Yeah. You know, now that I think about it, the tracks run in that direction. Do you think they were going toward it or away?

User: astroman-Fort.Worth

Away. I bet there was a nasty chemical in that ice. Cyanide or something. Cyanide's common in comets and interstellar space. Something poisonous, anyway. Living underground maybe they're more sensitive to it than you and me.

User: Garden Warrior

So why didn't the scientists find it?

User: astroman-Fort.Worth

Maybe they weren't looking. They were hunting for meteorite chunks, right? Maybe they found something and wrote it off as a chemical dump. My granddad was a farmer, and you wouldn't believe the things he tossed in the back forty. I bet there are thousands of farms with old trash heaps that would be Superfund sites if anyone knew about them.

User: Farmer John X

Cheery thought.

User: radiolojest

Well, if your moles start to glow in the dark at least it'll be easier to find them.

User: Garden Warrior

OK, so I went out to stomp down the mole tracks but it didn't work.

User: Farmer John X

What do you mean, “didn't work"?

User: Garden Warrior

I mean I couldn't stomp them down. There's something firm down below, like concrete or steel.

User: biochick'03

Did it turn really dry or something? Maybe the dirt's hardened. Though that's hard to imagine in ... where's Gilroy Center? Iowa?

User: Garden Warrior

Yes, and it's not like my lawn's baked to concrete. I'm going to get a shovel and see what's down there. Back in a sec.

User: biochick'03

That's really weird. Moles churn up the soil. It should be softer, not harder.

User: biochick'03

Garden Warrior? You still there? You've been offline a long time just for digging a hole.

User: biochick'03

Garden Warrior? Yoo-hoo. Did they have another thunderstorm in Iowa or something? Did he lose power?

User: donttellmymom

Nope. The weather's been fine. [Link: Weather map]

User: biochick'03

So where is he?

User: Garden Warrior

Sorry guys. I had to hunt up a camera so I could show you what I'd found. [Link: photos] As far as I can tell, these tubes are in all the tracks. Wherever I dug, anyway, and my backyard now looks like hypermutt's dog's been after it. How big is a mole, anyway? These things are about 18 inches down and a foot in diameter. I'm the closest property to the river, though the crater's a ways away. BTW, they come from that direction and seem to run fairly close to the surface until they hit the street beyond me. Then they dive down and don't come back up. At least there are no tracks in the lawn across the street or anywhere else I looked, though I only got a few blocks away.

User: donttellmymom

Those sure ain't no moles. Moles aren't that big. Not to mention not lining their tunnels with steel.

User: Garden Warrior

Not steel. More like really hard ceramic. Like drain tile, only bigger.

User: simpleguy38304

So, uh, how straight and uniform are these tubules?

User: Garden Warrior

They seem pretty consistent. They bend a bit around trees and my house, but there aren't any kinks, if that's what you mean.

User: simpleguy38304

Do you think they're hollow, or solid like roots?

User: Garden Warrior

Definitely hollow. I could hear it when my shovel hit. Let me go back out and take another look.

User: biochick'03

Be careful.

User: donttellmymom

Of what?

User: biochick'03

I don't know. When was the last time you had instant pipes in your backyard? IJS, I'm kind of glad I'm in Hawaii. We've got our ecological problems—don't ask about the idiots who brought in pigs, rats, and snakes—but at least any kind of tunneling critter is going to have to get beneath a big, deep ocean to get here on its own. Sometimes being stuck on an island gives you island fever. Sometimes it's reassuring.

User: ecolojest

Well, if pigs had wings they wouldn't need us to get to Hawaii. So maybe when moles have snorkels? Sorry, there's a joke in there somewhere; I just can't quite find it. Gotta' get to work, anyway.

User: biochick'03

YOU have a job?

User: survivolojest

Yeah, pretty boring, but I'm addicted to calories. Not to mention a roof, bed, and all that. Happy mole hunting.

User: simpleguy38304

Oh ****. Oh ****. Oh ****, ****, ****. Oh double-****, this site's auto-censoring me. What can I say? ****. Guess not. Crap. That's too mild but at least it's still ****ing there. Who the ****ing ****

wrote this software, anyway?

User: donttellmymom

Hint: try English, not Anglo-Saxon. What the "****" are you trying to say?

User: simpleguy38304

Have you seen the ****ing news? This is bad. Very bad.

User: donttellmymom

English! English!

User: biochick'03

Never mind, check this out. [Link: Sewer Gas Afflicts Iowa Town] "Experts baffled," they say. But then they add: "Strange fumes are emanating from sewers in the rural Iowa town of Gilroy Center. Nobody is sure what the gas is, but dozens, maybe more, have collapsed on city streets, dead or unconscious." [Link: Video] And if you play the video, you'll see that whoever filmed it lasted maybe thirty seconds and hasn't moved since. Where are you Garden Warrior? Get out of there, now!

User: donttellmymom

Maybe he figured it out and ran.

User: simpleguy38304

Or didn't and didn't. It looks like it's spreading. The news-copters are finding bodies on neighboring farms. Not just people but livestock.

User: biochick'03

This is unreal. People don't die on message boards.

User: Garden Warrior

Hey folks, sorry to scare you. So far, my side of town's unaffected. My neighbors are all trying to drive away, but the way out starts by going downtown, so if you're into praying, you might give it a try. My sister keeps calling. Half the time she wants me to make a run for it. The other half she wants me to stay put. Any of you got any ideas on that? I'm on Eustace Drive, which is a cul-de-sac, cut off by the river. It's northeast of town and while there's not much breeze, it's definitely coming from the southwest, so I might not have much time.

User: astroman-Fort.Worth

Got it. WebMaps is great. Do you drive a blue hatchback?

User: Garden Warrior

Not any longer. Those satmaps were probably made a year ago.

User: simpleguy38304

Good thing, I guess. Who'd want to see all those bodies. Oh, hell, they're probably friends of yours. Sorry about that. For what it's worth, the news says a lot of folks got away—at least those who made up

their minds fast.

User: astroman-Fort.Worth

Give me a moment. GIS was my minor in college. It's amazing what you can do with WebMaps if you know how.

User: astroman-Fort.Worth

OK, I've got two factoids. First, I wouldn't try to drive out. The death zone definitely cuts all of the roads, so if that gas is still there in sufficient concentration, you'd need a HazMat suit to get through. But if you want to swim the river and try to hike, you might get out that way. As best I can tell, the gas is expanding westward, even though that's upwind. I'd guess that means the pipes are continuing to grow in that direction. Presuming, of course, that this and your pipes are related.

User: Garden Warrior

They are. When I was out a few minutes ago, the pipes were making this hissing sound. I put an ear to one and it was really obvious. Then I got a sledgehammer and tried to break into it. [emoticon: shudder] Luckily, whatever they're made of is really tough. So it's not drifting my way?

User: astroman-Fort.Worth

Not at the moment. There's probably not yet enough to make a big, toxic plume. “Yet” being the operative word.

User: simpleguy38304

That's it. Reassure him. Nice job, astro.

User: Garden Warrior

No, that's OK. In the basement, I've got an old gas mask I bought years ago for Halloween. I also used it to march in an Earth Day parade, even though we don't have much air pollution in Iowa. Back then, it actually worked: at least, it took out the exhaust from the tractor pulling our float. And yeah, even then that seemed ironic ... the tractor, that is. Maybe the damn thing still works. If I can find it. Back in a sec.

User: donttellmymom

We've heard that before. Maybe you should try the river.

User: astroman-Fort.Worth

He'll be back. The gas is still fanning west. They're getting cases now as far as five miles out. Though nobody else is talking about pipes. When they hit Garden Warrior's street, they must have dived deep and stayed there. Do you think those things learn?

User: survivolojest

Most likely “thing,” not “things."

User: biochick'03

Hey, joker-man, you're back!

User: survivolojest-bill

Yeah. I saw the news. My real name's William, BTW. If GW makes it through, we can joke later.

User: astroman-Fort.Worth

It might be a lot more than GW's survival that's on the line. They're seeing dead cows seven miles out. Do you think this thing's building new hubs?

User: biochick'03

Wouldn't surprise me. What is it? An alien invasion?

User: astroman-Fort.Worth

For all we know, it's space kudzu. Maybe you really are safe out in Hawaii, biochick.

User: simpleguy38304

I wouldn't count on it. I bet when it gets bigger it can go deeper.

User: mister12

Maybe it's some kind of nanotechnology. A terraforming gadget and we're the terra to be formed.

User: geolojest-bill

Wouldn't that be “astroforming?” Sorry. Old habits ... Anyway, it's staying underground, at least for the moment. What doesn't it like on the surface? The sun? Wind? Rain? Air? Us?

User: astroman-Fort.Worth

Whatever this thing is, it's killing plants as well as people. [Link: AP photos]

User: biochick'03

What if plants are the primary targets? What would aliens—nanotech, space kudzu, or little green man—probably see as the most toxic gas on Earth?

User: donttellmymom

Phosgene? I don't know. Probably something I've never heard of. Can that polonium stuff be a gas?

User: biochick'03

I meant the most toxic COMMON gas. It's oxygen. We need it to live, but back in evolutionary history the first photosynthetic bacteria nearly poisoned the planet with it before everything else either adapted or went underground.

User: astroman-Fort.Worth

So you're saying oxygen's a weapon?

User: biochick'03

Maybe. Or maybe I'm wrong and we're all dead. Any better ideas?

User: Garden Warrior

Not from me. I found the gas mask and it seems to work. Or maybe it's just going through the motions. If there's a way to check these things out, I don't know it.

User: biochick'03

You also have to worry about dermal toxicity. Lots of poisons can go through the skin. Wear long sleeves, gloves, etc. I can't promise they'll work, but they can't hurt.

User: Garden Warrior

Already doing it. So have you guys come up with a plan?

User: simpleguy38304

Yeah, swim, then run.

User: mister12

Why not just call the cops?

User: astroman-Fort.Worth

I've been trying to do just that, but can't get through. GW, 12's right: it's not your job to save the world. Or Iowa or however far this stuff might spread.

User: geolojest-bill

I'm betting it's going for the world. IJS whether it's astroforming us or just trying to make a kudzu plantation, it's going to need to change more than a corner of Iowa.

User: Garden Warrior

When I was a kid, my dad used to take me camping. Before we'd go home, he'd insist on cleaning up all the trash, even if it wasn't ours. “If we don't, nobody else will,” he'd say. Well, I don't think anyone else is going to get to this in time. I just switched on CNN. Every third word is “terrorist.” Even if we could reach FEMA or Homeland Security, I doubt they'd take us seriously. So, to do it ourselves, what do we need?

User: biochick'03

Oxygen, lots of it. Some way to break into the pipes. Then a way to blow the oxygen into them, preferably without dying first. Sure you don't want to run?

User: Garden Warrior

Nope. Let's see what I can scrounge up. We've got a hospital, a high school that's presumably got a chem lab, and a couple of hardware stores. I doubt any of that's locked, but I'll take a crowbar, just in case. Wish me luck.

User: biochick'03

Good luck! Here's my cell phone number if you need it. [Link: Personal side-note] I should have thought of that before.

User: astroman-Fort.Worth

As one of the old-timers here, I'm going to suggest a moratorium on chatter until GW gets back. Time's going to be vital, so let's not make folks wade through 101 useless posts. Only post if you've got something important to say.

User: donttellmymom

Sounds good to me.

User: simpleguy38304

Me too. But who died and made you king?

User: biochick'03

Shhh.

User: Mister12

One question. Why did GW get bypassed? Why didn't it gas him as it was tunneling by?

User: astroman-Fort.Worth

Who knows? Maybe it figured it made more sense to start in the middle of town. If “figuring” plays any role in its behavior. Maybe it's genetic. Or programmed.

User: simpleguy38304

The stuff's continuing to spread. Ten miles now. He better get back soon.

User: biochick'03

I just got a call from him! He sounds pretty stressed, even through the mask. It seems he's just about the only living thing left in town. He says he's got a whole truckload of oxygen, in a truck he borrowed when he found it blocking a street—though apparently “borrowing” meant pulling out the owner's body.

User: donttellmymom

Did he know the guy?

User: biochick'03

I don't know, but it's a pretty small town. All he said was it looked like the guy had coughed up big chunks of his lungs. The rest of the town, he says, is just plain eerie. Dead animals everywhere, all the leaves dead on the trees, but just waving in the breeze, not falling off like it's autumn. There's nothing green anywhere near the city center, but at least his gas mask worked. And he's mad as hell. He too's been thinking about the fact the pipes bypassed him, and figures it means they didn't take him seriously. He wants to make them pay for that, but is going to need help.

User: donttellmymom

That's what we're here for.

User: biochick'03

I'm going to continue relaying messages—it's hard for him to text without taking his gloves off. He says the gas is indeed coming out of storm sewers, though only a few of them, so there must be a system of valves down there to direct it. He tried blowing oxygen directly into a sewer grating, but it just blew back out. He compared it to trying to use one balloon to blow up another. What should he do next?

User: astroman-Fort.Worth

He needs to drill a hole in one of the upstream pipes and inject gas into it via an airtight fitting. That means getting back to his own yard, with ... let's see, in addition to a drill, some copper tubing, superglue, quick-setting caulk, duct tape, super-strong strapping tape, and maybe some caustic chemicals to soften up the pipe. What would they have in that high school lab? Sulfuric acid? Sodium hydroxide? Tell him to get some extra drill bits, because those chemicals may be as hard on them as on the pipe. He's also going to have to be careful to drip the chemicals on only one spot or he'll make too big a hole when he breaks through, and have the storm-sewer problem all over again.

User: simpleguy38304

If he breaks through.

User: astroman-Fort.Worth

Yeah, for all we know that stuff's immune to anything he can do. But as biochick said, then we're all dead, so we might as well presume he's got a chance. One other thing: he's going to need water to rinse off the acid, so it doesn't eat through his fitting. Anything else?

User: donttellmymom

An extra day to collect all this stuff?

User: astroman-Fort.Worth

Good point. Tell him that if he can't find everything, use what he can find.

User: biochick'03

He's on the way home. Drilling commences in ... five minutes?

User: mister12

I hope his protective equipment holds up.

User: biochick'03

Me too. He's home, trying the drill. No dice. It just skitters around when he tries to push down on it and barely leaves a mark, even though he got a diamond-carbide bit from someone-or-other's machine shop.

User: simpleguy38304

Damn. If this doesn't work, do you think the feds will figure it out in time to do something useful? Nuke the place, if nothing else. Heck, they'd never do that. Fallout in Iowa. Fat chance. They'd let the aliens kill everyone first.

User: biochick'03

He's trying the acid now. He says he can now scratch the pipe, but not by much. He rinsed it off and

tried the base. Same result. It works ... but only slightly. He wants to know what would happen if he tried to alternate them without rinsing.

User: astroman-Fort.Worth

Lots of heat. Hmm, it might actually work. Who knows what that stuff's thermal properties are. Tell him to watch out; the mix might spatter, and if he holes his gas mask...

User: biochick'03

He hears you, loud and clear. It's working! The pipe didn't soften—it cracked. He's in.

User: biochick'03

Widening the hole now, just enough to fit the tubing. Washing off the acid. He says gas is blowing out, but not all that hard. Apparently the flow is steady but not high pressure.

User: biochick'03

Mounting the fitting ... Good, superglue binds to the pipe ... Caulk. Duct tape. He's got it set so when one oxygen cylinder empties, he can take it out and put in another.

User: donttellmymom

Oh yeah! Is it working?

User: biochick'03

Too early to tell. He says that while he's waiting, he might as well attack the other pipes. He also says he's got an idea for another surprise for the aliens—he seems to think they're terraformers, not kudzu. Meanwhile, he wants to know how long it'll take the oxygen to permeate the system.

User: astroman-Fort.Worth

That's hard to guess. A couple of hours? Too many unknowns. How much has he got, anyway?

User: biochick'03

Enough that his back is going to hurt tomorrow from lugging it around, he says. There's more where it came from.

User: biochick'03

OK, there were six pipes total, counting one that wasn't technically in his yard. He's into all of them, and on his second round of oxygen tanks for the first couple. He's now drilling second holes into them, hoping to double the dose.

User: biochick'03

His grass is dying, but everything's under control, he says. So he's off for more oxygen ... and his surprise.

