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Reader's Department: **EDITORIAL: ONLY FOLLOWING ORDERS** by Stanley Schmidt

The most notable fact about a recent story in my local newspaper was that it no longer seemed particularly newsworthy.

The item: One of New York's several "parkways" was shut down for several hours because a tractor-trailer truck turned onto the road and ripped its roof off on an overpass. Now, anyone who lives in the metropolitan area knows, and anyone who drives there professionally has an obligation to learn beforehand, that trucks are flatly forbidden on *all* of the area parkways. There are good reasons for that, one of which is that they can get into exactly that kind of trouble, and mess things up for the thousands of other vehicles that belong there.

So what was this one doing where it had no business? Its driver told police his GPS told him to do it, so he did. The news coverage I saw did not make clear whether for some reason he was unable to see the "No Trucks" signs routinely posted at parkway entrances, or failed to know about the general ban on trucks on parkways. If for some reason one of these conditions applied, I would be very interested in knowing why. The one thing that did seem pretty clear was that in the driver's mind, the GPS's instruction was an order to be obeyed without question.

The disturbingly un-novel aspect of the case is that it was by no means the first of its kind. At least twice in the previous few months, in the same small part of the country, other drivers had their cars wrecked because, they said, their GPS units told them to turn onto active railroad tracks.

I respectfully submit that any sensible person, instructed by anyone or anything to drive on railroad tracks, should think Real Hard at least twice before doing so. Driving a car on railroad tracks just isn't very bright, no matter who or what tells you to do so. *Trains* use those things, and they're a *lot* bigger than any car you're likely to be driving!

Predictably, every time I hear of such an incident, it's soon followed by a few people saying loudly that those infernal GPS contraptions should be banned because they can get people into trouble. Why, in the worst case, they could even get somebody killed!

Well ... certainly such actions, allegedly prompted by the GPS, can have those effects. But who's responsible for them—the GPS or the user?

Personally, I consider a GPS to be a fascinating, impressive, and valuable tool. I was a beta tester for one of the earliest in-car systems, and have used later versions on several occasions. Sometimes they've been extremely useful, making it easy to find destinations I'd never seen, in unfamiliar cities, without ever having to unfold (or refold) a paper map. Sometimes they've exhibited glitches; that first one, in particular, occasionally thought I was a block or so from where I was, and got *really* confused when I was still in a parking lot or garage and had not yet emerged onto a street it knew. But their accuracy, precision, and ease of use have improved considerably since then—and every one of them has come with prominent instructions, right up front, stating emphatically that its function was to provide useful information and it was the driver's responsibility to use that information to make sound decisions. In particular, he or she was explicitly warned not to follow any instruction that would involve an illegal or dangerous maneuver.

Such as driving onto railroad tracks, or a road not built to handle his kind of vehicle, or a one-way street going the other way.

Without having looked at the particular crossings where the railroad incidents took place, I'm skeptical about whether the GPS *really* told the drivers to turn onto the tracks. It seems much more likely that there was a street just beyond the tracks, which the driver should have recognized as what he was being

told to turn onto. But even if it did tell him to turn onto the tracks—if, for example, there was a flaw in its programming and it said there was a street where there really wasn't—the driver should have recognized that the machine was suggesting something that didn't make sense, and done something else that did.

Like go past the tracks, pull over, take a good look around, and ask the machine to calculate a new route. And, as a last resort, perhaps even pull out a paper map or ask a local for directions.

These incidents don't happen because GPS is a dangerous technology. They happen because people sometimes let themselves be lulled into relying too heavily and blindly on technology, treating it as a substitute for their own brains, senses, and judgment rather than as an extension of them.

That tendency is by no means limited to GPS. I've had a pizza clerk tell me she couldn't make change from a twenty because the computer was down. As a physics professor when handheld electronic calculators were just beginning to be widely available, I saw bright, advanced students get answers that were off by many orders of magnitude, and never suspect that anything was wrong because they were relying entirely on the machine.

I had a built-in antidote to that: I'd had a quantum mechanics professor in grad school who liked to spring "contests" on his students, in which, at the beginning of a class period, he would give us a problem and a very short time in which to solve it. We didn't have handheld calculators then, and he wouldn't have let us use them even if we had. The idea was to teach us to do, almost reflexively, what physicists sometimes call a back-of-the-envelope calculation or order-of-magnitude estimate. The answer only had to be correct within an order of magnitude (power of ten), but we had to get it in much less time than it would have taken to do an exact calculation. I suspect that anyone who survived that class formed the lifelong habit of making such an estimate anytime we did any calculation. And with that habit, we would have heard internal alarm bells anytime a calculator gave us an answer that was wildly wrong, and gone looking for a mistake in the way we'd set up the problem.

That kind of attitude is always an advantage when using any advanced technology to make decisions: use the technology, but always check the results against your own trained judgment. Sometimes the dangers of not doing so are "purely academic," but sometimes they're literally matters of life and death—even if the technologies involved aren't especially sophisticated. I vividly remember a section of Harvey Manning's mountain-climbing textbook *Mountaineering: The Freedom of the Hills*, which I read in a pre-GPS edition. The chapter on navigation gave detailed instructions on how you can use a topographical map and compass to determine where you are and how to get where you're going in roadless and often hostile terrain. But it tempered those with some no-nonsense advice on the importance of checking the conclusions you drew from map and compass against what you saw with your eyes: "If several bearings agree on a location with no similarity to the terrain, then the climber suspects it's a crazy old map, he has read the compass incorrectly, or maybe those peaks aren't Unsavory and Imposing after all."

So when people get themselves into trouble, inconvenience one another, or even get themselves killed, and try to blame it on technologies that they misused or abused, I have little sympathy for them. When others respond by calling for the elimination of the technologies, I have little sympathy for them, either. Most technologies, used properly, are wonderful things, allowing humans to achieve things that would be difficult or impossible without them. Depriving those who can learn to do that of their benefits, because some can't or won't hold up their end of the bargain, is not the solution to the problem of occasional mistakes or abuses. A more fruitful approach is to try to make sure that anyone using a technology understands that it's intended as a supplement to his own faculties, not a replacement for them.

And anyone who fails to appreciate that requirement, and act accordingly, must expect to live—and occasionally die—with the consequences.

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Poetry: **INSIGNIFICANCE** by by Edward M. Lerner

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In the beginning we were at the center of the universe—

Special.

Or so we saw ourselves until curiosity set in.

Then we discovered:

That the Earth is merely one planet among many, orbiting the Sun.

That the Sun is but an unexceptional star,

Born in obscurity to die in obscurity in a remote fringe of the Milky Way.

That the Milky Way is but one galaxy, unremarkable, among countless myriads.

That the universe is thirteen billion years old, give or take,

That it did fine without us for almost all of its existence,

And it will go on, unperturbed, if we leave.

We discovered all that. Ephemeral, Johnny-come-lately, back-end-of-nowhere us.

It seems we are special, after all.

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Novella: **WHERE THE WINDS ARE ALL ASLEEP** by Michael F. Flynn

When Shakespeare wrote, “There are more things in heaven and Earth...” he may have been more literally right than he realized....

If all those contentions with which the world is surfeit, the one that may never be settled is whether the Chordettes or the Four Aces recorded the definitive version of “Mr. Sandman.” Each rendition has its partisans in the Irish Pub, and these partisans will sometimes change sides just to keep the debate lively, the Irish being more committed to the argument than to the outcome. The debate is of long-standing; and in the jukebox of the Irish Pub, amidst the Clancies and the Dubliners and the Dayhills, there rests a single recording of each version. Sooner or later, those two old 45's will have to wear out, and that will be the end of it all.