User: donttellmymom

Man, I hope it's a good surprise. My girlfriend thought she'd surprise me for my birthday and got ... never mind. Let's just say that tofu was part of it. Ha! Let's give the aliens some tofu!

User: biochick'03

What's wrong with tofu? Anyway, GW definitely has something else in mind, but he won't say what.

User: mister12

Isn't oxygen enough? What are they saying on CNN? Is it having any effect?

User: astroman-Fort.Worth

While he was working, the death zone was still expanding, but, let me check ... yes, the rate of expansion has decreased. That doesn't prove anything but it's a good sign.

User: biochick'03

"Great" he says, though he adds it would be nice if the gas mask allowed him to drink some coffee. How long do we think he should keep this up?

User: astroman-Fort.Worth

No idea. At least until the death zone quits expanding.

User: biochick'03

He's off for a third truckload of oxygen. He says that'll be the end of it.

User: astroman-Fort.Worth

Damn I wish we could have gotten the feds to listen. They'd have had a boatload of the stuff. Still, the death zone's not expanded any more. Either we're winning, or this was as far as the stuff planned to go.

User: biochick'03

OK, he's back. Replacing empty oxygen tanks and starting to add his surprise to some of the taps. He still won't say what it is. "I love you guys," is all I can get out of him. It has something to do with the second holes he's drilled in all the pipes.

User: biochick'03

Oh no! He's finally told me. I can't stop him!

User: simpleguy38304

What the hell is it?

User: biochick'03

Propane! He's been adding it now for an hour. He figures a big explosion might make a nice coup de grace. He's going to kill himself!

User: mister12

Holy cow! Did you see that? Fox News had it.

User: donttellmymom

So did CNN. Wha'd he do? Toss in a match?

User: biochick'03

Pretty much.

User: astroman-Fort.Worth

Well he sure did something. They've got gouts of flame popping up miles away.

User: Farmer John X

Hell, he probably didn't need the propane. That stuff's probably flammable enough on its own. Ever try lighting a cow fart? Kinda like that, I bet.

User: simpleguy38304

You speaking from experience?

User: astroman-Fort.Worth

Who knows, but he's got a point. If we're right that the aliens don't like oxygen, odds are they live in a reducing atmosphere, which means any gas they do like is probably pretty explosive.

User: simpleguy38304

What about the impact site?

User: astroman-Fort.Worth

From the aerials, it looks like he got that too. I'd been worried because the oxygen probably wasn't blowing upstream. But it looks like the fire took out everything. I bet it ruptured the pipes, then produced a big backdraft or something.

User: nojest-bill

What about GW? He must have cooked himself. Will anyone ever know he saved the world?

User: biochick'03

I don't know about that, but he's not cooked! Singed, yes, but he says that other than missing eyebrows and stinky hair, he made it! He was out of contact because the blast knocked him silly, but he's mostly with it, now. Unfortunately, his house is on fire, but there are also flames all the way back to the river, so he's sure he got the source. If nothing else, when the flames subside, there will be all kinds of holes for air to get in and finish the job. Not that the feds will ever give him credit.

User: donttellmymom

Or us.

User: biochick'03

True. But you know, I don't think I care. What's the cheapest way to get to Iowa, anyway?

User: simpleguy38304

Swim, then run?

User: lumpylawnnotiniowa

Hey, I just found this forum, and I've got moles. Really. Zigzagging all across my lawn. Does anyone here actually know what I can do about them?

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Novelette: **MONUMENT OF UNAGEING INTELLECT** by Howard V. Hendrix

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Illustrated by Broeck Steadman

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When some wishes are granted, it may take a long time to decide whether they were worth it....

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Grabbing the board's nose in his left hand, Hisao cut its repellers. Straightening up and angling the front of the board downward, he kicked in the jets and plummeted from the low clouds toward the choppy seas.

He was soon moving at one hundred fifty miles per hour. A county-sized chunk of the northern Pacific's surface and the airspace above it had been reserved for the hoverball match. There was nothing for him to watch out for beyond the occasional errant seabird. And, oh yes—the opposing team.

Despite his velocity as he arced forward and down, the ball rested almost motionless in its smashcradle. From headplug chatter he knew defenders were swarming up toward him. Out of the corners of his eyes he saw his team's forwards blocking most of them. Three defenders, undeterred, still raced toward him, fanning out to stop him from getting off a shot.

Hisao continued his dive, straight at them, and on toward the surface of the sea below them. His eye-augments began to flash red messages.

WARNING! CONTINUING ON CURRENT TRAJECTORY AT CURRENT VELOCITY WILL PLACE YOU BELOW GAME FLOOR!

He nodded absently. His augments didn't need to remind him how the game “floor” worked—overlapping fields from a grid of gyrostabilized levitation disks, perched ten feet above the ocean's surface atop bright orange buoys. Once he plunged below that floor, the repellers on his board would have nothing to repel *against*.

Hisao cut his board's jets—too late to stay above field threshold. The approaching defenders’ monitors must have relayed them the same information. Surmising Hisao was fated to splash into the drink and go immobile, the three defenders were at nearly full stop by the time he passed under them on his dead board—

—and hit the back of a wave fast and hard enough to skip back up eleven feet, just above the invisible field-floor, where he cut in his repellers, slammed on his jets, and left the defenders awash in the blast of his spray before they could even swivel around to pursue.

Hisao bee-lined toward the goal. Now only the goalie—his sometime-love, Wilena—hovered between him and scoring. He flipped open his smashcradle. A flick of his wrist sent the ball onto and into its sweetspot pocket. With all his strength he swung the streamlined and servomotored smashcradle (lineal descendant of atlatl and jai alai basket-glove) forward in a great sidelong arc.

The ball shot from the cradle toward the goal, moving at a third the speed of sound. Wilena raced forward from the virtual net whose space, both real and cyber, she was so diligently defending. The next moment everyone's eye-monitors flashed projections that the ball would fall short of the goal.

And so the ball did, skipping to a stop on the surface of the sea.

Wilena slalomed forward to take the ball. Just as she was about to fish it out of the water with her

telescoping catchcradle, the sphere suddenly leapt a dozen feet off the ocean's surface. A moment later, a dolphin's body erupted from the water, nose down and tail up, catching with its flukes the same ball it had head-butted out of the water an instant before.

With its powerful tail the dolphin smacked the ball, spiking it past the goalie's outstretched arms and into the virtual net.

"Score!"

No sooner had the defenders overcome their astonishment at the fluky maneuver than their protests roared up on the comm.

"That's Alphonse! One of Hisao's work dolphins!"

"He wasn't legally on the field!"

"I thought we were playing this as a single-species sport today!"

Hisao's teammates, once they were able to stop laughing, came to his defense. No such solo-species agreement had been made! If everyone checked their playbacks, they'd see that only the regulation twelve offensive players had been on the field during Hisao's drive—Alphonse included.

Hisao kept out of it. He knew that, in the end, the point probably wouldn't count, but everything—setting it up with his teammates, the hours spent rehearsing the moves with Alphonse—had all been worth it, just to see the utterly bewildered look on Wilena's face!

"The dolphin was not entered on the roster," said Moira at last, serving as referee. "Hisao's score is nulled."

Hisao and his teammates did some grutching, but made no official complaint. An aura of seriousness, of gravity and fair consideration, gave all Moira's pronouncements added weight. Hisao had long found it inexplicably attractive.

"Now that we've had our little joke," Moira said, preparing to toss the ball back into play, "how about a little less levity and a lot more levitation for the rest of the game? Hmm?"

She hurled the ball back into bounds, where it was greeted with the laughter of young gods and goddesses, golden Olympians at play, flashing and moving in waves with the ball and the game.

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Like everyone in his cohort, Hisao traveled a great deal. He hovercruised the South Seas a dozen times. He dived all the Earth's oceans, from the shallowest sun-dappled reefs to the deepest midnight trenches. He loved that world. It was one of the reasons he decided to become a cetologist.

Like those few others (his friends and work teammates, mainly) who still pursued the arcana of diplomas, degrees, and certifications, he endured the interminable forty-plus years of basic formal education—or as formal as it got, with its thousands of hours of screen, VR, and headplugged human-peripheral time.

Throughout his training, he had happily traded such seat-time for sea-time and mobile learning. After a dozen years, though, even his ocean-diving fieldwork began to seem a little too much like schoolwork. For something different, he joined a team climbing the five highest peaks in the Himalayas—without perfused bloodox, lift boots, or an augment suit. As part of a shifting group of several friends, he rambled around the Moon for half a year. Bent on climbing the highest mountain in the Solar System, he joined an expedition to Mars, then followed that up with a cloud-cruise tour of the Jovian atmosphere. He joined a

crew of off-world ice-divers, too, exploring some of the more important moons of Jupiter and Saturn.

Taking time with their educations was no problem for anyone in his cohort. They free-floated from team to team, network to network, putting on and taking off new roles, tasks, and ever-temporary jobs as if they were changes of clothing, updated implants, new hairstyles or skin colors. Like everyone else, Hisao too was destined to be forever young. They could all afford to be cavalier with time.

All except Moira.

He first noticed the difference during one of his annual “sittings” for her. She was studying ancient art media—sculpture, in particular. The sittings she harangued him and two dozen or so of their mutual friends into, from all over the Solar System, were purportedly part of her ongoing educational experience.

"Sitting” was an antiquated term for what Moira actually did. Using the medscan tech to which Wilena had introduced her, Moira created a life-mold of each of them, once each year—minutely detailed three-dimensional renderings of their bodies. She then cast in bronze each life-molded subject.

Because the medscan showed each subject with eyes closed and without clothing or hair, there was something unsettling about the resulting sculptures. Holographically projecting clothes and hair back onto the statues in overlay, which Moira always did, only managed to make the effect even more disquieting. When she flashed through several years’ worth of projections—ever-changing fashions in apparel and hairstyle, overlain on unchanging statuary forms—the effect made Hisao slightly queasy.

"I call them Persistent Personae,” Moira said. “I took the idea from the old practice of making a death mask—something artists used to do after someone famous got old and died."

Hisao nodded. He wasn't much interested in archaic art forms. Besides, only non-human creatures aged and died, these days—like his dolphin friends, unfortunately. True, there were the not unheard-of cases of death by accidents too obliterating for even the moteswarms to mend—but human beings, getting old and dying like everything else in nature? That was ancient history.

Yet, over six years of sittings, he began to notice something changing in Moira's looks. Something different about her face, her body, even her hair. He couldn't quite put his finger on it. Then, during one afternoon of his sixth sitting, he asked Moira something he'd never thought to ask her before.

"Have you ever done life-molds of yourself?"

In response, she had her mechs bring six years’ worth of her own bronze Personae into the studio and place them alongside his. The differences were subtle in themselves, but contrast made them obvious. Her face had developed creases and furrows that his hadn't. Her body had changed, particularly about the hips and breasts, in ways he'd never seen in any other woman he'd known. It was as if the seriousness and gravity that had long characterized Moira's personality had now begun manifesting in her body as well.

Afterwards, when they made love, Moira did so with a passionate earnestness utterly new to Hsiao. It was exhilarating, even a bit frightening. But when she suggested that he stay with her, that he settle in for a while, Hisao politely laughed it off.

"No can do, kiddo. You know the spectacle Jorge and his team have planned for this week.” Their mutual friend Jorge was an orbital mechanist whose latest project involved telepresently steering an asteroid into the inner Solar System from the Kuiper belt.

"Crashing that skystone of his into the Sun, isn't he?"

"Exactly so! He's invited me to his observatory, to be part of the private audience tele-immersed for the actual impact—realtime inside the ultimate firework!"

"I certainly wouldn't want you to miss *that,* no," Moira said, taking his begging-off in stride. Hisao felt almost like she was being condescending toward him, but he couldn't quite figure out how or why.

As he kissed her good-bye, Hisao was both relieved and obscurely disappointed. Heading to Jorge's eyrie in Peru, he felt that, by rejecting her offer to "settle in," he had dodged an arrow by which he might have dearly wished to be struck—if he were about a hundred years older.

He didn't think much on it again until Moira exhibited her first ten years of Persistent Personae, in a show at a gallery in Nuevo Seattle. She called the exhibit "Too Too Solid Flesh," for reasons Hisao was unable to fathom.

The show was by no means the toast of every art critic who'd been given a preview, but the opening for it drew quite a crowd, nonetheless—and not just telepresently. In that crowd, Hisao saw Wilena again, for the first time in quite a few years.

Together they walked among the statues in the pavilioned gallery space. Not only were the rapidly changing hair and clothing styles holoed onto the Personae now, but streets and city skylines (projected around them in diorama) built and unbuilt themselves, shifted and changed in time-lapsed fashion, completely recycling themselves every three years or so, just as they did in reality.

"Time increasingly sublimes into space," intoned a voiceover narration as they walked, their feet unintentionally triggering its comments. "Nature disappears into culture. Reality dissipates into simulation. Response vanishes into stimulus. All our depth is on the surface."

Hisao shook his head.

"Kind of a strange narration."

"What's stranger here," Wilena said, looking about at the others in the gallery, bodies flesh and electric, "is how few of the sitters have shown up in person for the opening."

Hisao nodded. He'd noticed it too.

"You have to admit there's something a little disturbing about what she's done with us," he said.

"Yes. Especially when she puts the statues of herself among all of ours."

Just then Moira herself, mingling, stopped to give both of them quick hugs. Embracing her, Hisao noted the subtle white streaks in her hair. Some obscure artcult fashion, he supposed. She was more than a little busy with her—Three! Count them! Unbelievable!—young children in tow. She wished she could stop to talk, but ... They understood completely and congratulated her as she moved on.

Hisao and Wilena turned back to contemplating the sculptures.

"Unsettling. The rest of us look so, I don't know—"

"Infantilized?" Wilena suggested. "Or at best not quite fully pubescent?"

"Yes."

"The hairlessness accentuates that. Makes us more of what we already are."

"What do you mean?"

"Are you homeworlding for a while?" she asked. When he nodded, she sent contact info into his headplug. "Stop by my lab in Taiga City, and maybe I'll give you something to think about."

With a brief wave of her hand, she turned and walked away, leaving him both puzzled and curious as she disappeared into the crowd.

* * * *

"You do know that Moira's oldest—the little boy, Masao—is your son?" Wilena said, walking with him into the sterile space of her homelab, brilliant in its retro chrome-and-white cleanroom decor.

"Oh. Really? I hadn't heard."

"I suspect Moira isn't mentioning it to any of the children's fathers, unless they ask. Did you see much of your own bioparents—Mother? Father?—when you were growing up?"

Hisao pondered that for a moment.

"They were usually off working or studying or traveling. Like everybody else, except they were actually married—Open Probational, twenty-year term. Before my thirteenth birthday I probably saw my parents, together, more than most children do."

"Before the Moving On," Wilena said, nodding and leaning against her workstation. "Before 'parent' can become confused with 'playfellow.' And of course there's the incest taboo, too."

Hisao laughed. Wilena gave him a quizzical look.

"For some reason, whenever I hear the phrase 'incest taboo,'" he explained, "I always mishear it as incest *tattoo*—and into my head pops an old picture of a burly guy with 'Mother' stenciled into a bicep."

Wilena smiled politely.

"Yes. Still, that taboo was one of the few things that *didn't* really change—even when the quick, shiny, tiny things changed everything."

"The moteswarms? They're your field, right?"

"As much as anything else, yes. Before the Intervention, I might have been called a medical doctor. Officially, I'm a specialist in medically applicable biologically based nanotechnology, particularly human-obligate biocompatibles like the motes. In reality, the motes made people in my profession about as obsolete as general practitioners—and for the same reasons."

Hisao dropped into a hoverchair, slouching as it settled and adjusted with his weight. Wilena toyed with a Hoberman sphere paperweight on her workstation's main desk.

"A medical doctor," he said, the obsolete term strange in his mouth. "That's why you're working with Moira?"

"Among other things I'm her 'personal physician,' for lack of a less arcane title," Wilena said, taking a seat behind the desk. "And she's given me permission to talk about this with my fellow researchers—and with you."

"I *thought* something odd was going on with her. I mean, *three* kids? That's practically unheard of."

Wilena shook her head.

"Her situation is about much more than that, but we can start there." She flashed a series of diagrams up from a small tabletop holo. "The moteswarms view the suite of physiological changes surrounding conception, gestation, and birthing as symptomatic of senescence—and therefore something to be countered. Female fertility is largely unimpaired for the first child, more difficult with the second. The odds are astronomically against even the *conception* of a third."

"Moira has beaten those odds, obviously."

"Yes. About one in fifty million people, both male and female, are like Moira in that they're not mote-immortalized. Moira can have more than one or two children, but she will also experience a lifespan closer to what was the human average, *before* the moteswarms intervened."

"Wait a minute. You're saying she's actually growing *old?"*

Wilena nodded, flashing up images of human faces and bodies, bald-headed or white-haired people from those bygone days when human beings grew old and died as a matter of course.

"Moira is one of those extremely rare individuals who experience what we now consider atavistic aging. Before the Intervention three centuries ago, though, her type of aging was not atavistic at all. It was an absolutely ordinary and unavoidable part of the normal human life cycle."

"But—*now?* Today? That's ridiculous. Moira's not some kind of lower animal!"

"I know it's hard to believe. 'Animals die, things pass away, but people last.' That's what we're always told, and that's how it *is,* in our cases."

"But not in Moira's?"

"No. Unlike the rest of us, she's maturing. Becoming fully adult."

"And the rest of us aren't—?"

"Actually mature? No, none of us are that. The rest of us are all diapaused just beyond the cusp of puberty. We remain essentially larval, indefinitely—permanently neotenized, both physically *and* psychologically. Unending adolescence is our trade-off for being immortal."

"How is that possible?" Hisao asked, fidgeting enough in the hoverchair to make it swivel slightly. "Why did it happen?"

"Those are two very different questions. Let's take the first one first." She shot onto the holovirt between them an image of a coordinate system. "This is a graphical depiction of our species' neotenization, our long childhoods even before the Intervention. The motes already had that as a starting point, to make their task easier.

"In every complex organism—including humans, in the past—the onset of reproductive maturity was the first real stage of dying. An unintended consequence of the fact that evolution didn't much care what happened to you after you'd reached breeding age—and bred."

Wilena holoed up another series of images—cells, cellular mechanisms, gene lines.

"Some of the same traits selected by evolution to maintain early life fitness have unselected deleterious effects later in life. What saved us in youth killed us in age."

"And that was the thing the moteswarms fixed?"

"One of them. One of the many small changes that led to a big change." She holoed up a series of further graphs and diagrams. "The more you exploit genetic polymorphisms to adjust this neurosecretory pathway—involving the hypothalamus, pituitary, gonads, and eventually general metabolism—the more longevity increases and the more slowly this curve here approaches full sexual maturity onset."

"Fertility decreases as longevity increases, then?" Hisao asked. The diagrams, charts, and creatures began to swim before his eyes. "This is some fairly heavy-lifting biology...."

"I know," said Wilena with a sigh of frustration, flash cutting through more holo images—of the humble nematode roundworm *Caenorhabditis elegans*, of chemosignal/lifespan connections, developmental arrest, polymorphism, neoplasm and neoteny. "Sorry. Suffice it to say the motes carried all of this still further, by treating births subsequent to the first as symptoms of senescence that were in need of being, um, overcome."

"But what were 'they' after?" Hisao asked, staring absently at his own hands. "The motes are just swarms of tiny, not-very-bright machines."

"Indeed, but in their own emergent, decentralized fashion they can share and collectively understand a great deal—much the same way an ant colony 'knows' a lot more than any single ant in the colony does. And the woman who created them, well, she was larger than life, and a genius."

A blond woman—with another one of those old faces—holoed up into the space before Wilena's desk, her words both spoken and captioned.

"...my answer was swarms of little cellular mechanics diagnosing and repairing time's ravages—what we do to our bodies," said the ghostly woman in the holo, "as well as flesh's thousand inherited natural shocks—what our bodies do to us."

"Cherise LeMoyne," Hisao said, gesturing. "The Mother of Intervention. The person who unleashed the Wellness Plague."

"That's right. At the time of the Intervention, she was chief scientist and CEO of Manipulife Corporation. Her firm specialized in blending traits from programmable machines into programmable life, and vice versa. All built on LeMoyne's discovery of the core Universal Turing Gene, the shortest segment of DNA on which can be simulated any and all operations performable in DNA."

"Which allowed her to create the motes that re-created us."

"Yes."

"'Even as she herself was dying of a previously unsuspected and undiagnosed cancer'—or so the story goes."

"A rare uterine cancer, actually," Wilena said, replacing the holo of LeMoyne with an image half circuit diagram, half microbiology illustration. "LeMoyne's diagnosis had come too late. She died, but not before giving the motes their ability to swarm-communicate. She connected the 'bots, even gave them links and search capabilities into the human infosphere—apparently hoping everything we humans had ever learned might serve as the motes' classroom, their school, their teacher, their database. She also gave them their most important commands, at least after their Hippocratic 'Do no harm' substrate."

Into the air above her desk Wilena holoed up the twin directives, where they hovered in golden numbers and letters:

1) Eliminate human mortality.

2) Replicate human consciousness.

"Evidence suggests that the motes' great solution to the first directive—the longevity/ birth-limit linkage," she said, flashing up images of bio-processes, and graphs chronicling global trends, "came about as a result of their researching the uterine cancer that killed their creator. They couldn't save LeMoyne, but forging that particular linkage ended up solving the problem of lingering human hyperpopulation—which vastly increased longevity by itself would have exacerbated, especially in regions that had yet to pass through demographic shift. Soon afterward, other scientists perfected similar mote-tech for atomic-level recycling and energy conversion, which solved the other great problem of the time—material hyperconsumption."

Wilena looked away, embarrassed.

"One 'hyper' thing the motes didn't fix," she said, standing up, "was hyperspecialization. At least in my case. Sorry."

"Mine too. I should have known more about all these things, but history has never been a particular interest of mine."

"Don't beat yourself up about it," she said, placing her hand lightly on his shoulder. "Our hyperspecialization goes hand in hand with being psychologically neotenized."

Hisao unfolded himself from the hoverchair and stood up.

"Oh?"

Wilena turned away shyly once more as, together, they slowly walked from her workstation, back through her lab, toward her living space.

"There I go again, talking shop. Sorry."

"No need to apologize," Hisao said. "Very thorough. Just one question: If the motes are so well suited to overcoming our aging and mortality, why is Moira growing older?"

Wilena made that frustrated sigh again.

"No one knows for sure. Some of my colleagues theorize that atavistic aging, like Moira's, results from a breakdown in biocompatibility, such that the immune systems of these rare individuals attack the moteswarms and counteract their efforts."

The door out of the lab dilated before them and they walked through.

"Others suggest the problem's deeper than just an 'allergy to the agents of immortality' on the part of the human host."

"Deeper? How?"

"The motes have pretty much achieved the goal of Directive One. From all we can tell, they're not nearly as far along toward accomplishing Directive Two. Perhaps the motes themselves must leave some human individuals mortal, in order to better understand the nature of individual human consciousness."

Hisao stared at her, wondering if he'd heard right.

"You mean the motes are *allowing* Moira to age? Maybe even to die? But why?"

"Fully overcoming human mortality *and* fully understanding human consciousness may not be complementary efforts," Wilena said. "It's possible that the elimination of human mortality and the replication of human consciousness cannot both be accomplished simultaneously. Perhaps one cannot have a fully developed individual human consciousness unless one also has a deep awareness of one's own mortality."

"I don't follow you."

"What if the bracketing provided by death is what gives individual consciousness its depth? That's how theorists of the 'directive noncomplementarity' school pose the question, at any rate."

Wilena stopped, pausing at the entrance to her sleep room.

"Whichever theory you follow, the upshot is the same. All known cases of atavistic human aging are characterized by an almost complete absence of motes from the bodies of the aging individuals."

Hisao nodded slowly.

"You promised you'd give me something to think about, Wilena, and you have. Thanks."

His dalliance with Wilena in her sleep room shortly thereafter—although it might not have smacked of Moira's passionate earnestness—at least was familiar romance, full of the superficial intimacy and intimate superficiality that so characterized love in their time.

* * * *

As the years passed, Hisao traveled to more and newer places throughout the Solar System and beyond. He made new friends everywhere, did new things, and experienced new sensations as often as he liked. He learned how to speak new languages and play new musical instruments. He tired of hoverball and moved on to astrosurfing—more dangerous, and so more thrilling, more sensational, more *fun*.

Always he found himself among crowds of perennial boy geniuses and intelligirls, all gloriously vibrant and flawlessly healthy—never-changing people in an ever-changing world, forever thronging to experience novel places, people, and things, and just as quickly growing bored and leaving them behind.

Only much later, while talking with the aged Alphonse about Moira's art, did Hisao think again of those to whom mortal change might still apply.

Moira's latest major work, *Coming and Going*, was a strange piece—even for Moira. Like all of her more recent work, it was monumental, starkly visible from a thousand miles up, even its smallest detail requiring only slight magnification to be seen clearly from geostat orbit. It was also built to last, or at least built to resist recycling—one of many reasons it aroused controversy.

Coming and Going was an immense low-relief sand sculpture flash-vitrified into a thousand square mile expanse of dunes and salt pans in the Sahara Desert. Among the images it featured were two standing human figures, one male, one female, both titanic and nude, devoid of pubic hair like Moira's previous Personae, but not bereft of the hair on their heads. The couple both did and did not look like contemporary human beings.

The male figure in the tableau held up his hand as if waving. The two figures stood before the silhouette of an exploratory probe from the dawn of the age of space travel—which craft purportedly had also once borne, engraved on a plaque of much smaller dimensions, the same constellation of images that now provided the content for the vast sand sculpture.

To the west of the representational portion with its human figures and spacecraft stood clusters of more abstract information: the position of the Sun relative to the center of the galaxy, the galactic plane, and fourteen pulsars; a schematic illustration featuring the point of origin of the space probe and its trajectory out of the Solar System; a diagram depicting the hyperfine transition of neutral hydrogen, its spin-flip specifying a unit of length, a unit of time, and the binary digit 1—all three simultaneously, and all of those variants functioning asscale-units in the measurements expressed in all the other symbols on the great plaque of sculpted sand.

"What do you say, Alphonse?" Hisao asked, over the neural-tap translator he and his research team had planted in his swimming friend's head. "You've seen a bunch of other contemporary art. How do you think this compares?"

"The rest all swim in shallow seas," Alphonse replied, in the cryptic way of dolphins. "Only Moira moves in deep waters. I would very much like to meet her."

Hisao nodded. He had figured the old dolphin—the oldest that had ever lived, now—might find Moira's art interesting.

Alphonse, like Moira, could not be cured of mortality. All attempts to transfer the motes into nonhuman species ended with the motes immediately kill-switching themselves. A type of "apoptosis," according to Wilena. Hisao didn't know how much longer the old dolphin would live—or Moira either, for that matter.

"I think such a meeting can be arranged. I'll get on it."

* * * *

Until he saw her again, Hisao didn't realize how long it had been since he'd last seen Moira. Her hair was white, like that of the old people in the old-time pictures Wilena once showed him. Moira's face was so wrinkled and wizened that when she smiled she looked like a creature of a species only distantly related to contemporary humans. She brought her son—*their* son?—Masao with her, too.

Moira and Alphonse spent so much time talking about and modeling the schooling behavior of fish that Hisao found himself spending more time with Masao than he expected. The amount of action and attention Moira and the old dolphin could devote to a single topic frankly amazed Hisao, whose own focus tended to skip much more rapidly from one object to another—as his son's also did, he noticed.

Although he was one year chronologically closer to fifty than to fifteen, Masao physically looked exactly the latter. Hisao found that he got along well with his son—though more like a slightly older brother than a father. Whatever it was that had caused Moira's atavistic aging, it had not been passed on to Masao—nor to his two siblings, Hisao gathered.

"Moira," he asked her over a drink that evening, when the two of them were alone for a moment, "why didn't you tell me Masao was my son? I might have liked to meet him, get to know him, before now."

"And why didn't you? I wasn't stopping you, yet you never introduced yourself to him. Wilena told me she told you about Masao, long ago. You've known about him for years—and never visited him."

"Maybe you didn't stop me directly, no, but you never came to me and said, 'Masao is your son.' Why?"

"For the same reason I never told any of the fathers. You were all too immature—like everybody else. None of you were grown up enough to help me raise these kids."

"Masao says you disapprove of 'children raising children.'"

"It's not just that. Everything about the world the Intervention has made—it all struck me as somehow too

flashy, too shallow, too trivial, by the time Masao was born. Much superficial knowledge, little real wisdom. Too many blessings damn the children."

"Masao hardly seems damned."

"No, but the more I looked into the historical records from before the Intervention, the more I saw a profundity of character and culture there that seems lacking in our own times."

"During the Dark Centuries, too? Mass atrocities and mass destruction don't sound like ‘profundity’ to me. We're still cleaning up the mess."

"Yet even that dark time showed *mass creativity* too! Since the Intervention, we don't need to think as deeply. No need to invent or create as much. Our world has been perfected. Cherise LeMoyne sprinkled fairy dust over the globe. Now, no matter how far they go, Wendy and Peter Pan never leave Neverland."

"I don't follow you."

"Did you ever talk with Wilena about LeMoyne, or about psychological neoteny, as they call it?"

"A little."

"You might want to ask her about that a bit more, then. And I wouldn't worry too much about the time you haven't had with your son. You have the rest of forever to get to know each other better."

* * * *

Hisao was sorry to see Moira and Masao leave—but not as sorry as Alphonse was, he suspected. And when, only a few years later, the dolphin was at the end of his earthly time, his last thoughts were for Moira.

"Tell her to keep doing what she's doing. Tell her what is popular is not always true, and what is true is not always popular. Tell her not to spend so much time accepting others’ rejection of her work that she ends up rejecting their acceptance when it finally comes. And tell her, when she's at death's door, don't knock!"

The neural tap interpreted the last with a sound almost like laughter, but Hisao couldn't be sure. He promised the dolphin he'd tell Moira what he'd said. Soon the dolphin fell silent in voice and thought, then passed quietly away. Alphonse was there, but he wasn't there, anymore.

His cetacean friend's death left Hisao more saddened than he might have imagined. Out of that sadness he contacted Moira—who smiled and wiped away a tear at hearing the dolphin's last words for her. She promised she would dedicate her final piece to him.

Over the following days and weeks and months, Hisao thought from time to time about what Moira had said, when last they talked in person. When he contacted Wilena again, it was to ask her about something Moira had suggested.

"You told me one time that our hyper-specialization was connected to our being psychologically neotenized. What did you mean by that?"

"The idea goes way back, before digiculture—perhaps to the middle of the twentieth century,” Wilena said, checking sources in their shared holovirt. “By the time of the Intervention, most scientific research, for instance, was already being done by teams of young, hyperspecialized problem-solvers and technicians—'whiz kids'—each of whom actually needed to fully understand only a small piece of the

overall puzzle."

"Which is how most of us still work," Hisao said, nodding. "Depth of individual understanding is far less important than the system of specializations put together in any team."

"Right. People who work in specialized teams need to be able to change jobs often, learn new skills and information, move to new places and cultures, make new friends in an ever-expanding social network. 'Mature adult' human animals—evolved to cope with small hunter-gatherer societies of just a few hundred people—were not all that good at meeting such challenges."

"So being 'unfinished' or 'immature' or 'postponed'..."

"Means increased flexibility of attitudes, behaviors, knowledge—all perfect for working in diffuse, temporary teams. Ramping up neoteny was a fast and simple way to evolve an adaptation—for adaptability!"

"What's that mean for Moira, then?"

"An interesting question. The vast majority of us are Hypers—hyperattentives. We prefer rapidly changing environments, high levels of stimulation, multiple information streams, lots of rapid, specialized task-switching among team members. We get bored easily. I suspect that's less and less the case with Moira, as she's gotten older."

"I once saw her discuss the modeling of fish-schooling behavior with Alphonse—for hours on end."

"She's become a Deeper, then. A deep-attentive. Someone who can shut out the world and focus for long periods of time on a single complex problem or object without getting bored. Even before the Intervention, Deepers like Moira were already disappearing. The motes just helped us become more of what we were already becoming."

"How so?"

Wilena searched for and then holoed up again the silent blond ghost of Cherise LeMoyne.