At least such is the hope of the rest of us—agnostic as we are in the matter.

It was a Saturday evening in late October when Bill Poke reared up and said to Kelly Brady, “I'll show you what I mean."

Everyone else hunkered down, for this could mean only that another round in the Sandman Wars was about to begin. Bill was from Philadelphia and therefore a devotee of the Four Aces while Kelly, being of the female persuasion, favored the Chordettes.

The O Neill, seated to my right, said something in the Gaelic, the which does not bear translation in a family magazine such as this. He slipped off his stool and said, “I have to get to rehearsal,” before vanishing. A wily devil, he had taken a role the month before in a community theater performance of *The Sound of Music* in order to have this very excuse ready for this day. Even O Daugherty Himself was heard to heave a long sigh as he polished and rehung glasses in the overhead rack behind the oval bar. A short, wide-set man, he slicked his hair down, parted in the middle. “I'm thinking,” he said to me, “that this will outlast the Troubles."

Doc Mooney entered just as the first bars of the Chordettes chimed out. “Jaysus, Mary, an’ Joseph,” he cried. “Not again!” Although an atheist himself, he was not above calling on help in extremity. Nonetheless, he entered and took the stool beside me that the O Neill had so lately vacated. “A gin and tonic, Mr. O Daugherty, if you please. It's been a busy day at the morgue, with little in the way of live-ly con-ver-sa-tion.” These last two words, he lilted, he being a man who liked to savor his speech.

"And while you're at it,” said I, “my Guinness could use some reinforcement."

"Oh, and could it now?” Himself answered, setting a fresh mug emphatically before me. “And will you be paying the O Neill's tab as well?"

A wily devil, the O'Neill, as I have often said.

"Slainte!" Doc lifted his gin to me and I tapped it with my Guinness. “That damned song,” he complained with a toss of his head toward the jukebox, “is an earworm. I'll be a week exorcising it."

"Why, then you are in luck,” I told him, “for here comes the very man for an exorcism."

The door to the street had opened to the dry-leafed autumn weather to admit Father James McGinnity, S.J. He was accompanied by a slim, young woman wearing an Irish barleycorn wool tweed cap and a suede jacket. But before Doc could so much as hail the priest, the young woman cocked a head to the jukebox, turned the brightest red I have ever seen on the female flesh, and spun on the good father. “Is this some kind of *joke!"* she demanded. And then, suiting actions to words, she strode to the power

cord and pulled the Chordettes from our ears. The music died in that peculiar winding-down fashion of old vinyl recordings.

Bill and Kelly had been swing dancing to the music. (You don't think that musicological metaphysics was their only purpose in the playing of it, do you? This was the music of their youth, and in it they could be always young.) As the Chordettes groaned to a halt, Kelly blanched and turned on the newcomer. “You!” she cried. “If you've damaged my record...!"

Doc muttered under his breath. “One down. One to go."

Bill Poke moved to Kelly's defense. “Young lady, I think you owe my friend an apology.” Now Bill, in his youth had agitated the gravel with the best of ‘em—he had been cool when “cool” was new—and something of the young greaser remained in the old man.

The woman in the Ivy cap turned to Fr. McGinnity. “It wasn't a prank?” At the silent shake of his head, she broke into tears, and Father put his arm around her shoulders and led her to the bar. “A pint of bitters for my niece, here; and white wine for myself.” And then he spoke to her gently so that we could not hear.

Apologies thereafter flowed all around. Jeanne Price, that being her name, begged from Kelly a forgiveness gradually and only grudgingly allowed. In penance, Jeanne offered to buy a round for the house. That drew Danny Mulloney from the back room, where he had been practicing for an upcoming pool contest with Jimmy Shaugnessy. He was fated to lose—Jimmy had never lost a game to our certain knowledge—but Danny was working on the point spread.

Shortly, the *craic* was flowing. Bill and Kelly explained about their long-standing debate, and I think Jeanne saw that it was not about the music at all. Father introduced her to Doc and myself. Danny excused himself and returned to his balls. It being early afternoon, no one else was about. This is the best time to buy a round for the house, should the mood ever strike you.

"She doesn't look a bit like you, Jim,” Doc said. “Sure you're related?"

"Ah, she has my sister's face,” the priest explained. “And her brains. ‘Little Jee’ is a doctor of biology, and she has clicked her heels and flown in from her emerald city—I speak of Seattle—to participate in a conference at the University. A featured speaker,” he added with no little familial pride.

"Not that it impressed anyone there,” Jeanne murmured, but I think she meant the comment only for herself.

"And what conference was that?” Kelly asked.

"Approaches to Abiogenesis and the Monogenic Problem,” she answered—though to no great enlightenment on anyone's part. Seeing our perplexity, she added, “Abiogenesis is the origin of life from non-living matter."

A crafty gleam came into Doc's eye, and I shot one anxious glance toward the pool room before whispering, “No! Don't say it!"

But it was no use. “You mean it has to do with *e-vo-lution?"* the Doc announced; and no sooner had the words slipped the leash of his tongue than Danny Mulloney burst forth from the back room, cue in hand, seeking infidels to smite.

You see, Danny had forsaken Holy Mother Church a few years back for one of those sects that worship a text rather than a God, and “*evil*-ution” was the pea under his personal mattress. Doc and he had

danced this particular jig more than once in the past. Like the old warhorse, “he sayeth among the trumpets Aha! and smelleth the battle afar off."

But Jeanne said, “Oh, not really. Abiogenesis isn't evolution."

I don't know who was more deflated at this, Danny or Doc. The looks on their faces so perfectly mirrored each other that I nearly burst out laughing.

"It isn't?” said Kelly. “But didn't you say it was about the origin of life?"

"Yes, but evolution is about the origin of *species,* not the origin of *life*. Biological evolution is driven by Malthusian pressure on resources. Individuals less able to secure those resources produce fewer offspring, so those better fit eventually prevail. Well, for that you need organisms—and competition for resources. That doesn't apply to non-living matter, most of which just sits around without either reproducing *or* competing. So something other than natural selection must have kicked off the whole thing."

Danny had been steadily brightening throughout this explanation, never a good sign. Now, he cried, “You mean ... like God?” He said this as though the possibility had only just now occurred to him.

Jeanne glanced at her uncle before answering. “Ah, probably not the way you think."

Doc said, “Hey, Jim! Are you going to let her get away with that?"

McGinnity shrugged. “Not my field. My specialty is paleography—ancient manuscripts."

Doc lifted his gin and tonic. “Say something ancient for us."

Hoisting his wine in reply, the priest said, “en arxh hn o logosz, kai o logosz hn prosz ton ueon, kai ueosz hn o logosz."

* * * *

Himself had been sipping from a water bottle he kept behind the bar. Now he choked on a swallow. It was a good laugh all around; but I wondered if Doc knew what the good father had quoted at him.

Bill Poke brushed off the whole matter. “Whatever happened that long ago is nowheresville. I sold Buicks for forty years and not once did ‘evolution’ or—what'd you call it? A-buy-o'genesis? Or for that matter, ‘Genesis'—ever add a dime to my commission."

"Well, now,” said Doc, “I've been cutting up the dearly departed for twenty years and not once did Buicks help me diagnose the cause of death."

"Except for auto accidents,” I suggested in a helpful tone. Doc gave me a disgusted look.