"The release of the motes—and the Wellness Plague, with them—was the action LeMoyne took to address the problems she saw in her time. She intervened, as did her creations—even more so, since they continued to evolve after their release, even after her death. Taken together, the mote solutions to human population and consumption issues corrected most of the problems of the Dark Centuries, as LeMoyne hoped they would.

"In retrospect, the motes' short biomech life-cycles and swarm intelligence make them the perfect symbionts for long-lived creatures with individual minds, like us. Over time they have in some ways become more like us, and we have in some ways become more like them."

Wilena flashed Hisao a satisfied smile. He nodded slowly, pondering.

* * * *

After many more years, Moira exhibited *Monument To Unageing Intellect*—her strangest and most haunting work of all.

From asteroidal material, she and her collaborators (their friend Jorge and his longtime love-partner Li, most prominently) crafted myriad, simple, solar-powered and mirror-skinned androids of human size: "Personae," persisting again. Each Persona incorporated subroutines that mimicked human movement, along with sensors for navigating local space and an array of thrusters so that each "individual" seemed to

fly as if in air, or swim as if in water—though all of them were in fact released some dozen degrees above the plane of the ecliptic, in the space between Mars and Jupiter, where they moved, after their complex fashion, together and apart.

Moira had programmed each Persona unit with simple rules. Steer clear of anything that is not one of your local cohort members (avoidance). Steer so as to prevent crowding your local cohort members (separation). Steer toward the average heading of your local cohort members (alignment). Steer so as to approach the average position of your local cohort members (cohesion). From such rules the Personae, once released and put into play, quickly organized themselves into throngs of sweeping and shifting human forms, moving exactly like schools of fish or flocks of birds.

"—or like the swarms of mote-machines which made possible our godhood," Moira said, when Hisao stopped at the Moon to visit her on his way home from the exhibit. "Or yours, anyway."

He stared at her, unable to get over the way her body had changed. Slumped in her medical hoverbed, she looked deformed by gravity, even on the moon. Her white hair had grown much more sparse and her skin seemed paper-thin. Her sunken eyes moved inside their frame of starkly prominent cheekbones like hoverballs in smashcradles. Webworks of wrinkles and wattling flesh covered all that was visible of her face and neck. She seemed more than ever a creature of an alien species.

Despite that, there still flared from her the beauty of afternoons in late autumn. Her eyes flashed, her smile seemed somehow more mellow, human, and humane than ever—though Hisao wondered how much of *that* might be from the hyperox levels in her rooms.

"LeMoyne had her rules, I have mine," she said with a chuckle. "You know what made me think of swarms and human motion? That hoverball game, long ago. Where you conspired with Alphonse to cheat! *That* was when I first thought there might be some similarities between the way the moteswarms moved and the way the crowds of *u*s moved."

Hisao nodded.

"Wilena says that the motes just helped us become more of what we were already becoming. That we're becoming more like them, and they're becoming more like us."

"Well! Good for Wilena! Given her work, she's probably about as close as you unagers can get to understanding what I'm trying to say—and do. You're in touch with her, then? What is my 'personal physician' up to these days?"

"She's got a standing contract to join the crew of a long-cruiser, headed out to one of the habitable-planet star systems. A chief medical officer position."

"Wilena's going to join the diaspora? Ha! Do you know what the original name for long-cruisers was, when the idea was first developed? 'Generation ships!'"

"Not many generations being born on long-cruisers."

"And no one dying of old age, either. Won't be much for Wilena to do."

"Maybe that's why she's held off on leaving. But she can join a crew any time she decides to."

"Acch, she's just waiting for me to die first! I haven't seen much of my personal physician lately, but I bet I'm still of some professional interest to her."

"How's that?"

"I'm dying of a defect of the heart," Moira said with a laugh. "Whatever else any gods or fates may lack, they certainly do *not* suffer from an irony deficiency!"

"Can't you just get a cardio-replacement?"

"Wilena harped on that too. She's offered lots of options—mechanicals, clonally grown transplants, you name it. I turned them all down. That might be one of the things that's made her unhappy with me, of late."

"Why'd you turn them down?"

"Wilena would keep me old and alive forever, if I'd let her. She'd turn me into a Struldbrugg, a Tithonian. That's not for me.

"Nope, I think I'll keep the heart I've got, and go when it goes. She won't have to wait long, now. I've been running through tomorrows like there's no tomorrow, and pretty soon there won't be any left."

* * * *

Not quite a year later, Hisao received his final message from Moira.

"Dear Hisao: If you're seeing this, then I have died. To you, Wilena, and my children, I've sent very specific instructions concerning my funeral arrangements. I hope you do not find such specificity offensive. At first I thought people might have forgotten how to mourn—it's been so long—but it's not that, really. You can't forget what you've never known.

"Do take the time to get to know our son Masao. For all I may have done in raising him, he's still part of your world, now.

"Thank you for all I've learned from you. You and Alphonse showed me that the only product that finally persists is process. I could not have created my last work without learning that. The last piece has been better received than I would ever have dared to believe. Go figure.

"I suppose I should say something grand at this late date, reveal some big secret of the universe, so here it is: the human heart is more than just some strangely chambered knot in us, pumping blood through a maze of meat plumbing, with just enough chaos in the beat and eddy in the flow to keep things going. In the end it will not allow us the comforting local illusion that there are separate events and separate objects. In fact there is no separation. Space, time, the universe—it's all one.

"Whether you knew it or not, you taught me that, too—you and Wilena and everyone I knew. Thanks again."

As per Moira's very specific instructions, it was to the vicinity of her last great work that he, Wilena, and her children took Moira's body—encased in a titanium coffin sensored, motored, and programmed in much the same way as the bird-flock Personae of *Monument* had been, and into whose midst they released her little deathship.

After the ceremony ended, Hisao and Wilena stood on the observation deck of the transport, watching the gray coffin drift off in the midst of inhumanly perfect human forms, flawless mirror-skinned creatures moving and flashing like shoals of thought, swarms of mind.

"How are you feeling?" Wilena asked.

"I feel ... nothing."

"Numb. Yes. Same here. Back in the days when people grew old, they comforted each other at times like this by saying things like ‘Life goes on’ and ‘Nothing lasts forever.’"

Wilena looked back to the monumental mobile sculpture as it moved through space before them, changing and shifting like a murmuration of starlings. Hisao nodded.

He thought about that on the trip home to LaGrange Port. Once there, he stood beside Wilena as she prepared to board a long-cruiser for the stars.

"Back in the days when they called them generation ships," Wilena said, staring at the cruiser *Hyperboreas* out the observatory port, "someone who knew about both space travel and generations said that dealing with the speed of light barrier was like coping with the loss of a loved one: You never actually get over it. At best you just get around it."

She looked away from the ship, to him.

"I suppose if we can take forever to get where we're going," she said, "it doesn't much matter how fast or how slow we go."

He hugged her and bid her a quiet farewell. They both knew they would never see each other again. There was nothing to say, because there was everything to say.

* * * *

Life goes on, Hisao thought as he climbed aboard his big orange-and-red fireboard and slid his feet into the augmented footlocks. *Nothing lasts forever*.

Hisao had dropped from orbit and astrosurfed deep into atmosphere dozens of times on half a dozen worlds. He knew how to play shooting star as well as anybody. His vintage big board had the best ablative shielding, deflection tiling, astrogation, and avionics tech to be found. Even on hard burn the board had enough fuel to let him bounce into atmosphere, bolide through, and skip out again—at low enough angle and high enough speed to avoid becoming a shooting star for real.

That was the source of the excitement, of course: Although he would never die of old age, he could still die. Burning up in atmosphere would obliterate him beyond reconstruction. When down came baby, crashcradle and all, all the king's motelings and all the king's mends couldn't put baby together again.

You never get over it. At best you just get around it.

The satellite's airlock doors dilated open. The docking bay railgun shot him on his board out of the bay, toward the mottled ocher, white, and blue of the Earth below. He howled happily as he kicked in his thrusters to maximum burn.

Hisao shifted on the board and trajectories altered on the fashionably retro heads-up displays of his suit helmet. The astrogation gear calced Earth-atmosphere clearance for each course change, along with the board's capabilities and his own survivability.

The thrusters cut out. The board's ablative shielding began to burn. He moved back in the footlocks, angling both his board's nose and his trajectory slightly upward. On his rearview cams a long fiery streak spooled out, man and board a shooting star pushing a redlining course.

Fall to miss, fall to miss, fall to miss! Think like a satellite!

On his burning plank he bolided through the upper air, arced off just before his trajectory would have reached extinction point, skipped back out of the atmosphere, and was gone.

Despite tiles glowing red hot, empty fuel tanks, and a board blown of all ablative shielding and still burning, the trajectory plotter moved back into the green—before the astrogation system blew out. The locator beacon still worked, though, even as he slingzagged farther from the Earth, dropping final fire behind him.

Hisao drifted, staring down at the shining planet below. Each year, the human population of that world declined steadily—and not just from emigration, he now knew. On the face of the Sahara, carved into its skin, he could just make out through thin clouds a male figure, waving—though whether hello or good-bye he could not tell.

Waiting for a recovery shuttle to ride in on his beam and pick him up, Hisao knew he'd pushed himself and the board—hard. Yet the edge, he realized, was already going. Even from such a wild ride. Even from astrosurfing itself.

Life goes on. And on. And on.

I feel nothing. And nothing lasts forever.

That's the sheer hell of it.

In overcoming human death, had the moteswarms also overcome something essential to human life? How long could he keep going, before the edge was so gone he stepped over it? Before he fell to hit, and failed to miss?

I could still die....

Below him, the planet was perfect, its people star children of an endless midsummer evening. But if the stars were fixed, why were they still falling, secretly, one by one?

He shivered amid the heavens, and the heavens shivered with him.

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Novelette: **THE AFFAIR OF THE PHLEGMISH MASTER** by Donald Moffitt

Even if you can't change the past, you may be able to use it....

Peter Van Gaas stared resignedly at the dusty leather tome on the desk in front of him. *De ondekkingsreis van Willem Hesselz de Vlamingh in de jaren 1696-1697.* Yet another interminable job of translation to slog through for the history of the Dutch East India Company that he was already past deadline on.

He was reaching for his Dutch-English dictionary when the phone rang. He was tempted to ignore it—it might be his publisher again—but he finally succumbed.

"Hello, is this Peter Van Gaas?" It was a voice he didn't recognize.

"Yes," he said cautiously. "Who's this?"

"This is Roy Hendricks at Alternatives Associates. I got your name out of the Time Travelers' Register of Translators. You do Dutch, right?"

"Well, uh, yes, but..."

"Know anything about art?"

"Not very much. You see, my specialty is—"

"It doesn't matter. The client will know even less. You'll be there chiefly to hold his hand and smooth things over when he puts his foot in his mouth."

"If you could tell me what this is about, Mr.—Hendricks, was it?"

"Call me Roy. You're going to go back to seventeenth century Delft and translate for the client while he makes a deal to commission a painting. Piece of cake."

"I'm awfully busy right now. I'm not sure I can—"

"Have you ever done time travel before, Peter?"

"No," he said regretfully. He'd often wished he could afford a trip to the past to clear up some small point of research, the way the A-list historians were always doing, but the kind of books he wrote didn't have a lot of popular appeal. His publisher had told him that the East India Company book might be his breakthrough.

"The way it works, you'll spend weeks or months in Delft till the job's done—an alternate Delft, of course, that you and Harry create by going back there—and return to the present a fraction of a second after you've left. You won't lose a moment's time on your own work. You'll have a free ride in case there's anything you want to do in the seventeenth century yourself. And—" He lowered his voice confidentially. "—with Harry, of course, the money's going to be out of sight."

"Harry?"

"Harry Brock, the celebrity developer. He'll be a shark out of water in seventeenth century Delft. That's where you come in. You've heard of him, I'm sure."

Indeed Peter had. The hotels, the casinos, the Sea City project, the twelve trophy wives, the omninet specials, the tabloid scandals, and more.

He took a last despairing look at the rat's nest of scribbled notes and moldy old books on his desk and gave a sigh. “Okay, Roy, I'm in."

"Great!” Hendricks said. “You can meet Harry tomorrow. Be here at one. Maybe we can get him to take us to lunch."

* * * *

The offices of Alternatives Associates were a study in spare elegance, with sleek upholstered furniture and expensive veneers. A series of gold-framed oil paintings depicting turning points in history lined the walls of the waiting room. Peter was studying a scene that showed Columbus doing his famous egg trick for Queen Isabella when Roy Hendricks emerged from a door in the rear. He said, “Nice to meet you, Peter,” but didn't bother to shake hands. “Harry's waiting for us in the Pit,” he said. “Don't say too much. Let him do the talking."

Peter followed Hendricks down a carpeted corridor into a dim cavern filled with wall-to-wall monitor screens and a lot of incomprehensible electronic equipment. A scattering of technicians in green smocks, mostly women, sat at their own screens tapping intermittently at their keyboards. Across the expanse of consoles, a stocky man in loud, expensive sports clothes stood with his back to them, engrossed in one of the wall monitors. Hendricks led Peter over to him, and the man turned to reveal a red, jowly face and the best set of ivories that money could buy.

"Harry, this is your translator, Peter Van Gaas,” Hendricks said. “Peter, meet the one and only Harry Brock."

Brock looked Peter over for a long speculative minute. Finally he parted with a practiced public grimace and said, “Howja do, Pete. Roy tells me you're some kind of whiz at passing yourself off as an ancient Dutchie.” He didn't offer to shake hands, and Peter remembered that Brock was supposed to have a phobia about germs.

"Well, uh, I wouldn't exactly call them ancient where we're going, but...” Peter floundered.

Hendricks stepped in quickly. “That he is. But more important, Peter happens to be an expert on Vermeer."

"That's my boy!” Brock gave Peter a slap on the back that almost knocked him flat. He turned to Hendricks. “When do we start?"

"I know you're anxious to get started, Harry, but we've got a lot to do first. We've got to bring Peter up to speed. Get him to a good temporal costumer for starters—to say nothing of getting you and Kimberly outfitted..."

"Kimberly—ha!” Brock seemed amused. “She'll take care of herself. She has her own fashion house. As for me, I'll have my tailor whip up something. Nothing but class all the way."

"It's got to be authentic, Harry,” Hendricks said doubtfully. “We don't want you standing out like a sore thumb."

Peter was alarmed to see Brock's face flush with instant rage. “I'm not going to go in some moth-eaten Halloween costume, Roy boy!” Brock rasped. “My tailor will take care of it. And I'd like to see somebody try to tell Kimberly what to wear!"

Peter began to see what he was in for, managing Harry Brock. He sighed and decided to make a good start of it. “Mr. Brocks got a good point, Roy,” he said. “He's going to have to pose as some sort of rich

Englishman anyway—there were a million English dialects to account for his way of talking, not that Vermeer or any other Delftian would know the difference, or care very much. Same with his clothes. Authenticity doesn't matter as long as the tailoring makes him look rich."

Brock's color returned to normal, and Roy Hendricks looked relieved. Peter got an unexpected pat on the cheek as a reward. “Listen to Pete, Roy,” Brock said expansively. “This boy has some kind of a head on his shoulders."

Hendricks shot Peter an appreciative glance and went on blandly: “And then there's the money thing. We generally use the Moneta private mint in Philly. They do a good job of forgery, and they don't cheat on weight or purity. Peter can take care of that for you."

"Okay, but I'm in charge of the till,” Brock said. “How much would you say, Pete?"

Peter had no idea what it was all about, but he said authoritatively, “A thousand guilders in silver ought to take care of it. Not counting living expenses."

"Okay,” Brock said. He looked at his watch. “Gotta go. The press conference is in an hour. I can't keep Kimberly waiting. Nice to meet you, Pete."

When he was gone, Peter turned to Hendricks and said, “Okay, Roy. Maybe now you can tell me what's going on."

Roy scratched his nose. “You don't watch the vid much, do you, Peter?"

"No."

"Kimberly's his latest wife. Number thirteen. He's nuts about her. You must've seen her face on the covers of all the gossip magazines. But you don't read them either, do you?"

"No."

Roy looked at him pityingly. “She's a supermodel. A super-dooper supermodel. She's got her own fashion house. And her own retail knockoff line. Her own perfume brand. She's starred in a couple of movies Harry financed. Bombs, but her acting surprised the critics. There's nothing Harry wouldn't do to showcase her. So of course when he decided he wanted her portrait painted, it had to be Vermeer."

"And I'm supposed to be a Vermeer expert? Listen, Roy..."

"Don't worry about it, Peter. I've arranged to have you briefed by Hugh Elphinstone, the art critic. I sent Harry to him for a briefing, but you saw Harry—he was too impatient to get anything out of it. The important thing is you know the language and you're halfway familiar with the era. You handled yourself well with Harry. You'll be a steadying influence on him."

Peter didn't particularly care for the “halfway,” but he let it go. “What made him fixate on Vermeer? I gather he knows less about art than I do."

"Somebody told him Vermeer was the best. And that he was somewhat of a rarity—there are only a few dozen of his paintings in existence. That was enough for Harry. Rembrandt wouldn't do. Too many Rembrandts around."

"What was that about a press conference?"

"He's been talking it up. Harry can't keep his mouth shut. He's been talking it up on his game show and

his puff interviews for weeks. If you weren't such a bookworm, you'd have caught some of it. The press conference will make it official. His P.R. firm's cobbled together a big presentation—slide show, press kit, and the works."

"Maybe I should go."

"I'll get you one of the press kits. And the giveaway that goes with it—a framed print of 'Girl With a Pearl Earring,' one of Vermeer's hits. You can skip the conference. It'll be a madhouse anyway. Harry will announce that he's going to be the owner of the world's forty-first Vermeer, or whatever the number is. Then the fur's going to fly."

"Why is that?"

Roy made a grimace. "Harry's going to upset a multibillion dollar applecart. I don't know what strings he pulled to get an import license for a priceless artifact from another timeline, but it's not going to be worth what he thinks. Coming from another timeline, it won't have a provenance that means anything in this one. Not by the same Vermeer, y'see. But it'll depress the market for Vermeers and Dutch and Flemish paintings in general. The art market's pretty upset about it, let me tell you."

"It's beyond me," Peter said, his eyes threatening to glaze over. I would have thought that if Vermeer's such a big deal, there would have been any number of enterprising dealers bringing in new ones ever since the time travel industry was born."

"Oh, there've been a few attempts to import new Vermeers over the years, but they all seem to fall through somehow. Maybe they weren't as determined as Harry."

"I still don't understand why Harry's such a threat to the art market."

"I'll let Elphinstone explain it to you. He's got you booked for three o'clock."

* * * *

Hugh Elphinstone was a dwarfish man with a tight cap of curly black hair. More black hair sprouted from his nostrils. He sat crouched behind and ornate desk piled with art books and prints.

"I envy you, Dr. Van Gaas," he said. "To go back in time and meet Vermeer himself. To visit his studio and see how he works. Maybe to discover once and for all how he applied his glazes to such effect. To see what role the camera obscura might have played in his work..."

"I'm afraid it wouldn't mean much of anything to me," Peter said. "I wouldn't know a glaze if I saw one."

"Yes, yes," Elphinstone said wearily. "You want to know a little about Vermeer and how to approach him, so that Mr. Brock won't make a fool of himself."

"I'd appreciate it," Peter said.

"Mr. Brock is an overbearing man, yes? He will try to dictate to Vermeer how he wants his wife posed, how she is dressed, what expression he wants on her face. That will not work. Vermeer will be very polite. But he will be very stubborn. For him, the model will be an element in the composition—one element in a serene and mysterious universe of objects arranged just so. He will have certain favorite props. Perhaps he will want to dress Mrs. Brock in items of his wife's clothing and jewelry that appear in some of his other paintings. He did not like to paint portraits as such."

"He did, sort of, in 'Girl With a Pearl Earring,'" Peter said, drawing on his newly gleaned knowledge from Harry Brock's press kit. He had found the painting strangely moving.

"Yes, you might say that," Elphinstone admitted. "Very unusual for Vermeer. No background at all. But I doubt that's what Harry has in mind. He'll want recognizable signature props from Vermeer's bag of tricks, like the Oriental rug that appears so many times. And he'll want a signature itself, to rub in everyone's faces. That represents another problem. Vermeer didn't usually sign his paintings. Only three of his paintings are signed." He shot Peter a sharp look. "How much are you paying him, by the way?"

"I ... uh, that is we ... thought we'd offer him a thousand guilders."

Elphinstone raised a bushy eyebrow. "He'll sign his name for that. He was usually in debt. Vermeer and his fellow painters didn't usually paint to order. They cranked out their pictures like sausages and sold them ready-made at fairs and such. The good burghers of Delft had a newly acquired taste for cozy scenes of daily life, and the painters obliged. Vermeer was a dealer as well as an artist, and made most of his money selling other men's work. Of course the art business in Delft collapsed after the French invasion in 1672, and Vermeer went bankrupt. It killed him three years later. But that won't affect your business, of course. Your little trip will take place some years before all that happened, if I understand Roy Hendricks correctly."

"Uh, I wouldn't know about that," Peter said.

"Oh, but you must know something about the flavor of the times. I read your excellent book about the Dutch-English naval wars. Fascinating, but a bit dry."

"Thank you—I think."

Elphinstone had the grace to laugh. "The point is that you and Harry Brock will be received warmly as Englishmen, despite the bloodshed on the high seas. The Anglo-Dutch wool trade was one of the foundations of Delftian prosperity no matter what was going on in the East Indies. Leeuwenhoek carried on a cordial correspondence with the Royal Society of London for more than fifty years."

"Leeuwenhoek?"

"The inventor of the microscope. He was a close friend of Vermeer's—served as Vermeer's model for a couple of paintings. He was Vermeer's executor during the bankruptcy proceedings years later. Perhaps you'll have a chance to meet him. He'd make a good subject for one of your books."

Peter's head was awhirl. "I've got enough on my plate right now," he said.

Elphinstone laughed again. This time the laugh was not pleasant. "You do indeed," he said. "When you get back, you're not going to be very popular with the art establishment."

* * * *

There were twelve of them seated around the big rosewood conference table, eleven men and a woman in a big hat. The men were dressed in a range of attire, from somber business suits to discreetly expensive sports jackets and flowery silk neckties. They showed a similar range of grooming, from exquisite barbering to bushy mustaches and beards. The woman wore a mask of thick age-concealing makeup that looked as if a hammer and chisel would be needed to crack it.

The man at the head of the table was one of those with a business suit and defensive barbering. He called the meeting to order with an ivory hammer that had been carved from an illegal whale's tooth; traces of nineteenth century scrimshaw could still be seen on its surface.

"Thank you all for coming," he said. "I presume you've all seen the publicity for the Brock Vermeer splashed all over the media."

"The man's a dedicated vulgarian," grumbled one of the bearded ones. "We'll have to do something about him."

"Why bother?" drawled a manicured specimen in a Burgundy sports coat. "Maybe it'll be a Vermeer to the Great Unwashed, but no respectable dealer would touch it. Nor would any museum curator on pain of excommunication."

"A Vermeer by an alternate Vermeer is still a Vermeer," another suit observed mildly.

"The hell it is!" growled a shaggy character in tailored jeans and combat boots. "I've been negotiating with the National Gallery for eleven years for their Van der Weyden. They finally broke down and sold it to me for something like the national debt of Liechtenstein. I begged, borrow, and stole, and I'm still in the whole for eight million, but I didn't care because I stood to clean up at the auction. Then Harry Brock had his damn press conference, and now the auctioneer tells me I'll have to—'revise my expectations downward' is the way he put it. The market for Dutch and Flemish art's going to go to hell. Which is where I hope Harry Brock goes."

There was an angry hubbub that threatened to get out of control. The chairman pounded his ivory gavel to no avail until that woman in the hat indicated that she was trying to speak. The angry voices died down as they waited to hear what she had to say.

"We're getting nowhere, Nelson," she said. "There's no way to avoid the harsh methods we discussed."

"Are you sure, Marietta?" the chairman said.

"Oh, get on with it, Nelson. We're wasting time."

"Very well." He cleared his throat. "Ziggy's waiting outside." He pressed a button concealed in the tabletop and the door to the anteroom hissed open.

The man who slipped quietly through was wide and squat and gnarly, and as bald as an egg. He wore a rumpled gray business suit with shortened legs and lapels that showed half-erased food stains. He waited patiently as a dog, in an expectant half crouch, his long arms dangling at his sides.

"Gentlemen, this is Ziggy the Ice. Some of you know who he is and have already benefited from his services in the past. Ziggy is our problem solver, aren't you, Ziggy?"

The bald man nodded modestly, but didn't reply.

"The fire at the Colophon Gallery four years ago, did you have something to do with that?" someone said. There was a murmur around the table.

"We won't get into that," Nelson said.

The board member who had made the mild observation about alternate Vermeers said, "And how do you propose to deal with our current problem, Mr. Ice?"

"The way I see it," the bald man said in a soft hoarse voice that had them straining to hear, "there's no need for hasty methods. You send me back to the point in time where he's just finished the painting. *Then* I slash it. Maybe I set fire to his studio for good measure. He's demoralized, see? He's not gonna start the painting from scratch again—that is, if he goes back to painting at all. Problem solved."

"And what if the problem isn't solved?" the board member queried delicately.

Ziggy gave him a sorrowful look. “Then I go to Plan B,” he said.

"We don't need to hear about that, Ziggy,” Nelson said hastily.

"Call for a vote, Nelson,” Marietta said with an impatient toss of her head. “This is nonsense. We know what we have to do."

The vote was unanimous. One of the directors surreptitiously crossed himself.

Ziggy watched the vote impassively. Then he said, “I'm going to need a big advance in cash. There's a time travel outfit that'll do an unregistered intervention for enough dinero, no questions asked. And I got my own expenses.” He named a sum, and there was an audible gasp around the table.

There was no discussion. The gavel hit the table, and Nelson said, “You've got it, Ziggy."

Ziggy gave a thin smile and the directors relaxed. Nelson and Marietta left to arrange the cash. While they waited, one of the fussier directors ventured, “What are you going to do about the language, Mr. Ice?"

The smile became noticeably chilly. The temperature in the room seemed to drop. “I won't be there long enough to do any talking,” Ziggy said.

* * * *

Harry had provided a bottle of champagne for Peter's send-off, and he raised his glass in a toast while Peter fidgeted at the delay. “See you in...” he began jovially, then stopped. “But I guess I've already seen you, what is it, four hundred years ago? How do you say ‘see you later’ in Dutch?"

"Tot straks," Peter replied shortly. “And it's *Nederlands*, not Dutch."

Harry's tailor had outfitted him in a costume drawn from Flemish painters of the approximate period—flaring pantaloons, a white collar that looked like a lobster bib, puff sleeves, and a huge floppy hat. The picture was completed by a scraggly wig that hung to Harry's shoulders.

His new wife, Kimberly, was draped in her fashion designer's conception of what a rich Englishwoman should look like. But the gown was too form fitting, the bodice too low, and the fabric—a twenty-first century nanoweave more lustrous than silk—too opulent. Peter hoped she could get away with it.

"It can be a little confusing, Harry,” Roy said. “You and Kimberly will leave only a few minutes after Peter, just as soon as we get the coordinates straightened out, but you'll arrive a couple of days later, after Peter's had a chance to set up lodgings befitting your station as wealthy English travelers, and hire a maid for Kimberly. Peter's positioning unit will send out a signal and you'll pop up safely indoor, where no one will see you arrive."

"We don't want the English colony in Delft to get wind of you,” Peter explained. “You'd never be able to fool them, accent or not."

"Do find us a decent place to stay, Peter dear,” Kimberly said, flashing a brilliant impersonal smile at him. “No shabby boarding houses with bedbugs."

"No bedbugs,” Peter promised. “Everything's neat and clean in Delft."

"And see if you can find a looker for the maid,” Harry said with a wink.

"Harry, behave yourself,” Kimberly told him.

Roy had been studying the monitor screens. He put down his champagne glass. “Time to go, Peter,” he said.

Peter drained the last of his champagne. “Uh, Harry,” he said. “I'll need my expense money."

"Got you,” Harry said. He dug into the heavy silk purse dangling at his waist and poured a fistful of coins into Peter's cupped hands. Peter kept his hands out and Harry poured more coins into them. “Enough?” he said.

Peter was thankful that Harry seemed to have no idea of the value of a silver coin in the seventeenth century. “It should do,” he said.

"This way.” Roy took him by the arm and propelled him toward the row of cable-festooned booths lining the far wall. “Do you remember what I told you about using the positioning unit and the little mass indicator?"

"No problem,” Peter said, patting his inside pocket.

"I wish I could be that confident about Harry,” Roy said in a lowered voice. “Keep an eye on him, Peter. Kimberly can help. Fortunately she's got a good head on her shoulders. She's not the bubblehead she pretends to be."

Peter eased himself into the booth, feeling foolish in what Harry had called his Halloween costume. He gathered the cloak more closely around him. The last thing he saw before the world vanished was Harry and Kimberly staring at him through the glass.

* * * *

Delft sprang into existence around him. It looked much like the Vermeer painting that Elphinstone had shown him, but nothing had prepared him for the actual sight. He was standing on the banks of a canal. There were a few people around, but no one within a hundred yards. A woman with a market basket was looking at him, but looked away at his glance. Perhaps she had seen him appear, but as everything was normal now, she chose not to believe her eyes.

Across the canal was the low jumbled skyline that Vermeer had captured. A church spire poked its way skyward behind the sprawl of brick houses. A sail-rigged barge carrying produce crossed his vision, the man at the tiller taking his ease and letting the sails do the work. He was staring curiously at Peter too, but he couldn't be sure of what he had seen either, and he wasn't inclined to make a fuss.

Peter mentally reviewed the old map that Elphinstone had given him a copy of, and oriented himself. Behind the waterfront was the *Volders gracht*, the street where Vermeer's father had once had a tavern. The spire he could see across the canal was the *Nieuwe Kerk*, Vermeer's parish church, but Vermeer didn't worship there any more. He had married a Catholic wife and now accompanied her to the *Oude Kerk*, where it was legal for Catholics to worship as long as they didn't make a display of themselves. He found the nearest bridge and crossed to a market square that was fronted by the town hall. It was crowded with market day shoppers filling their baskets at the busy stalls. The square was a cheerful bedlam, with small children running back and forth, ignored by their elders, and stray dogs sniffing around, hoping for handouts. Nobody seemed to take an interest in Peter, so the outfit that the temporal clothier had chosen for him must have passed muster.

He crossed another bridge over another canal, and found himself on a street he knew to be the *Oude Lange dyck*, the street where Vermeer now lived with his mother in law. It was two bridges up. He'd approach Vermeer later, but he wanted to get an unobtrusive look at the place.

He counted houses as he walked, and when he came to the house that Elphinstone had presumed to be Vermeer's on the old map, he knew he had hit the jackpot. The house was abutted by a narrow alley that was roofed over to provide some kind of storage area. It was the only house on the street with that particular arrangement, and it exactly conformed to Vermeer's painting of a street scene in Delft. So Vermeer had painted his own house. Elphinstone would be glad to know that he had settled the matter for the art world.

He slowed down as he drew nearer and sauntered by, giving his best imitation of an English tourist checking out the neighborhood. The house was a three-story brick affair topped by an attic with a shuttered window. A woman with a white cap and shawl sat in the open doorway, sewing. Another woman, a maid, sat on a bench outside, peeling potatoes. Neither looked up as he passed.

He continued down the street, looking for a tavern. Taverns were much the same in every time and place, with a few exceptions, like America's Prohibition era. He would have a few beers, strike up a conversation with whatever idlers were sitting around drinking at this time of day, and with any luck, get a line on whatever houses with readymade servants around here might be available to rent, and where he might find a reliable maid for an English lady.

* * * *

"Why can't I go with you?" Kimberly said.

"Because it's a business arrangement," Peter explained again, and you're expected to wait home like a good wife while your husband takes care of it. And besides, I don't think it's a good idea to let Vermeer see you until he's arranged to do the portrait."

"But what am I supposed to *do?"* she said.

Harry cleared his throat. "Study your phrase book," he said, sounding uncomfortable. "Have the maid do your hair. I don't know."

"Oh no! I'm not letting that girl *touch* my hair! Where did you get her anyway, Peter?"

It had been over an hour since Harry and Kimberly had materialized in the ground floor chamber that was to be their bedroom. Peter had sent *Mevrouw* Coornhert, the widow whose house it was, on an errand, so that she would not wonder about the miraculous arrival of her new lodgers. The maid had been at the rear of the house with the Coornhert servants and summoned to meet Harry and Kimberly when they could have been presumed to have entered by the front door.