"Evolution makes a lot of difference, Bill,” Jeanne said. “It's been very helpful in planning research programs, developing new medicines, diagnosing new strains of disease. And just generally making sense out of a mess of data. What it comes down to is this: Either new species branch off older species, or they just ‘poof’ into existence. And they don't ‘poof.’”

"Jim,” Doc said, trying again, “aren't you going to jump into this?"

McGinnity finished his wine and set the glass down, circled it with his finger to indicate a second. “And why should I? I don't have a dog in the hunt."

"I thought this creation thing was part of your religion."

"Oh, *creation,* sure. But not creation*ism."*

Danny snorted in derision. “Typical Jesuitical evasion..."

"I don't get it,” said Kelly. “What's the difference?"

"Creation,” said McGinnity, “is bringing being from nonbeing. That's not the same as changing one form of matter into another—like changing sodium and chlorine into salt or one species of ape into another. I should hope that no one would invoke God in the course of an ordinary scientific explanation."

Danny crossed his arms. “Some things are so unlikely, they couldn't happen by chance. Microbiological machinery. The cosmologic numbers. You need a Designer to make them happen. They've proved that."

"Ah, Danny,” said the priest, “there's no need for theokinetics."

Now it was Doc's turn to choke on his drink. “Theokinetics ...?"

McGinnity accepted his second white wine. “The idea that God's creative power can only be expressed by events *beyond* the natural capacities of matter. Danny, it's not the *exceptions* to the natural law that demonstrate the orderliness of creation. It's the existence of the natural laws themselves. My Church holds that God created matter with the natural capacity to act directly, in a manner accessible to reason."

"Then,” said Doc, “you don't need the God Hypothesis."

"No more than you need the ‘Frank Whittle Hypothesis’ to understand how a jet engine works. You'll never find him, no matter how many measurements and tests you perform on the engine's parts and components. That's because the ‘Whittle Hypothesis’ simply isn't an engineering problem."

Jeanne spoke up. “Beside, the odds may not be as long as you think, Danny. There are only about a thousand or so possible protein folds. That's a limit set by physics and chemistry, not by natural selection."

"Not by natural selection?” Another mask of faux surprise. “You mean Darwin was *wrong?"*

"No, I mean a theory can explain *many* things without being tortured into explaining *every*thing. Darwin's natural selection explains certain kinds of evolution. Kimura's neutral selection explains other kinds. Neither one explains abiogenesis."

"Wait a minute,” said Kelly. “What was that about *natural* and *neutral* selection?"

"Natural selection is mostly a culling of unfit variations, with encouragement to the occasional advantageous one. Neutral selection is ... Well, living creatures have a drive to go on living. *Whatever* variation the roll of the genetic dice comes up with, if it's not outright deadly, the creature will probably find some way to use it for *something*. That is, it's not so much that the trait is advantageous, but that the organism uses it to its advantage. *Much* faster evolution that way."

"What about Fox's protocells?” said Doc. “Didn't his experiments show that heating amino acids produces vesicles that grow and bud, just like living cells?"

"The paraffin in a lava lamp can ‘grow and bud,’ too,” said Jeanne. “That doesn't make it alive. His protocells have no true metabolic processes. They don't *act;* they're *acted upon*. Like the bubbles growing and budding in a glass of beer.” She held her glass up to show us. “There's no internal information, so there's nothing there to evolve."

"Worse luck, that.” I suggested, studying my Guinness.

Doc remained skeptical. “The theory of evolution is as well established as the theory of gravity."

Jeanne set her glass down. “Exactly—and the theory of gravity has been drastically revised since the Victorian Age. What I'm saying is that when you're not dealing with organisms struggling to survive and reproduce, it may be that ordinary physics and chemistry matter more than Darwinian selection. And...” She pursed her lips and turned to her uncle. “And I don't really want to talk about this, Uncle Jim. I've spent all day talking about it and defending a son of a bitch, and I'd really much rather talk about the World Series or, or *anything* else."

Father McGinnity smiled. “Think the Cubs can take it this time?"

Bill Poke, delighted for a topic he could contribute to, said, “Naw. You hate to see old traditions die."

Doc was downcast by this turn of events, and I could see Danny was too. He hesitated a moment, as if to return to the back room, then shrugged, leaned his cue against the wall, and took a stool. “Black and tan,” he told Himself.

For myself I wondered why Jeanne Price had spent all day defending a son of a bitch, but the answer was not then forthcoming.

Not until later, after Joe and Kelly had gone and the evening traffic had softened to the point where Doc contemplated the completion of his journey home. Danny had gone out and returned with a tray of sandwiches from the deli on the corner, for while he was impervious to reason on certain matters, he did own a generous spirit. Father McGinnity had nursed his second white wine as if it were a patient in critical care, and had watched with increasingly evident dismay as his niece put herself outside of one pint after another.

Not that you could see it on her, beyond the ruddy flush that is the curse of the Gael. Her voice took on no slur, and she kept up her end of the banter as it drifted from one topic to another. Perhaps a slight surliness had crept into her tone. Though she was still its master, “the creature” was lurking, ready to pounce.

When she raised her hand to signal another pint, her uncle seized her wrist and whispered urgently. What he said, we could not hear, but its import was clear to all. Doc looked away, and even Danny Mulloney fell silent. The glass that Himself was polishing squeaked under his ministrations.

Jeanne pulled herself from her uncle's grasp. “I know what's best for me! O Daugherty, please?” She hefted her glass for the refill.

But Himself only shook his head. “It's sometimes better to pour the bitters out than to pour them in. They're a poor medicine for any pain."

For a moment, I was unsure whether Jeanne would throw the glass or not, for there was a wild look in her eye on the other end of which I'd loathe to be. But then she set it down like a hammer and a shudder passed through her and she began to cry.

It was a quiet weeping, not the *caoine* of mourning, though there was something of the keening in it. It was the lament for things lost past all recovery, which the Irish know down in their bones.

Finally, Jeanne sucked in a long, gasping breath and wiped her eyes with a bar napkin. “I'm so sorry,” she told us. “You'd not want my troubles. Did you ever...” and she looked to Himself as she asked, “Did you ever miss a toothache when it was gone?"

"I can't say I have," he answered.

"I went down with him, but I don't have to go down with him. It's *my* career, right? I had to stand up there and listen to them laugh at me. They all thought it was a joke—*un hommage dans l'humeur*—and I had to pretend it was. I had to laugh with them. That hurt. He was a son of a bitch, and I had to mock his life's work. Can there be a greater cruelty than that?"

"There was bound to be a man in the back of such tears," said Himself.

But Jeanne shook her head. "It wasn't like that. No broken hearts. I didn't like him."

"It isn't always the *love* of a man that drives a woman to tears."

"This world is a vale of tears," Danny suggested. "But He is with us to guide and comfort."

Jeanne's smile was as brief as a flash of sun on a cloudy day. "That's what Uncle Jim tells me." She let her breath out slowly, ran a finger down the sweaty side of her empty glass, and looked on something that only she could see. Then she sat upright on her stool. "Alright. I'll have to explain some things; but this is how I went down with Luke Bonhomme. Luke Bonhomme! Oh, was there ever a man with so inapt a name!"

* * * *

I should begin by telling you that I love the outdoors. When I went into biology I pictured myself in the wild. A naturalist, observing and recording, describing new species. I didn't count on days spent tied to desks, buried in journals, importuned by grade-crazed students. Ah, but there's nothing for it when you're an associate professor but to bend yourself to the wheel. At times, gazing at blank and bored young faces, I would wonder: Are there green fields somewhere? Lonely, rocky crags? Dank tidal estuaries? Dark and haunted caves? So whenever—as Melville wrote—it's 'a damp, drizzly November in my soul,' I know it's time to get out in the field as soon as I can. It is a way I have of driving off the strangulation of the ivy-covered walls.

Now grant money has never come easy to me—I don't have the knack for writing the proposals—but it bounds toward Luke Bonhomme like eager puppy dogs. So when the word went around the department that he was organizing field work for the summer quarter, I went to see if I could hang some research of my own on his proposal.

I'm not sure if he even knew who I was at that point. Certainly he gave that impression. Now, I might have been new, but the department is small, and it may have been a calculated affront intended to show me my appointed place in his universe. But then, he lived in a Lukocentric universe, so he may not have been intentionally rude. He may only have been thoughtlessly so. I think that may be worse.

How was he rude? It was in everything he did. The way he pursed his lips when he talked to you. They way he always made you wait when you called on him with a question. It was in the way he *walked,* for the love o' Mary. But ... Oh, he was brilliant!

When I suggested that I include my researches on micro-adaptations of alpine flora—we were going to Mount Rainier for the field work—he smirked and told me that was in the wrong direction.

I almost told him to, ah ... But he was already in love with himself, and I really did need the field work. Publish or perish, right? But Luke told me that since it was *his* grant, I'd write about what he told me to write about. Something no doubt to ornament his own research.

"Don't worry," he told me in that nasal drone of his. "The Nobel Prize will make up for it. If you follow

me to Rainier, you can follow me to Stockholm."

Well. No one ever said he lacked confidence.

Alright, Uncle Jim. ybrisz. But, by God, I think he could have gotten there! What's the point of falling unless you've first scaled a height?

* * * *

It was my outdoor experience, of course. Otherwise, I don't know if he would have taken me on. But he asked me about caving and rock climbing, and what I said must have made an impression because by the time I got back to my office there was an e-mail waiting for me. “You're in,” it read. “Arrange spelunking gear for five people. Camping supplies for two months.” Evidently, I could be useful. That was the only criterion. At the very least, I could tell him that cavers never say “spelunking."

* * * *

I met three of the others later that same day.

Knobby Bryant was Luke's grad student: young, wiry, and with a prominent Adam's apple. Bonhomme needed a serf to do his scut work. Knobby had climbing experience, but he was along mainly to keep Luke's notes and samples.

Cap McConnell was, in theory, Bonhomme's peer, but while in theory there is no difference between theory and practice, in practice there is. I found out later that McConnell was up for tenure but shy on his publications. Luke had promised him a breakthrough in geochemistry, and so a certain spirit of desperation had lured him into our company.

Wendy Chen was an engineering student. She would not be climbing with us, but would stay above and monitor the fiber-optic link that we would maintain.

* * * *

We took a rental van out State Road 165 to the park entrance and from there to the Carbon River trailhead. I drove and Knobby sat shotgun. He fairly bounced in his seat the whole while, so excited was he to be part of the project. In the back seat, Cap stared morosely at the passing scenery while Luke read maps and jotted from time to time in a pocket journal.

A ranger met us at the trailhead, and there were papers and other formalities. Stay on trails. Do not pick flowers. Carry the “10 Essentials” and Leave No Trace of your visit. I could hear the ranger capitalize Leave No Trace. This was all done with such grave solemnity that I nearly raised my right hand and swore on a map of the park.

I could tell the ranger was not happy. The amount of our equipment hinted that a trace of something might be left somewhere. “What are extremophiles?” she asked, referring to our permit.

"Biological lifeforms,” Luke answered, “that have adapted to extreme conditions—around ocean thermal vents or, as we hope to learn, in deep lightless caverns.” He managed to say this in a tone that implied some deficiency on the ranger's part for not having known.

Certainly the ranger heard it that way. She folded the documents and stuck them in a pocket of her jacket. “Your permit expires in six weeks,” she reminded us.

The second van had arrived behind us with Wendy and four more grad students co-opted for the day to carry our equipment to our base camp. Since no wheeled vehicles were permitted inside the park, it all had to be carried in by Shank's Mare. The grad students were husky outdoors types and were getting

fifty bucks for the work.

We divided the equipment among us and each took a share, except Luke, who had the maps and walked on ahead of us. I think he liked being “bwana” with a line of bearers behind him. Cap and I carried the power source, each of us taking a handle. We would use it to power our communicator and recharge our batteries and lights while belowground. We planned to spend several weeks below ground, and it wouldn't do to lose our lights or our contact with base camp. It's dark down there. Cavers have been known to hallucinate when deprived too long of light. I don't know what the ranger would have done if she had known our “battery” was a nuclear device, like those they use to power deep space probes. People sometimes don't think clearly about things like that.

It was a three hour hike. Just past Alice Falls, there was a side valley running off to the right, and on a boulder at the fork in the trail sat a large man with black ponytailed hair and wearing a sleeveless bush jacket. He had arms like legs, and they were decorated with intricate tattooing.

"Our guide,” said Luke.

Billy Quiemuth was a Nisqually Indian from down near Fort Lewis. When he saw us coming, he studied us for a moment, then rose and said, “This way,” and turned up the side valley. Luke had started to say, “Let's keep moving,” but he was saying it already to Billy's back. I think he was a little miffed that the guide hadn't waited for instructions.

Billy's stride could eat miles, but after a few minutes he looked back and saw that, burdened by our equipment, we had fallen behind, and with a shrug, he adjusted his pace to ours. His whole body said, “I ain't in no hurry."

"The cave is an old Indian site,” Luke told Cap and me as we struggled behind him. He held up an old browned notebook tied up with a string.

"Sacred?” asked Cap.

"Aren't they always?"

"Naw,” said Billy without turning. “That's all done with. I'm a Presbyterian. We used to go to this cave an’ smoke weed when I was a kid."

* * * *

It was late afternoon when we reached the mouth of the cave. Luke had our “bearers” set the equipment just inside, micromanaging until they had things arranged to suit him. It would be a three-hour hike back for them, and they were not wishful of finishing that hike in the dark. Even with the flashlights that were one of the “Ten Essentials,” that would be a chancy thing.

Luke paid the four with checks. It was a Friday afternoon and he paid them with checks. That was so ... so *Luke*.

The first thing we did was arrange our sleeping bags and set up the stove. We would begin our descent in the morning after a meal and a good night's rest. I wondered why Luke had really brought us here. Extremophiles, my left buttock. [Sorry, uncle.]

That evening, after we had eaten, Luke gathered us around the lamp. It was bright—LED, and powered like I said off atomic batteries—but caves have that peculiar property by which their shadows are not dissipated by light, but rather retreat deeper into cracks and crevices. It seemed as if we only illuminated the darkness.

Knobby vibrated so much that I thought his clothing would catch fire. Beside him Cap sat like one of the rocks he studied, so that between them the two averaged a normal amount of movement. As to the other two members of our group, Billy sat apart with his eyes closed, apparently asleep, while Wendy busied herself running tests on the communication gear. The research as such did not involve them.