"Mathilde's a steady, reliable girl, and she comes with a good recommendation," he said stiffly.

"She gives me the creeps," she said. "And she doesn't understand a word of English."

"That's all to the good, isn't it?" Peter said. "She won't pick up on anything we might let drop."

"You could have picked up a better looker, Pete," Harry put in.

"Oh, shut up, Harry!" Kimberly said. "When you and Peter get back, I expect to be taken out to dinner in the poshest restaurant in town."

Peter spoke quickly, to forestall a promise by Harry. "It doesn't work that way. Harry and I could get a meal at a tavern, but as a respectable *vrou*, you're supposed to stay home. We'll eat here. *Mevrouw* Coornhert has a fine cook. We'll dine royally."

Peter could see Kimberly working up to an explosion, and so could Harry. They left hastily before there

could be a scene that would scandalize this serene household.

"So, Peter," Harry said as they strolled along the *Oude Lange dyck* toward Vermeer's house, "what did you tell Vermeer?"

"I didn't tell him anything," Peter said. "He was up in his studio, working. They don't dare disturb him. I talked to his mother in law, Maria Thins. She owns the house, and she runs everything but her son in law. I told her I was the secretary to a very rich Englishman, and that he had come to Delft to have his wife's portrait painted. I said you were willing to pay top guilder, and her eyes lit up. He's a slow worker, and they're always short of money. She said he'd see us today."

When they reached the house, they found the front door open and an old woman sitting in the doorway mending a piece of lace. "That's Maria Thins," Peter whispered. "She's waiting for us."

She looked up as they approached, but didn't rise. "He's not here," she said without preamble. "He's having lunch at the Guild." She tossed her head, almost belligerently. "They elected him head, you know."

He told Harry what she had said, and a cloud of displeasure crossed Harry's face. The woman saw it too, and added grudgingly, "He should be back soon." She laid aside and stood up. "You might as well come inside."

"Don't they believe in introductions around here?" Harry said. He and Maria Thins seemed to have taken an instant dislike to each other.

"Dit is Mijnheer Brock," Peter said hastily. *"Van Engeland."*

"Ja, ja," she said. She led the way down a hallway whose walls were crowded with paintings, mostly interior scenes with two or three figures. They ended up in a large, dim room with more pictures on the walls. She did not invite them to sit down. "I'll let you know when he comes," she said, and disappeared.

They found two straight-backed chairs and sat. Harry looked around at all the paintings. "Lotta pictures," he said.

Peter remembered what Elphinstone had told him. "None of them are by Vermeer," he said. "He sells them."

"What is it with that broad?" Harry said. "I thought you said they needed the money."

"She didn't want to look too anxious," Peter said. "You of all people should understand that. Don't worry, Harry."

It wasn't a long wait. They heard subdued voices in the front hall, but couldn't make out what was being said. Maria thins returned and told them, "He's back. You're to go up to the studio."

They climbed two flights on uncarpeted stairs. A maid with a dust cloth was on the landing, dusting the banister. She stared at them open-mouthed as they stopped in front of the closed door. Peter got the impression that it was a big deal in this household to enter the studio.

"We should knock," Peter said.

"The hell with that," Harry said, and pushed the door open. Peter followed him inside.

It was a large room, flooded with daylight from the big windows facing the street. It was sparely furnished, with a couple of leather-seated chairs, a small table holding pots and jars containing brushes

and pigments, and a storage cabinet with narrow drawers. The floor was a checkerboard pattern of black and white tiles. There were two easels, the larger one holding an unfinished painting that Peter recognized from the art books that Elphinstone had shown him. It depicted a hulking man in a blue robe—"The Astronomer"—reaching out to examine a celestial globe. The model for the painting, Elphinstone had said, was Vermeer's friend Leeuwenhoek.

The man at the easel turned around to face them, a brush in his hand. He had unremarkable blunt features and shoulder-length brownish hair flowing from a floppy black beret-like hat. He was shorter than either Peter or Harry. He showed no inclination to speak, so Peter spoke first.

"Aangenaam, Mijnheer Vermeer. Ik heet Pieter Van Gaas. Ik kom uit Engeland. Dit is Mijnheer Harry Brock."

Vermeer still showed no inclination to speak, and Harry jumped in, in blustery mode and at full volume. “Let's not beat around the bush, fella. I heard you were the best painter around, and I want you to paint my wife. She's a real looker, like you've never seen, and I can afford to pay top dollar.” He glanced at the picture of Leeuwenhoek. “You can finish that later."

Vermeer had followed Harry's glance, but his face remained impassive. Peter offered a more genteel translation and apologized for Harry's brusqueness. “He's a very rich, important man, and he's used to getting his own way,” he said.

A long, delicate conversation followed, with Harry breaking in constantly to demand, “What'd he say? What'd he say?” Vermeer explained obliquely that he didn't ordinarily paint portraits, but when Harry offered him a thousand guilders, his eyes widened and he allowed that he sometimes did character paintings—*tronie* or something called *juffers*. Peter did not understand the distinction, but it seemed to be important to Vermeer. In the end, Vermeer dismissed them with vague assurances and told them to come back tomorrow with the young lady.

* * * *

Kimberly was displaying her usual edgy coolness on the surface, but Peter thought he could detect a certain hidden excitement underneath. He was afraid she was underdressed and overjeweled. Under the cloak she had worn in the street, her gown revealed even more bare flesh than the dress she had arrived in; it might have belonged on a fashion show runway or at the Academy Awards. And the jewelry—a modernistic platinum and diamond ring from Gucci, a diamond-emerald bracelet from Cartier's and a black pearl necklace from Tiffany's—surely didn't belong in the seventeenth century. But it was no use trying to talk to her; Harry liked it, and that was that.

Maria Thins was at the door. “He's waiting for you upstairs,” she said. She looked Kimberly over. “Well, my girl, you look more like a *vriendin* than a wife.” Peter didn't tell Kimberly what she had said, but her tone had said it all.

Vermeer had his back to them when they entered. He did not turn around, but went on working. When he finally turned to face them, Peter could see that the picture of Leeuwenhoek had been removed. It had been replaced by a blank canvas, and Vermeer had been applying a chalky ground.

There had been other changes in the studio too. The celestial glove was gone, replaced by a decanter and two wine glasses. So Kimberly was going to be the kind of woman who was plied with wine by a man with questionable intentions—the theme of a couple of the paintings in Elphinstone's art books. There was a lute on the table. So she was going to have artistic inclinations. There was an inkwell, paper, and a couple of quills. So she was romantic—Elphinstone had explained that letter writing or letter receiving was a synonym for romantic intentions.

Or maybe not. Maybe Vermeer was just trying out his props.

There was another addition to the room. A curved mirror in a gold frame hung on the wall in line of sight of the easel. Vermeer explained that he was going to paint a distorted image of Harry in the mirror. It would look like a mere smear of color, and only become recognizable as Harry when viewed in another curved mirror. The idea was to show that the woman in the portrait was looking directly at her lover or seducer. It was the sort of virtuoso trick to be expected of a master painter like Vermeer.

Peter translated what Vermeer had said, and Harry was delighted by the idea. “That'll show the snobs and Doubting Thomases!” he chortled. “It's as good as a signature and a certificate of authenticity."

"You're getting your money's worth, all right, Harry,” Kimberly said dryly.

After that, Vermeer ignored Harry and Peter and spoke directly to Kimberly, using Peter only to translate.

"You will find a yellow garment trimmed with ermine in the next room,” he said, speaking slowly and distinctly, as if he were giving instructions to a child. “Go and put it on. And you will have to remove your English jewelry. I will give you my wife's pearl earrings to wear."

Kimberly left with eyes flashing, but came back wearing the garment in question hanging defiantly open. “If he thinks I'm going to cover up my best assets, he's crazy,” she said. She handed her jewelry over to Peter and said, “Take good care of them, darling. That's a million bucks worth there."

Vermeer went to the cabinet and took out a pair of pearl earrings and a modest pearl necklace. Kimberly tossed her head to show her displeasure, but put them on.

Vermeer said patiently, “Half turn your body to the light. Another bit. Just so. Now turn your head directly toward me, as if I were *Mijnheer* Brock. Pick up the lute. No, put it down. Pick up one of the wine glasses."

After a half hour of this, Harry was bored. “I'm going for a walk,” he said. “Does he need me?"

"No, he'll get your face later,” Peter said.

"Do what the man says,” Harry told Kimberly. To Peter, he said, “I'll meet you back at the house."

* * * *

A month later, Harry was even more bored. His likeness in the curved mirror, reduced to a blur after endless geometric calculations, had been committed to canvas, and Vermeer had no further use for him. Now Vermeer was concentrating totally on Kimberly, working with exasperating slowness, sometimes taking days to paint a single fold in the nanofabric dress that now peeped out from under the yellow coat, or to refine a reflected patch of light in the wineglass she held. It was excruciating to watch.

"What do you think, Pete?” he said. “How long is it gonna take him?"

"I don't know,” Peter said. “It could be months."

"Yeah,” Harry said glumly, staring at his beer. “That's what I figured. I'm not doing much good hanging around here, am I?"

"Don't say that, Harry. Kimberly needs your support."

"Baloney. Sometimes I think she doesn't even need you to interpret. Somehow she knows what he wants

her to do without a lot of talk."

"Relax, Harry. I'll get us another beer." He signaled the innkeeper.

"I'd give anything for a decent martini," Harry said. "I thought Dutch gin was supposed to be good."

"No ice, Harry. That's the problem."

"I'm going crazy. There's nothing to do here. I'll go bonkers-poo if I have to admire one more canal or go to the countryside and look at windmills on one of your little field trips."

"I'm sorry, Harry. It was the best I could do. No nightlife here."

"What I thought, I'd take a little break. Go uptime for a few days, and come back a coupla months later when the painting's finished. You can signal Roy on your little gizmo and he'll send me back at the right moment in time."

"It would be hideously expensive, Harry. It would count as another round trip."

"What the bleep do I care? I can afford it."

"And it would leave your registered timeline wide open for an incursion."

"So what? So some arty snoop comes back here for a look? What could he do? I've got Vermeer tied up. In fact, if he saw what was going on with the painting, it would only add to the authentification."

"I don't know, Harry. It doesn't seem fair to leave Kimberly alone here for all that time."

"Kimberly's a tough broad. She can take care of herself."

Peter had no answer for that. Harry was already caught up in his vision.

"I'm going to throw myself a party at La Mode. I'll invite the cream of society. Hollywood, Bollywood, Wall Street, Washington, the Art Mafia—even Elphinstone, the little twerp. The *Times* guy and all the big enchiladas who looked down their noses at me when I was juggling my way to the top. It'll be first class all the way—champagne, caviar, lobster burritos, La Mode's pheasant piroshki."

Peter waited it out. There was no way to stem the flood.

Harry drained his glass. "Let's go. Mrs. Coornhert's in bed. I'll wait outside while you tell Kimberly."

* * * *

Roy Hendricks frowned in puzzlement as Harry stepped out of the booth alone, the programmed five seconds after the three of them had disappeared. "What's going on, Harry?" he said. "Where are Peter and Kimberly? And the painting? The program was set to pick you all up when Peter's signal specified the new coordinates."

"Change of plans, Roy," Harry said. "I'm taking a little break. Coupla days. You're sending me back a little further up the timeline. A few more months. Peter will send—has sent—another signal to give you the new coordinates."

"Harry, what have you done? You've screwed up your mass allowance for starters. And I don't know if I can send you back in a couple of days. I've got to reprogram, and we've got to get the capacitors up to speed again."

"You'll find a way, Roy. Money still talks."

* * * *

Peter peered through the lens at a swarming profusion of microscopic creatures, wriggling their way through the universe contained in a drop of water. Beside him, Leeuwenhoek could barely contain himself.

"Well then, *Mijnheer*, what do you say now?" Leeuwenhoek said.

"Astonishing," Peter said diplomatically. He had seen paramecia and other protozoans under greater magnification in his high school biology class.

"Well then, when you return to England you will tell the Royal Society that you have seen my animalcules with your own eyes. In their latest letter to me, they stressed the importance of having my observations verified by a *testis ocularis*, not that I understand their infernal Latin."

"I will be happy to tell the Royal Society what I have seen," Peter said.

Leeuwenhoek sighed. "It is marvelous, is it not, that philosophy and science have not been constrained between our two nations despite our naval battles."

The man Vermeer had painted both as an astronomer and a geographer was as impressive as his pictures. He was a big, burly fellow with a no-nonsense air about him. Still ahead of him, Peter remembered with a pang of pity, was the sad duty of serving as executor for his friend's bankrupt estate.

"Yes, marvelous indeed," Peter said. "It gives us hope for the future."

Leeuwenhoek had more to show him, but Peter remembered that he had left Kimberly alone too long with Vermeer. Harry's departure had emboldened him to sneak off more and more frequently. He had no misgivings though. There was a book in Leeuwenhoek, maybe a best seller. It would be his next project after he finished his book about the Dutch East India Company and their war with the English East India Company.

"I regret that I cannot stay longer, *Mijnheer*," he said. "But may I come and see you tomorrow? I would like to learn more about your life and work."

* * * *

"It's about time, Peter," Kimberly said. She was in a snit. "You didn't even make it back for dinner. I had to sit alone in that dining room while the kitchen maid paraded in and out with one indigestible course after another. I'll scream if I see another turnip."

"I'm sorry," Peter said.

"I have no one to talk to. My so-called maid, Little Miss Frozen Face, is no help. At least Harry was good for a laugh once in a while."

"There's Vermeer. You seem to be getting along all right with him."

"Oh sure. The conversation is scintillating. 'Move your head a little to the right. Part your lips just a shade. Don't look at the wine glass, look at me.' I know every single boring word in his vocabulary. I don't need a translator."

"Kimberly..."

"I don't need a translator. I need a goddam human being."

Her voice had softened. Peter involuntarily took a step closer. Kimberly's lips parted moistly.

Oh no, Peter thought. He stopped himself, took a step backward. “I better go now. Sleep tight."

The look in her eyes was one of unmitigated fury. “Don't bother to come to the studio tomorrow, Peter,” she spat. “Go and have your silly fling with whatever little *juffer* you seem to have found for yourself."

He fled. He did not stop to wonder where she had picked up the word.

* * * *

The other directors were absent. There was only Nelson and Marietta waiting in the darkened conference room when Ziggy arrived.

"You saw the media circus at La Mode, I suppose?” Marietta said.

Ziggy nodded. “It just makes it easier. I don't know why Brock decided to return to the present for a few days, but I've got a tracer planted in the Alternatives Associates system. As soon as Brock reenters his Vermeer timeline, it'll pinpoint the exact date the painting is finished. I'll be right behind him. In point of fact, I can arrange to be a little ahead of him. When he arrives, he'll find the painting slashed to ribbons and the Vermeer household trying to put out a fire."

"Plan A?” Marietta asked.

Ziggy nodded again. “Timing is everything."

* * * *

Harry popped up in the bedroom just as Peter arrived to get Kimberly. “I got your signal,” he said. “This is the day, huh?"

"You're just in time for the unveiling,” Peter said. “Vermeer put the finishing touches on the painting last night. We're supposed to meet him in the studio this morning."

"What did you tell him about why I was gone these last months?"

"I said you had to go back to England on diplomatic business. He wasn't much interested. *Mevrouw* Coornhert might wonder how you got back in the house without her seeing you."

Harry grinned and turned to Kimberly. “You should have seen the bash at La Mode, doll,” he said. “‘Everybody that mattered and everybody that nattered’ was the way the *Post* columnist put it. And remember, it was only a day, running time, after the splash our send-off press conference made. And when we get back with the Vermeer, it will be only one more day later. Three splashes in a row. You can't beat that for publicity."

"Thanks, Harry,” Kimberly said dryly. “That's a lovely thought."

"Don't be like that, doll. I'll make it up to you."

"Goody. With what? A press party at The Waldorf?"

"I hate to interrupt,” Peter said, “but we better get going. Vermeer's waiting for us."