Luke unfastened the flap of his bush jacket and extracted that yellow-brown notebook I had seen him reading earlier. He removed the rubber bands that held it together. “This,” he explained, “is the journal of Ezra John. He was a naturalist of the old frontier days. He traveled up the Red River, along the Missouri, across the Great Basin and the Rockies, eventually here to the Pacific Northwest. He made literally thousands of observations and sketches of the flora and fauna he saw along the way. He also made geological observations, McConnell, which should interest you, especially of the ‘sand blows’ in and around Cahokia and the Mississippi Valley."

"'Sand blows,'" said Knobby. It could be taken for an acknowledgment or a question.

Luke nodded to Cap. “Why don't you explain, McConnell?"

Cap grimaced, perhaps wondering if Luke were not trying to catch him out with a pop quiz. “It's a ‘sand volcano',” he said. “During earthquakes, water-saturated sediments below ground can liquefy and shoot up through the soil, making a cone of sand, complete with a crater in the top. They can range from a few millimeters to a few meters in diameter. You say this John fellow visited Cahokia. Quite a few sand blows erupted around there during the New Madrid earthquake in, oh, 1810, I think."

"In 1811 and ‘12,” Luke said.

Cap looked at him for a moment and then said, “Yeah. Okay."

"Sand,” said Luke in a meditative voice, “is silicon dioxide."

"Mostly,” said Cap. “There are limestone sands and gypsum sands and—"

Luke waved his hand. “Not usually inland or outside the tropics. The blows around the New Madrid and other earthquake sites were silicon dioxide.” He smiled benignly.

While we waited for enlightenment on this trivial point, Billy spoke up, showing that he had been listening all along. “Ezra John, he was a Choctaw Indian come up from down the Territories, back after the Removal. He lived with the Nisqually for several years. Made quite an impression, because we'd never seen a civilized Indian before. Then he faded from oral history into oral tradition and became a culture hero. There are stories about him. Jeeze, I haven't thought about those stories in years. The tales say the Earth Mother gave him birth. He come up, taught the Nisqually crafts like farming and blacksmithing, then the Earth swallowed him again."

"Blacksmithing, I can understand,” I said, “but farming?"

"Ah, that's just how folklore works. Once events are far enough in the past, they all happen at the same time. ‘Origin time’ instead of ‘historical time.’ Real people become culture heroes and whatever needs explaining is assigned to one of ‘em. De Brazza was a real man when he reached the Congo in 1880, but by 1960 he had become a culture hero to the Tio folk who lived there. Same thing happened to Ezra John. They don't tell *his* story no more; they tell stories *about* him.” When he saw us looking at him, he shrugged. “Anthropology major. Seattle U.” He grinned. “Self-defense. I plan to study the folks who come to study us."

Luke had listened with the benign patience that said others were doing his work for him. When Billy

lapsed into silence, Luke turned his flashlight to the cave wall just above the entrance. There, chiseled into the rock was a symbol: **EJ**

"E J," he explained, as if we couldn't see it for ourselves. "His monogram." Luke wagged the tattered journal he kept in his pocket. "He filled twenty-seven notebooks on his various journeys. This is the last. The twenty-seventh. It describes his journey deep into the earth—and what he found at the bottom."

I had been silent during this entire discussion, busying myself with our equipment. But I had finally grown tired of Luke's little games and, just to end the matter, I set the climbing ropes aside. "And what was that?"

Luke smiled at me like I was a dim pupil who had finally asked a bright question. "The answer to the monogenesis problem."

Doc interrupted. "Monogenesis. You mentioned that before. What is it, exactly?"

Father McGinnity grinned. "In theology, 'monogenes' means 'the only-begotten.'"

Jeanne had been staring vacantly at something invisible and shook herself aware. "Nothing quite so dramatic as *that,* uncle. No. You see if abiogenesis is inherent in the laws of physics and chemistry and not in the whims of chance, then..."

"Then why did it happen only once?" That was Danny, and it surprised us all that he would see it first. "Sure," he continued in a rush. "If it was so *natural,* so *inevitable,* why didn't life happen twice right here on Earth? Why isn't it happening every day? But you say life was only created once—just like Genesis says."

"What Genesis says," Father McGinnity told him, "is '*p*roducat terra animam viventem in genere suo...' That's the Vulgate. 'Let *the earth* bring forth all kinds of living things.' You'll note *nature* does the bringing forth, and I don't see that God told her to stop."

Danny lowered his glass of Harp to the countertop of the bar. "Are you trying to tell me that *evolution is in the Bible?"*

Jeanne winced. "'Let *the earth* bring forth?' No wonder Davischen was so hostile this afternoon!" But she did not then elaborate on the comment.

"Besides," Doc said, "any lifeforms that got started later would have been gobbled up by the ones already here."

"The stillbirth theory," Jeanne said. "That's one answer."

"But there are others," I suggested. "Or you wouldn't've called it the 'monogenesis *problem.'"*

"Oh, certainly. Through any finite collection of facts you can draw an infinite number of theories. Danny was right to ask why abiogenesis happened only once—if it did. But Doc might be wrong. It's not always the established lifeforms that win out. In fact, evolution pretty much says the opposite, doesn't it? The Ediacaran biota are truly weird. They don't fit into the known phyla. The Cambrian biota do—mostly. Did the Ediacarans evolve into the Cambrians? Or were they two separate events, with the Cambrians replacing their predecessors? The fossil record is too sparse to say. And here's a third possibility: All the major modern phyla appear abruptly in the Cambrian Explosion. Would it be so strange if some phyla originated in separate abiogenetic events in different places around the world, established themselves in distinct niches, and then spread out and mingled, giving the impression of an 'explosion'? Sponges and jellyfish really are peculiar compared to the bilaterian rest of us."

Doc waved a hand. “Aah. But those've all got related DNA. Remember when they found those creatures living around the deep ocean thermal vents, and they thought at first that they might represent an *in*-de-*pen*-dent Tree of Life? But their DNA turned out to be the same as all the rest of us, which proves they share the same origin."

But Jeanne had warmed to her topic. “Doc, if physics and chemistry do set boundary conditions on the DNA, similarity needn't indicate common descent. It may only indicate a limited solution set. The determinism of physics and chemistry takes a big bite out of the randomness of evolution. Sorry, Danny, but it needn't be as improbable as Hoyle insisted. But it also mucks up the molecular clock, and *that* may mean that there are multiple geneses that we simply can't distinguish because their DNA *looks* like they might be related. But I could not imagine that Luke Bonhomme would have so proudly announced that we would find ‘the answer to the monogenesis problem’ if that answer were that it only happened once. He had to have meant a second genesis, a second tree of life."

* * * *

But Luke was a tease [Jeanne said, taking up the tale once more]. He told us only enough to lead us on. I should have reasoned ahead of him, but all I could foresee was that he had found a clue in John's journal hinting at some deep-in-the-earth extremophile. I didn't see how its DNA would be different enough to settle the matter. The monogenesis advocates would say the DNA showed evidence of common descent. The polygenesis advocates would say the DNA seemed related because there were only so many possible ways that DNA could look.

But of course if I could see that, so could Luke, and he would never have assembled our little expedition if the only thing lurking at the end of it would be a resounding “maybe."

The first descent was the roughest: a nearly sheer chimney, the dead remnant of a volcanic vent. Billy tossed a rock down the center and grinned ferociously while we counted off the seconds before its rattle announced the depth of the tube. He winked at me. “Remember what they say. Gravity is not our friend.” But an LED lantern, lowered into the shaft, revealed pitons driven into the rock at intervals. John had gone this way, and what he could do with old-style hemp ropes we could do with modern nylon.

In the two weeks running up to the expedition, I had tested each of our team-members’ climbing ability and was satisfied that even Knobby could handle the descent. Billy, I was not sure about, as I had not met him until that day, and I assumed at first that he had only been hired to guide us to the cave. But stepping to the lip of the chimney, he looked into the darkness and grinned at me. “Not as deep as it looks."

"No?"

"Deeper.” He chuckled. “But there's a ledge about three hundred feet down where we can rest."

I paused while lowering the rope with our supplies. “You've been down there already?"

He nodded. “A little ways."

"What do you think we'll find down there?"

"Depends on what you look for, doesn't it."

* * * *

We expected the temperature below ground to run around fifty degrees, the mean for this region. We had dressed in thin layers for comfort, and now we pulled on our coveralls—fewer loose edges to catch on things—and donned and checked out climbing harnesses. We said good-bye to Wendy, promised to

call in once a day, and went down the chimney.

I won't go into that climb in any great detail. It was painstaking, but not especially daunting, and a climber who doesn't take pains can wind up dead. I went first and Billy went last, since we were the more experienced climbers. I did a straight shot, abseiling with my chest rack. On the way down, I passed several old pitons hammered into the rock, and along one stretch, a length of old hemp still hung. Ezra John had evidently left ropes in place, but they had decayed over the years. I warned the others not to grab hold of them and continued down. When I reached the ledge, I belayed for Knobby and Luke. Billy came last and drove in rebelays at intervals to facilitate our return climb.

Like John, we left the ropes in place. I wondered if climbers a century hence would know who we had been when they found their frizzled remains.

It took most of the day to complete the descent, and although Luke was anxious to press on and Knobby was like a bunny with a drum, I insisted we make camp. Luke chafed, but he was smart enough to realize that you don't bring an expert along in order to ignore her advice. I could see that Billy was ready to back me up, but he kept silent. The last thing a climb leader needs is a second leader.

* * * *

Before turning in, I checked the rest of our equipment, and Knobby attached the fiber-optic cable to a repeater. We had several spools of it and planned to run them out as far as we could. Knobby plugged in the transmitter and called Wendy. It was just a test. We could have hollered up the chimney to her.

I circled the room into which we had come, saw three clefts that seemed to lead out of it, and over one of them was an **EJ**. I turned a lamp into its dark interior, but it didn't get much lighter.

"It widens out farther down," Billy told me over my shoulder.

"A good thing, too, given the baggage we're carrying. Any more pitches like the chimney?"

"One more I know about, but not as long or steep."

I grunted, then turned to face him. "Any idea what Luke has in store for us?"

He only shrugged. "The elder gods, maybe?"

"The elder gods."

"These mountains, they were people once. There's a Nisqually legend about the Beautiful Firekeeper. She kept the peace between two quarrelsome brothers; so when the Great God turned them into mountains, she was turned into a third mountain set between 'em."

"Were they, now? Which mountains?"

"The brothers became Mount Adams and Mount Hood. The firekeeper became Mount St. Helens. Appropriate, don't you think, for a firekeeper? But in the story it was the two brothers who were always blowing their tops. I think Nisqually legends remember a time when the volcanoes were more active."

"What about Mount Rainier?" I asked him. "Do you have a story for this mountain?"

"The Miser of the Mountain..."

"Supper's ready," said Cap, who had volunteered to cook this time. Chicken soup. Red beans and rice. It smelled wonderful.

Luke emerged from the folding tent he had brought along for his lordly privacy and looked around. “Here,” he told Cap. “Look these over and tell me what they say to you.” He plopped a stack of papers beside the geologist, who glanced at them before attending to the soup. Luke tossed his head toward the crack in the rocks. “Quiemuth. Is that the way John took? Never mind. I see his mark. Bryant, come with me.” And then he returned to his sanctum. A few moments later, Knobby ducked inside with him.

Cap did not look up from his cooking. “Maybe he'll trip and fall down a volcanic tube."

"That's a terrible thing to say,” I told Cap.

"The man ain't a fool, neither,” said Billy.

Cap grumbled some more, served out the food, and hollered to Knobby to come and get it. “The great man can figure the rest out for himself,” he said.

* * * *

After supper, as I was cleaning the plates, Luke held another of his “underground seminars.” His answer to the problem of abiogenesis was a resurrection of the Smith-Cairns hypothesis, which disappointed me, because I had been expecting something more twisted, more novel.

Clays result naturally from silicates in solution, and their fault structure, domain structure and cross-sectional shape are all copied as they accrete. When mechanical stresses cause them to snap this information is exposed at the ends of both the resulting crystals.

"In other words,” said Luke, “it's heritable information."

"Not really,” I told him. “The crystals don't *build* themselves from it the way biological organisms self-assemble from their DNA."

"It's information,” Luke insisted. “And the two fragments get it from the original. Fits *my* definition. Now, suppose one form of clay is stickier and so more likely to silt up a stream bed. That leads to further sedimentation, and to flat areas exposed to the air. The flat areas dry out, the wind blows the dust around, and some of the crystals fall into another stream and start the cycle over. So the sticky clays become more successful. Natural selection."

"Sticky clays,” said Cap in a voice less than convinced.

"It needn't be stickiness, McConnell,” Luke said. “Brittleness, weight, speed of growth, anything that expedites replication will make that form of crystal more common."

"It's not natural selection, Luke,” I told him. “Not the Darwinian kind. Not every natural sorting mechanism can be called—"

"Oh, quite right, Price. Quite right. But it is a prototype for the real thing, isn't it? Just like the replication of fracture domains and such is a prototype for ‘heritable information.’ It needn't be the real thing to be *like* the real thing. I'm glad you see that."

Luke had a way of turning criticism of his ideas into support for his ideas. You could point out a flaw in his reasoning and the next thing you knew it was part of his reasoning. Laying into him was like punching pillows. Suddenly, nothing happened! The head pat was worst of all.

Knobby said, “But what has that to do with abiogenesis?"

"It's quite simple, Bryant ... Complex proto-organic molecules can be catalyzed by the surface properties

of silicates. You should know this, McConnell. The surface grooves can entrap these carbon polymers, protecting them from UV or wave action that might otherwise disrupt them; and they will be ‘carried along for the ride’ as the crystals grow and fracture. At some point, exaptation occurs and the organic molecules begin to grow and replicate on their own."

"You mean,” said Cap, “that at some point a miracle occurs. It's an attractive story, Bonhomme, but all the hand-waving plausibility in the world won't get you over the empirical hump."

Knobby rose to his thesis advisor's defense: “But it makes sense."

"Yeah? So did antiperistalsis, geocentrism, and the world-flood."

Luke was accustomed to Knobby's agreeable nature. Cap rubbed him the wrong way. “The flood is a creationist fable,” he said.

"So is life being formed from the clay of the earth,” Cap answered. “But Xenophanes never read the Bible. He was a Greek pagan who drew his conclusions from the facts. He'd seen marine fossils in the mountains of Greece, and the only *natural* process he knew of that could deposit ocean life on land was a flood. It was seafloor uplift that would have sounded supernatural to him. He couldn't see it happening."

"You're right,” Luke countered blandly, “we mustn't assume that Smith-Cairns is false just because we can't *see* the process going on today."

That flustered Cap, because he hadn't been drawing that conclusion. Me, I leave philosophy to those trained to do it—and scientists are notoriously rotten philosophers. But I must have made a face of some sort because Luke turned to me. “And what are your thoughts, Price?"