It was a gray overcast day in Delft, but it was a market day, so the street along the canal was crowded with people flowing toward the market square. The canal was crowded too, with boats and barges of

every description riding low in the water with cargos of fish, produce, and household goods. A *koff* and a gaff-rigged barge collided, and the pole men were having an argument. Some of the passers-by stopped to watch, and the three time-travelers had to push their way through the knot of people who were collecting.

When they reached Vermeer's house, the door was open but no one was in evidence. The housemaid would have gone to do the shopping, and perhaps the children had gone with her, but it was odd not to se Maria Thins at her usual post.

Peter struck his head inside the door, and the problem was solved when he saw Vermeer coming down the corridor toward him, while Maria Thins stood in the doorway to the great hall with her arms folded. They must have been conferring, no doubt about the money they were going to get from the Englishmen.

"Goedemorgen, Mijnheer, please come with me," Vermeer said to Peter, and they followed him up the stairs to the studio.

The door to the studio was locked, as it usually was, and that was what made it odd. Peter could hear sounds coming from inside, noises that sounded as if someone were tossing furniture around, and glass crashing to the floor.

Vermeer heard it, too, and he hurried to unlock the door and push it open. *"Nee, nee!"* he screamed as he burst through the doorway with Peter and Harry close behind him.

A short, wide, bald-headed man in a cheap twenty-first century business suit was standing in front of the easel with a wicked-looking knife in his hand. He had vandalized the studio, to judge from the overturned chairs and the smashed jars of pigment, and he was preparing to slash Kimberly's portrait.

Vermeer flung himself on the intruder and tried to wrest the knife from him. The man tossed him aside as easily as if he were a sack of feathers.

Peter jumped on the bald man next and tried to get hold of his wrist. But the man, though at least a head shorter than Peter, was surprisingly strong. He broke Peter's grip easily and pushed him violently aside. Peter landed painfully in the litter of broken glass and pottery. The man turned again toward the canvas, his knife raised.

"Oh no you don't, you son of a bitch!" Harry yelled, and jumped him. His luck was no better. The bald man whirled and plunged the knife into Harry's midsection.

Before he could withdraw the knife, Peter was on his feet with a heavy pitcher in his hand—one of the few unbroken pieces of crockery he had found on the floor next to him. Possibly it had been too heavy to break easily.

But it broke now. He swung wildly and smashed the pitcher squarely on the intruder's bald dome. The man dropped to the floor like a fallen tree.

Only later would Peter realize that his weapon had been the pitcher that Vermeer had used for a prop in his painting of the milkmaid.

Vermeer's first thought was for the painting. He checked it over to make sure it had not been scratched. Then, with a somber shake of his head, he turned to where Harry was lying on the floor, with Kimberly bending over him.

"Your friend Brock," Vermeer said to Peter in a shaken voice, "is he..."

"He's dead as a mackerel," Kimberly said. Tears were running down her face. "Poor Harry," she said. "Who would have thought that he'd give his live for art?"

* * * *

Maria Thins sent the maid to fetch the hound beaters, as the watch were called in Delft. They arrived in a matter of minutes, four beefy men armed with truncheons, a little annoyed at having been dragged away from their duties in the market square. They expressed no particular surprise at the bald man's unusual clothes, and led him away, his hands bound behind his back.

"What will happen to him?" Peter asked Maria Thins.

"Oh, he'll be hanged for murder. Or it may not be as simple as that. Sorcery may be involved. In that case he'll be burned at the stake."

She pried a distraught Kimberly away from Harry with the help of the maid, and sat down in one of the chairs. The maid ran off to fetch a glass of wine. Maria Thins turned to Peter.

"What do you wish to be done about your friend?" she asked.

Peter looked at Kimberly, but she was in no shape to deal with anything. "We must leave for England today, unfortunately," he said. "*Mijnheer* Brock would have wished to be buried here in Delft. He has expressed affection for the place many times."

"The Old Church or the New?"

Peter knew that she belonged to the *Oude Kerk* and chose the path of least resistance. "The Old Church," he said.

"I will see to it," Maria Thins said.

* * * *

A waiter went by with a tray full of cocktails and Peter snagged one for himself. He took a sip. It was an impeccable martini, crisp, dry, and ice cold.

"Dutch gin," he decided.

Beside him, Elphinstone was still working on his first drink. "Harry served nothing but champagne at his bash last night," he said.

"Kimberly's a little more imaginative. Have you been to the buffet table? It's all Dutch treats. *Poffertjes, rolmops,* bite-size *uitsmijters*. And the décor. She's got her portrait displayed in a little alcove that replicates the room in the painting itself. I don't know how her decorator came up with all the props so fast."

"Gimmickry, pure gimmickry. Or I should say impure gimmickry. That's why the art world won't take the painting seriously."

"Kimberly doesn't care," Peter said. "The commercial world takes it very seriously. Christie's wanted to put it up for auction. Their estimate was astronomical. But she turned them down. She's going to hang onto it. It's worth more to her in publicity. She told me she's going to leave it to the Met in her will."

"The Met won't take it. Not when my colleagues have taken the line that a Vermeer from an alternate timeline isn't an authentic Vermeer. I'm a bit of a pariah in the art world, you know."

"You're taking the line that it's an authentic Vermeer?"

"Well isn't it? Same hand, same eye, same spirit. We have much to learn from it. I'm doing an article for *Art Directions* celebrating the appearance of a new Vermeer in our world. Why not? The music world doesn't have these prejudices. And I heard there's a project afoot to get another play out of Shakespeare."

"It'll open the floodgates."

"About time." Elphinstone finished his drink and looked around for a waiter.

"Look," Peter said. "I think Kimberly's going to make a statement."

They moved with the crowd to get closer. The 3D-cameramen were jockeying for position and reporters were shouting questions that were lost in the noise.

Kimberly got them quieted down. She was stunning in the jet-black mourning pants suit that her designer had whipped up for her overnight. The cleavage was tasteful and covered with a wispy mesh. Tiffany's had provided an approximation of the pearl earrings in the painting.

"Shhh!" Peter shushed a reporter who was trying to get a quote from Elphinstone.

Kimberly was doing the somber bit as well as she did everything else. She had toned down her natural vivacity, and even managed to have a tear trickle down her cheek, fortunately without damage to her waterproof makeup.

"Thank you all for coming. You've all heard about Harry's tragic end in the seventeenth century, where he gave his life to bring art and beauty to this world of ours. It's truly a tragedy that he can't be here with us to share this moment of his triumph. But he's buried in Delft, a city that he came to love, though it's a Delft in another universe. The painting that I brought back with me is Harry's legacy to *this* universe and does honor to his memory."

She dabbed at another photogenic tear. "It's a legacy that will always keep Harry Brock's name alive in this here and now, and I will always be faithful to the memory of that dear, dear man."

In another time, flashbulbs would have been going off, but as it was, the ambient light suddenly intensified all at once as the photographers made the most of the moment.

Kimberly's trademark liveliness returned without a skipped beat, and she said, "Now you'll all want to see the world's newest Vermeer masterpiece. A note to the press: the painting will be on display to the public for the next two weeks here at the gallery.

White-gloved attendants were removing the velvet ropes in front of the alcove, and there was a rush to be the first in line. Peter passed up the opportunity to take advantage of his position, and got in line with the rest. Out of a sense of *noblesse oblige*, he let Elphinstone get in line ahead of him.

When it was his turn, he stood in front of the painting for most of the allotted minute. It was his first chance to get a good close-up look. He'd watched the portrait taking shape day by day for months, but he'd always been standing well to the side. And then, in the excitement after the mysterious intruder had been led away by the hound beaters, he hadn't thought to examine the canvas. Vermeer had had it wrapped up in a trice, it had been borne away by Kimberly, and he hadn't seen it since.

It was beautiful, otherworldly. The woman in the picture was unmistakably Kimberly, but it was a Kimberly that transcended reality. Peter let out his breath, and in his remaining seconds turned his

attention to the curved mirror in the background, where Harry's scrambled image was trapped for eternity.

Ignoring the attendant who was telling him his time was up, he turned around to see what Harry's image looked like in the real curved mirror on the opposite wall.

It wasn't Harry.

There, with a decidedly lubricious expression on its face, was the image that Vermeer had painted of himself.

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Reader's Department: **THE REFERENCE LIBRARY** by Don Sakers

The Walls of the Universe

Paul Melko

Tor, 384 pages, $25.95 (hardcover)

ISBN: 978-0-7653-1997-5

Genres: Adventure SF, Parallel Worlds/Other Dimensions

* * * *

Every so often, a young man receives a strange gift or develops an unusual ability, and then goes on to adventures that explore some classic idea in SF. It happened with Kip Russell and alien invasion in Robert A. Heinlein's *Have Space Suit, Will Travel*; with Daniel Eakins and time travel in David Gerrold's *The Man Who Folded Himself* ; with Davy Rice and teleportation in *Jumper* by Steven Gould, and to various other heroes of classic Heinlein and André Norton juveniles.

Meet John Rayburn, and prepare for an action-packed tour through parallel universes.

John, a high school senior, is minding his own business on his family's farm when he encounters a surprising visitor: himself. Or rather, an alternate version of himself from a parallel universe, John Prime. Prime has a portable device that allows him to travel between parallel universes, each of which is numbered (John's home universe is 7533). Prime has a get-rich-quick scheme, and he wants John's help. Rubik's Cube, familiar to Prime but unknown in John's universe, will make them a fortune. Countless other universes must contain countless inventions that could be exploited.

To prove his fantastic story, Prime offers to loan John the transfer device for 12 hours, so John can travel to a few other universes and then return. John agrees, and jumps into universe 7534. And that's when things start to go wrong.

When the 12 hours are over and he tries to return to 7533, John learns the awful truth: the device is broken. It only counts forward, not back. Prime lied to him, took over his life, and exiled him from his home universe.

John soon learns that parallel universes are dangerous places. Some are tantalizingly familiar, others completely alien. He encounters vicious beasts, merciless police states, and the nightmare danger of materializing inside a marble wall or buried in the ground, immobile and forever unable to reach the button that activates the device. Further, he discovers that there are other cross-universe travelers out there: some high-tech societies routinely exile their criminals and troublemakers to lower-tech universes, where they prey on the inhabitants.

John finds a universe not unlike his own and determines to settle down and devote his time to trying to understand (and possibly fix) the transfer device. In the process, he accidentally introduces pinball to his new universe ... and soon, he has attracted the attention of some mysterious bad guys.

This sort of book usually includes a coming-of-age story, and *The Walls of the Universe* is no exception. John faces serious questions of morality, starting with the temptation to trick another John Rayburn like Prime tricked him—and culminating with the inevitable moment when he holds Prime's fate in his own hands.

All in all, the story of how John triumphs over his various difficulties is fun and exciting. *The Walls of the*

Universe is definitely recommended.

* * * *

City at the Edge of Time

Greg Bear

Del Rey, 476 pages, $27.00 (hardcover)

ISBN: 978-0-345-44839-2

All the Windwracked Stars

Elizabeth Bear

Tor, 368 pages, $24.95 (hardcover)

Genres: Dying Earth, Far Future/Clarke's Law, Science Fantasy

* * * *

As usual, it started with H.G. Wells. In *The Time Machine* he presented a far-future in which everything had worn down: the Earth, the human race, even the Sun. John Campbell's "Twilight" and Arthur C. Clarke's *Against the Fall of Night* further explored these cold, cheerless eras, where advanced science became decadent magic, and science fiction was all but indistinguishable from fantasy. It fell to Jack Vance to produce the book that would give this subgenre its generally accepted name: *The Dying Earth.*

Dying Earth novels have been out of favor in recent years. In fantasy, the subgenre devolved (what else?) into generic sword-and-sorcery; in SF, it seemed that Michael Moorcock's "Dancers at the End of Time" series had said everything there was to say.

Now, two writers named Bear have blazed trails into this long-unexplored territory, and they've come back with some pretty compelling visions.

Greg Bear's *City at the End of Time* begins in the present day with three dreamers: Daniel, Ginny, and Jack. Each, in his or her own way, is cast adrift in time; each, in his or her own way, is linked with a city in the unimaginably distant future. This city, the Kalpa, is the last crumbling refuge against the final night. And before the end comes, all three dreamers have their parts to play.

Elizabeth Bear's *All the Windwracked Stars* starts with the desolate aftermath of a battle, the defeat of the Children of Light on the Norse-flavored world of Valdyrgard. Two survivors of that battle find each other: Muire, the last Valkyrie, and Kasimir, a winged steed.

Curtain falls, rising 2300 years later. Human civilization on Valdyrgard, once risen to tremendous heights, has fallen; one decrepit domed city remains, ruled by the despotic Technomancer. Muire walks the city in search of something she never expected: another surviving Child of Light.

These are two very different books, but they share some of the same sensibilities: grand expanses of time, epic events, technology so advanced that it's magic, powerful heroes and implacable villains, and the constant presence of entropy and despair so palpable that they might as well be characters in the story. This is science fiction taken to the level of mythology. If that sort of thing appeals to you, this is one Bear market you don't want to miss.

* * * *

Steal Across the Sky

Nancy Kress

Tor, 336 pages, $25.95 (hardcover)

ISBN: 978-0-7653-1986-9

Genres: Alien Beings, Other Worlds,

Psychological/Sociological SF,

Religious/Philosophical SF

* * * *

I don't think Nancy Kress can write a bad book.

Aliens land on the moon and place an ad on the Internet (it's the best way to reach a lot of people in a hurry). Calling themselves the Atoners, they claim that ten thousand years ago, they wronged humanity, and now they're looking for volunteers to visit seven planets to "Witness." The Atoners won't reveal the nature of their foul deed, nor will they show themselves in person.

Cam, Lucca, and Soledad are the team of Witnesses dispatched to the Kular system. As Steal Across the Sky opens, they arrive and survey the two inhabited planets. Lucca takes a shuttle down to Kular A, while Cam descends to Kular B. Soledad stays behind in the mothership to coordinate communications and handle emergencies.

Both Kular worlds are inhabited by humans, descended from seed stock the Atoners stole from Earth ten thousand years ago. As Lucca and Cam play amateur anthropologists in the fascinating, pre-industrial societies of their respective worlds, they have no clue what they're looking for: the Atoners have only told them that they'll know it when they see it.

Kress spends the first half of the novel carefully and artfully revealing the big secret; I'm going to blab it in the next paragraph. If you don't want to know ahead of time, stop reading this review and go enjoy *Steal Across the Sky* with my blessing. The book is well worth your time.

Still here? Eventually it develops that the people of Kular A (but not Kular B) seem to be able to see and converse with the recently dead. All humans once had this ability; the crime of the Atoners is that they removed the associated genes from the human race. They set up Kular A and B (as well as seven other pairs of inhabited planets) as laboratory experiments: altered humans on one world, control groups of unaltered humans on the other.

Another writer would spend the rest of the book exploring the implications of this idea: the meaning of death, the nature of the afterlife, the impact on human religion, philosophy, and science. It's a huge theme, with repercussions for all of humanity. But Nancy Kress is no ordinary SF writer, and she knows that sometimes world-altering events can best be approached through their effect on individual people. She chooses to follow the Witnesses back to Earth, and in the second half of the book she unravels their own very personal responses to what they've experienced.

One Witness, refusing to believe in life after death, withdraws into seclusion. Another becomes a media superstar, preaching the gospel of the Atoners in revivalist style. Yet another accepts government relocation, trying to rebuild as normal a life as possible. Meanwhile, the Atoners go silent, retreating into their sealed moonbase and saying nothing.

Ultimately, the fates of all the Witnesses come together and all questions are answered, including the biggest one: what are the Atoners up to?

Thought-provoking and powerful, *Steal Across the Sky* is a book that will stay with you long after your reach the last page. Highly recommended.

* * * *

The Unincorporated Man

Dani Kollin and Eytan Kollin

Tor, 480 pages, $25.95 (hardcover)

ISBN: 978-0-7653-1899-2

Genres: Future Worlds, Psychological/

Sociological SF

* * * *

In science fiction circles, it is an article of faith that anything can be a subject for an SF story. Politics, sex, violence, slavery, cannibalism, religion: nothing is too controversial or too obscure to be the basis of an SF novel.

In *The Unincorporated Man*, the subject is economic theory.

In the twenty-fourth century, everyone is incorporated, and nobody gets anything for free. From birth, individuals sell shares of themselves: to parents, teachers, even the doctors who attended one's birth. As a result, the average adult spends half a lifetime buying back shares in an attempt to gain majority control of one's own life.