"You have an answer,” I told him, “or you think you do, or you wouldn't be dragging us down the rabbit hole with you. So why not just tell us?"

"I told each of you: Follow me here and you can follow me to Stockholm."

"Me too?” said Billy with an impossibly innocent look.

Luke treated the question as a joke, and talk drifted, as it always does among scientists, to the possibility of testing the theory. What would constitute supporting evidence? What would provide falsification? That was not as easy a question as it sounds. The Greeks thought heliocentrism falsified because it contradicted known facts: There was no observable parallax in the fixed stars. Duhem thought Maxwell had been falsified by permanent magnets—and the electron was like an epicycle, a particle-of-convenience tacked on to save the equations. I wondered what Luke thought he had in his back pocket.

And I wondered too what “obvious truths” we held that would give future scientists the chuckles.

I suddenly realized that Cap was the key member of our team. Knobby was along to be Luke's slave, and Billy and I were along to ensure climb safety. But why exactly had Luke Bonhomme dragged Cap into this?

I could only conclude that Luke believed that Ezra John had found a fossilized clay matrix—and we were there to witness its discovery.

* * * *

Of course, what does a fossilized *rock* look like?

* * * *

The next day saw a series of climbs down a few short pitches, into which a flight of steps had been carved. Billy—and Ezra John—had told us about them, but it was still a startling thing to find this far underground.

"Nisqually carve ‘em,” said Billy, “or whoever come before us."

"Why would they have come down here?” I asked him.

Billy shrugged. “Religion, maybe. The stairs were cut by Those Who Came Early. Remember I told you how oral tradition has only two eras: historical times and origin times? About the Early Ones, we don't even have origin stories."

The steps led to a gallery of colored crystals that caught all of us short, even Luke, who had known it was ahead. The crystals grew in beds on the wall of the cavern and flickered in ochre and green and red. Knobby so far forgot himself that he whispered, “It's beautiful."

Billy nodded. “I'd've carved those steps myself, just to come here."

"John described this gallery in his journal,” said Luke, “but ... I can see that words failed him."

"Fracto-luminescence,” Cap told us. “The crystals convert vibrations into light. Hey! Remember crystal radio sets?” The crystals blinked as he spoke. I was reminded of Christmas tree lights, not crystal radio sets. I wondered if these “light echoes” of our words would convince Luke that the crystals had a “language."

"John had two Nisqually guides with him,” Luke told us, “and he mentioned how the crystals flickered and flashed to their shouts of amazement."

"Hear that hum?” asked Billy.

The rest of us hadn't noticed any sound until then, and Billy's question led naturally to a comic interval in which we were all crying out “quiet!” and “hush!” until by incremental steps we achieved silence. Luke turned off his lamp as well, and the rest of us followed suit until utter and absolute darkness enveloped us.

There is no more still a place on earth than a deep cavern. The only sound was our own breath; there was not the slightest hint of a breeze.

Sand-strewn caverns, cool and deep,

Where the winds are all asleep.

Sand strewn ... The crystals continued to flicker, but more dimly. I thought I could detect, just beyond the range of my own hearing, a hum like the sigh of a dying organ.

"Subsonics?” Cap guessed. “The Juan de Fuca plate is subducting under the North American plate somewhere down below us. Very low frequency vibrations from the subduction may be inducing light flashes in the crystals."

"I said hush, McConnell.” Luke had a laser pointer. I don't know why. Maybe he expected to give a lecture. When he aimed it at a nearby crystal, it began to purr—I don't know how better to describe it—it began to purr like a cat in sunlight.

"It works both ways,” he said. “Light induces sound."

The sound of the first crystal induced light in its neighbors, and soon the chain reaction had the crystal

bed blinking again. Luke flipped his pointer off, blanketing us once more in absolute darkness as the colors slowly damped out.

This time, before anyone could speak, a ripple of color passed like a glissando through the crystals, running from our left to a bend just out of sight on our right. At the same time, the floor of the passage trembled. It was like the rumble you sometimes feel on a Manhattan street as a subway train passes beneath you.

"Microquake," Knobby whispered, and he looked back at the way we had come. I think it had not occurred to him until then what an earthquake might mean underground. Luke, however, looked off into the shadows on our right.

* * * *

When we made camp that night, Luke called Wendy on our land line. Reception was good, considering that we had spliced the repeaters into the line ourselves. Luke reported that all was well and Cap added something about the singing crystals. I think at that point he had a paper in mind to get his tenure. For my own part, I mentioned some fairly ordinary cave-dwellers I had found and written descriptions of, including a species of sightless bat. New species, to be sure, but not new *kinds* of species.

Well, thousands of papers have been written on "discoveries" far less momentous. Quantity, not content, mattered. Darwin or Newton, taking thoughtful years between books, would never have survived in today's academe. Or they would have been forced by the selective pressures of survival to dribble out their insights in half-formed tidbits.

* * * *

The next day's descent led to an ancient lava tube that sloped sharply downward. It was hard not to pick up speed as we made our way along it. Knobby forgot himself and stumbled into an awkward canter before he outran his legs and went body surfing on the harsh flooring of the tube. He was badly scraped and bruised, but it could have been much worse. Shortly after, Cap lost his grip on the spool of fiber-optic cable we were unreeling behind us and it clattered ahead into the darkness. Billy grunted and said, "We shoulda thought of that sooner." He drove a spike into the wall of the tube and hung a motion-activated LED floodlight on it. Cap said, with a sly voice, "We're not supposed to leave anything behind when we leave." But Billy only shrugged. "Ranger no like 'um, she come down an' take 'um."

A moment later, the fiber-optic cable, which had been lying slack on the floor, abruptly straightened and went taut with an audible twang. Cap laughed nervously. "Looks like we caught something." Luke turned and looked at him, but said nothing.

Billy and I rigged a rope and pulley to the tube wall, and we used that to control our descent down the steep pitch.

* * * *

What had made the fiber-optic cable go taut was that the reel, bouncing and rolling down the tube, had reached a wide crevasse in the rock and had tumbled into it. It hung now like a plumb bob on the end of the cable, pulling it. I was surprised it had not broken loose.

The chasm ran through a chamber whose ceiling was lost in the darkness above and whose floor was lost in the darkness below.

Cap whistled and panned his LED along the fissure. "Deep fault line," he said. "Part of the Western Rainier Seismic Zone. Secondary cracking in the North American Plate, I think." He turned to Billy. "You see, the Juan de Fuca Plate out in the Pacific, it's subducting ... It's shoving its way under..." He emphasized this with hand motions. "...*under* the North American Plate, ploughing northeastward at

three to four centimeters per year and pitching downward at thirty to sixty degrees. That's why the Sea-Tac region has so many earthquakes—and why the Cascades are a range of not-so dead volcanoes. The Cascades are the result of crumpling ... Say, that tube we came down was pitched about forty degrees. I bet it tracks the subducting plate beneath us. In fact, I wonder if this crevasse is deep enough that we could actually *see* the Juan de Fuca itself at the bottom—"

A man suddenly finding himself in his comfort zone can become remarkably loquacious. For me, volcanoes and subduction earthquakes were hardly more comforting than that Rainier's status as “extinct volcano” was only provisional. St. Helen's had been extinct, too, until it wasn't.

But Cap's sudden silence drew our attention, and we aimed our own lamps to join where his own now rested.

Sixty feet below the lip of the sheer drop and a few dozen yards to our left was a ledge. And on that ledge lay a body.