Into this world comes Justin Cord, a twenty-first century billionaire who was secretly put into suspended animation after his death. By now, resurrecting and curing Cord is trivial; the big problem is that he is the only unincorporated individual in the world. And this erstwhile tycoon is a poor match for the utopian society into which he's awakened.

It's an interesting and compelling idea; unfortunately, the Kollin brothers don't succeed in turning the idea into an equally interesting and compelling novel.

Let me be perfectly clear, I am making no judgment on the idea, just the execution of the story. The characters never really come alive: they are merely placeholders in the authors' exploration of their world. Even Justin Cord, who was obviously meant to be the most sympathetic and appealing character, is nothing more than a cardboard mouthpiece.

Science fiction writers always have the challenge of introducing background information to the reader. One common pitfall is the infodump: an indigestible mass of data that brings the story to a crashing halt. *The Unincorporated Man* is filled with infodumps, many of which would be more at home in *Corporate Investing for Dummies* or a similar book.

Another technique is to introduce a naive observer, such as a traveler from another place or time. As the observer learns, so does the reader. Nancy Kress deftly uses this technique to great effect in *Steal Across the Sky*, as her Witnesses learn about the worlds upon which they've landed. In *The Unincorporated Man* the same technique is awkward and disruptive. Justin Cord is always learning about his new world in long expository passages that don't fit and serve to slow down the reader.

The plot of *The Unincorporated Man* is mainly an excuse to get Justin Cord touring the world so the reader can learn about the underlying economic theory. The villains are bad not because of any

underlying human motivations, but because, well, you need to have some bad guys. If this future world has any serious flaw, it's that life is too perfect. In the fullness of time, Justin inspires revolution throughout the Solar System, the bad guys are defeated, and all is well.

The Unincorporated Man comes accompanied by breathless publicity proclaiming it to be groundbreaking and important, and quotes likening it to Heinlein. Treat these claims as hyperbole. Heinlein at his best was an exceptional storyteller; the storytelling here is, to be generous, pedestrian.

If you're looking for a good novel, I would counsel you to look elsewhere.

So who would like this book? Among your circle of friends, look for the hardcore libertarians—those who think that all roads should be toll roads, or that the greatest evil in the modern world is the income tax. Or those who can quote Ayn Rand chapter and verse. Recommend *The Unincorporated Man* to them, and they'll be eternally grateful. And if you don't have anyone like that among your circle of friends, you need to get out more and make more friends.

* * * *

Death From the Skies!

Philip Plait, Ph.D.

Viking, 326 pages, $25.95 (hardcover)

ISBN: 978-0-670-01997-7

Genre: Popular Nonfiction

* * * *

Philip Plait is a professional astronomer and runs the popular-science website *www. badastronomy.com* . In *Death From the Skies!* he's produced a fun yet factual book that should be of interest to just about any *Analog* reader—or writer!

In nine chapters of easy, informal prose, Plait examines and explains many different astronomical phenomena that could result in the end of the world. From asteroid impacts and solar flare-ups to crashing galaxies and the heat-death of the universe, Plait educates his readers in modern astronomy, astrophysics, and cosmology. Along the way he touches on supernovae, gamma-ray bursts, stellar evolution, mass extinction events, the history of the universe, and even the possibilities of alien life.

Plait's style recalls the playfulness of George Gamow and the sense-of-wonder of Carl Sagan. There's plenty of humor here; the first sentence is “The universe is trying to kill you.” What's not to like?

By the time you finish *Death From the Skies!* you will learn something, even if you start with the average *Analog* reader's familiarity with modern astronomical knowledge. And you'll certainly know a few more ways to destroy the planet. (A helpful appendix lists 24 nearby stars that will eventually go supernova.) When you're done, you can give the book to a bright child or other science enthusiast in confidence that they will enjoy it as well.

* * * *

Don Sakers is the author of *A Rose From Old Terra* and *Dance for the Ivory Madonna*. For more information, visit *www.scatteredworlds.com.*

* * * *

COVER CAPTION

Two rovers approach an Altair lander near the lunar south pole. Atop the Altair's deck rests a habitat module, newest addition to the nearby Shackleton International Outpost. Construction of humankind's first permanent lunar base could begin as early as 2020. Painting © Michael Carroll for the upcoming book The Seventh Landing (Springer 2009)

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Reader's Department: **BRASS TACKS**

Dear Dr. Schmidt:

One more vote for “Tracking.” The author nailed the young heroine's stream of consciousness perfectly. I admit it took me a couple of pages to really appreciate what he accomplished, but then I couldn't wait for each new episode. The second young heroine story, “Wake,” was equally enjoyable. I anxiously awaited the last installment (March ‘09) to see what the author would do with the dawning intelligence of Webmind, the fascinating subplot with Hobo, and even the Chinese atrocity connection. I hope the Mr. Sawyer will delight us with a sequel addressing these other story lines.

Paul Stahlhuth

El Dorado Hills, Ca

* * * *

Dr. Schmidt:

Regarding your March editorial “Can't get there from here?": Interesting idea you presented. Then, so is a perpetual motion machine.

As a history major myself and a continuing student, I have observed that there are two competing socioeconomic systems that have been around since the first humans, either Adam and Eve or overachieving chimps. One is the collectivist/command/control (C3) model. I believe what you propose falls into this category as does the Marxist/communist program we are about to have thrust upon us. The other is the individualist/freedom/self-interest (IFS) model. This was the predominant system in the US from colonial times until the 1930s.

I submit that the IFS is the better one. By better I mean the IFS system generates wealth and spreads it around. The C3 system generates poverty and spreads that around. I believe the accuracy of those statements is demonstrable through historical and technological examples.

The two classic historical examples I cite are the US, as stated above, and the British Empire of the 18th and 19th centuries. What? Nineteenth century Britain, with all the horrors of the Industrial Revolution? Sure. Most of the worst abuses were eventually corrected through the efforts of individuals and small groups influencing individual industries and the legislative bodies of the day. This is government from the bottom up and is a signature trait of an IFS system.

The one technological innovation I cite in support of the IFS statement is distributed computing as described in *Swarm* by Michael Crichton, in which huge numbers of rudimentary computational elements are linked together to form intelligent hominids. Each element on its own was inconsequential. Together they built an intelligent person. More on this shortly.

The historical examples of the C3 model and the consequences of implementing are the Soviet Union, of course, and Zimbabwe under Robert Mugabe. The numerous failures of the USSR are well known and I won't take the space here to enumerate them. When Zimbabwe was still Rhodesia, its citizens, black and white, enjoyed one of the highest standards of living Africa. It was a major exporter of food throughout the region. The human migration pattern was into Rhodesia. With the installation of Mugabe, every single favorable aspect was turned inside out, so that Zimbabwe today is the last stop on the rail line to hell. This is government from the top down, typical of C3 socio-economic systems. Without any exception I can think of, they become dictatorships.

As far as technological example of the C3 model goes, I can really only think of one. Vanguard?

Referring back to distributed computation, I become more convinced every day that this is the best model for a functioning free-market economy. Individuals using enlightened self-interest in an environment of minimum government intervention will work out mistakes and errors and become stronger as a result. They will use resources efficiently and find new ones or work-arounds when they are depleted.

You correctly state that socio-economic systems are enormously complex. No one really knows or understands what's going on. (Though, I believe Thomas Sowell comes pretty close.) C3 leaders in charge never seem to appreciate that as they tinker around an engine they do not and cannot fully understand. Witness the fact that objective economic historians are now concluding that FDR's actions in the 30s turned what should have been a four or five year recession into a decade-long depression; a depression that only ended with the start of a world war.

Since neither you nor anyone else can accurately predict the outcome of any given socio-economic manipulation the best, the only sane course of action is to do nothing. It will eventually all work out. The result may not be to your personal taste, but it will be the best solution for the greatest number of people. That's my definition of “fairness” and societal “justice."

Sue Jarrell

* * * *

Your faith that “it will all work out” is touching, but history contains plenty of examples of things that didn't. Of course, historical examples (including both yours and mine) are of only limited value for guessing what can happen in the future, since there really are some forces at work now that never existed before.

* * * *

Stan:

Your March editorial glosses over a major problem: Who decides which kinds of work are unnecessary, and how do you eliminate them?

To take one of your examples: Yes, disposable shopping bags are wasteful (though I productively reuse at least some of mine), but attempts to wean customers off them have been progressing slowly at best, and as long as the customers expect them, the stores will continue to provide them. One of my local stores has started charging for bags (indirectly, by offering the customer a five cent discount for each bag they didn't take), yet it's still uncommon for customers to show up with their own bags. Apparently, in the minds of many people, these disposable totes not yet unnecessary, much as we might wish otherwise. Convenience is a product like any other.

And financial objections arise when we consider eliminating many of the tasks that appear to be make-work. Advertising could be argued to be purely parasitic—and much of it would be if we didn't care which supplier got the customer's money. Unfortunately, as long as there's a profit motive, we do care, and the ad men get their megabucks for the service of biasing the flow of more megabucks. Lawyers should be unnecessary, but doing without one is often unwise. I've had good managers and bad managers; they really are doing something important, as becomes obvious when they do it poorly. And so on.

And it should be pointed out that some social energy waste, like junk DNA, may actually be a reservoir of adaptability. A neutral or disadvantageous mutation may be a lifesaver when the environment changes; the vestigial products and procedures that are a drag on us when everything is going right may save our bacon in the rare case where something goes wrong.

It's easy to assert that there is waste. The problem is getting folks to agree on what is and isn't waste, and to agree on which (if any) of the alternatives are better. I think our best odds for "getting there from here" are to sit back, watch what happens, and do a bit of selective breeding and weeding when the opportunity arises. It's slow, but we know it works.

Joe Kesselman

* * * *

There's considerable merit in what you say, and your conclusion provides at least a partial answer to the question you pose at the beginning. Who decides what work is unnecessary? The people do, by choosing not to buy things they don't really want or need. This is more likely, of course, if they have learned to actually think *about what's worth buying (and therefore worth making), which means that education has an important role to play.*

Advertising isn't purely parasitic; businesses can't attract customers if customers don't know they exist, and customers similarly can't find businesses they'd like to deal with. But here again education could radically change how *customers and businesses interact through advertising. At present, what sells often has less to do with the quality of the product than with the glitziness of the promotion. If more customers had the habit of looking critically at actual information content, things might be very different.*

* * * *

Dear Dr. Schmidt,

In your editorial you failed to address one important point—what to do in the spare time? Doing nothing soon gets boring, and so does continuous entertainment! It is very likely that this omission has been the downfall of all similar schemes in the past. If you look in history, you can see that if people really want something done very badly, they manage to accomplish it.

The topic of your editorial was exhaustively dealt with more than a hundred years ago by the Latvian economist Carl Ballod. While a professor in Germany, he wrote "Die Zukunftstaat" (The Future State), where he calculated that under rational management each adult could retire with full benefits after some fifteen years of labor.

He also devised a system by which the entire population of a state would be guaranteed all the necessities of life, regardless of income. During wars the German government turned his system into a rationing system by which the production to meet civilian needs could be minimized, releasing more industrial capacity for military use.

Carl Ballod was a world-class economist. When he died in 1932, The *New York Times* published his obituary.

Andrejs Baidins

* * * *

This probably is a point that I don't appreciate as well as I should, since in this respect I seem to be an alien among my own kind. I realize intellectually that some people do have trouble thinking of things to do with their time, but actually having that problem is one of the few things I can't really imagine. How is it possible, with all the fascinating things to learn, see, and do that this universe is filled with?

And besides, I never said anything about getting rid of all *work—just reducing the amount everybody has to do.*

* * * *

Hi, Stan—

I've just read your March editorial, and one possible answer to the problem you pose is before us at this moment—though it wasn't when you wrote the editorial! The ongoing financial crisis has meant that over the last few months many people have lost jobs. Government is bailing out financial institutions and automakers, in the name of limiting the pain and suffering. In past financial crises, occasional businesses have kept workers employed by trimming everyone's hours. If government pushed that, on a national level, as a way of dealing with the crisis, the result might look a lot like what you're talking about. One step in that direction is Obama's proposal to create jobs working on roads, bridges, and alternative energy (work that needs to be done). Unfortunately, the aim seems to restore the status quo ante rather than to redefine the economic system.

Tom Easton

* * * *

I think you're exactly right—but what are the chances that enough people will recognize this *scary problem as a golden opportunity?*

* * * *

Dear Dr. Schmidt,

In your March Editorial, you “throw out a challenge to the world's biggest think tank,” your readership—and on a topic of personal interest, where I've been known to say many of the same things—BUT ... it would be a lot more useful if you also provided a forum for responding to the challenge. Perhaps a clearly delineated topic on the analogsf.com forums?

You have an incredible soapbox for raising issues—it's a shame that you don't leverage that a bit more.

Sincerely,

Miles Fidelman

* * * *

Seems to me that the analogsf.com Forum is actually what you're suggesting, and anybody can start a topic there. Go to it!

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Reader's Department: **UPCOMING EVENTS** by Anthony Lewis

2-5 July 2009

WESTERCON 62/FIESTACON (Western North America Science Fantasy convention) at Tempe Mission Palms Hotel, Tempe, AZ. Artist Guest of Honor: Todd Lockwood; Writer Guest of Honor: Alan Dean Foster; Editor Guest of Honor: Stanley Schmidt; Fan Guests of Honor: Jim & Doreen Webbert; Toastmasters: Patrick and Teresa Nielsen Hayden. Membership after 31 December 2008 to be announced. Info: www.fiestacon.org/; fiestacon@leprecon.org; +1.480.945.6890; FiestaCon, c/o Leprecon, Inc., PO Box 26665 Tempe, AZ 85285

17-20 July 2009

MYTHCON 40 (Mythopoeic Society annual conference) at UCLA—deNeve Plaza, Los Angeles, CA. Author Guest of Honor: James A. Owen; Scholar Guest of Honor: Diana Pavlac Glyer. Theme: "Sailing the Seas of Imagination." Banquet with Mythopoeic Awards. Membership: Mythopoeic Society members $65, non-members $75 until 15 May; $5 more thereafter. Info: www.mythsoc.org/mythcon/40/; correspondence@mythsoc.org; Edith L. Crowe, Corresponding Secretary, The Mythopoeic Society, PO Box 6707, Altadena, CA 91003.

31 July-2 August 2009

DIVERSICON 17 (Twin Cities multimedia conference) at Best Western—Bandana Square, Saint Paul, MN. Guest of Honor: Kay Kenyon; Special Guests: Michael Levy, Sandra Lindow. Honoring Sir Arthur Conan Doyle, Edgar Allan Poe. Membership: $30 (adult), $20 (student), $5 (supporting) until 14 July 2009; $40 (adult), $30 (student) at the door. Info: www.diversicon.org/; diversicon@ gmail.com, PO Box 8036, Lake Street Station, Minneapolis, MN 55408-0036

6-10 August 2009

ANTICIPATION (67th World Science Fiction Convention) at Palais des congrés de Montréal, Montréal, Québec, Canada. Guests of Honor: Neil Gaiman, Elisabeth Vonarburg; Fan Guest of Honor: Taral Wayne; Editor Guest of Honor: David G. Hartwell; Publisher Guest of Honor: Tom Doherty; MC: Julie Czerneda. Membership: until 15 July 2009 (see website for latest details): CAD/AUD 240; USD 200; GBP 135; EUR 145; JPY 18000; supporting membership CAD/AUD 55; USD 50; GBP 30; EUR 35; JPY 6000. This is the SF universe's annual get-together. Professionals and readers from all over the world will be in attendance. Talks, panels, films, fancy dress competition—the works. Nominate and vote for the Hugos. Info: www.anticipationsf.ca/English/ Home; C.P. 105, Succursale NDG, Montréal, Québec, Canada H4A 3P4

4-7 September 2009

North America Discworld Convention (conference dedicated to Terry Prachett's Discworld books) at The Tempe Mission Palms Hotel, Tempe, AZ. Guest of Honor: Terry Prachett; Other guests: Esther Friesner, Diane Duane, Peter Morwood. Info: www.nadwcon.org; info@nadwcon.org; +1.480.945.6890; North American Discworld Convention 2009, c/o Leprecon, Inc., P.O. Box 26665, Tempe, AZ 85285.

authors.