Clad in heavy flannels and resting on a canvas rucksack, the mummified eyeless thing stared back at us. The unnatural angle of repose bespoke a broken back. The ragged and torn hands and missing fingernails told of a frantic grabbing for handholds that had not been there.

Billy peered over the edge. He saluted the body. “Hello, Ezra."

The rest of us looked at him. “How do you know it's him,” Knobby asked after a moment.

Billy shrugged. “How many people ever came down here?"

Luke wagged the daybook like a chastising finger. “If that's him, how'd his journal make it back to wind up in our library's collection? There's a point a little farther to our right where the crevasse closes up to no more than a crack in the ground. That's the way John describes."

But Billy only shrugged again. “Okay. Maybe it ain't him."

I moved a little to the left, until I was standing directly over the ledge, and played my light across the rocks opposite. There was a tunnel there that looked like the continuation of our lava tube, broken off and offset slightly by the shifting fault at some unimaginable past time. I sensed that someone had come to stand beside me and turned to see Billy.

"A good run,” he said with a toss of his head to the opposite tube, “and a man in top condition could leap across the fissure, easy."

"But why risk it, if he could just step across farther down?"

"Why, that's a good question,” said Billy. “And maybe if we learn the answer to it we can avoid joining ol’ Ezra down there on the ledge."

I tried to see into the darkness of the tube's continuation, but my lamp only illuminated the shadows. “What's down that way?"

"Dunno. Never came this far. But the story of the Miser on the Mountain tells us that you can't climb Mt. Rainier without leaving something behind for each thing you take.” He looked at the mummy on the ledge. “Don't know if it makes a difference if you climb down instead of up, but whoever that is down there—Ezra or some nameless stranger—he sure left a lot behind. I hope whatever he took was worth it. Come on, we gotta haul the rest of the cable out of the pit."

* * * *

When we continued our downward trek the next day, the sharp edge of Cap's enthusiasm had been dulled, but he did not revert to that sullen temper in which he had begun the trip. “I'll get at least two good papers out of this,” he had confided to me once we were in camp and had checked in with Wendy. “That rift gave me some ideas about the Nisqually Quake of 2001."

Luke didn't even look up from his own note taking. “Have you finished studying the seismic charts I gave you?"

He didn't seem to expect an answer, which was a good thing because Cap didn't give him one. If you ever want to take the bloom off a rose or wipe the smile from a baby's face, Luke is your man.

I really do think there is a value to going down now and then on your knees. If I hadn't done so, I would never have seen them.

I was on my knees because Ezra John had taken us through an especially tight passage, and while Knobby could duck-walk with only a scrape to his temple from an unfriendly stalactite, the rest of us had to crawl. That's how I noticed the grotto off to the left.

Perhaps it was the sound of a slight rustle, perhaps it was a hint of motion in the darkness. Perhaps it was the smell. “Hey!” I cried, being last in line in that particular passage. “Which of you guys cut one?” I heard a giggle from up ahead—Knobby, I think—as I played my lamp into the grotto.

The Medusa Grotto, I called it afterward. All along the floor against lefthand wall was a writhing bed of white tubes from which red gill-like structures emerged and retracted. They looked like small crimson snakes trying to strike the rock itself. *Careful,* I remember thinking, *you'll blunt your fangs.* I ran my light around the rest of the grotto, but the strange creatures were nowhere else. “Hey!” I cried more loudly. “Get a load of this!"

From farther ahead I could hear Cap's voice. “What is it?"

"Lipstick applicators dancing the samba.” That earned me silence, followed by the sounds of others crawling back up the passageway. Well, they *did* look like lipstick applicators, and their wavy motions would do for dancing. Suddenly, it all clicked into place, and I knew what I was looking at, and I knew it would make my reputation.

"Well, well, well,” I whispered. “What are *you* guys doing *here?"*

* * * *

"Tube worms,” I told the others when they had crowded with me around the mouth of the grotto. “They were discovered in ‘77, living around thermal vents in the Pacific. In the deeps, they can grow up to nine meters long. The tube's made of chitin and that red structure absorbs oxygen, carbon dioxide, and hydrogen sulfide from the vent waters."

"That red thing's the worm, then?” asked Knobby. “And it lives inside the tube? Sort of like coral?"

"No the whole thing is the tube worm; but ... the tube worm's not the whole thing. You see, they've no mouth or digestive system. So by themselves they'd be unable to eat. But their blood has the ‘superpower’ to transport the H2S from the vent waters to billions of bacteria that inhabit its insides. The bacteria use the H2S and provide carbon for the worm to grow. In a certain sense, the tube worm isn't even a whole organism—without the resident bacteria, it would be just dead organic matter. But the worm and the bacteria together ... They're on the way to becoming a standalone organism. Don't tell me there are no ‘transitional’ forms. Don't ever try to tell me that."

I was actually trembling. There is a certain feeling known only to scientists and mathematicians—and perhaps to explorers—when something new swims into their ken.

"Ezra John didn't mention those things," said Luke. "Come along Bryant. We've notes to collate." Crouched at the back of our group, he did not have a clear view, but as an expert in extremophiles he had to be familiar with the Pacific vent creatures. It suddenly occurred to me that Luke Bonhomme was jealous. Cap's discoveries had not threatened him, since they were off his turf, so to speak, and he could always claim that he had led Cap to them. But I had pulled this one out of a hat, and in his own specialty. And in front of witnesses.

Cap and Billy remained behind with me. Cap nodded at the tube worms. "And these are special because ...?"

Billy grunted. "I don't notice any vent waters in there."

"That's right," I told them. "Cap, help me out here. Tube worms have been found on the Galapagos Ridge, the East Pacific Rise, and the Juan de Fuca Ridge. Where would the next underwater ridge be?"

Cap thought about it some and then broke into a grin. "Why, we'd be standing on it right now."

"That's what I figured. As the Juan de Fuca plate jacked everything up, that ridge turned to dry land and this one vent species managed to hold on for the entire ride and become a *terrestrial* form. Volcanoes emit hydrogen sulfide, and these 'Rainier tubeworms' must have somehow learned to harvest it from the air rather than from vent waters."

"Never seen those except around stinkstone," Billy said. "I always though they were plants of some sort."

"When did you see tubeworms before? You said you'd never gone beyond the Nisqually Stairs."

"Oh, they're in other chambers, down ways John never took. Besides, I got a tradition to uphold."

"What tradition?"

He grunted and assumed his "Noble Redman" pose. "White man find new thing, but Injun know it long ago."

Cap frowned. "What is 'stinkstone'?"

Billy cocked his head and grinned. "Stone that stinks. That's the—watchum callit—strata, those worm things are touching." He indicated a band of greasy-looking rock. Cap inched into the grotto to get a better look.

"Foid," I heard him mutter. I thought it was some sort of geological cuss word, but he explained that a "foid" was an igneous rock that contained more than sixty percent feldspathoid, and that feldspathoids were tectosilicates that resembled feldspars. He did not explain "tectosilicate," which was just as well, or the terminological dominoes would still be toppling.

He did add that such foids were both rare and unusual. At that point, he invoked "alkali hydrosulfides" and other like occult terms, but I fell to thinking that a rare species of igneous rock and a rare species of terrestrial tube-worm would not be cohabiting by chance alone. That would be rare to the second power.

"Why do you call it 'stinkstone,'" I asked Billy.

Our guide grinned and, opening his canteen, he took a sip and spat it at the rock.

Cap ducked back. “Oh, man! What the...” Then he sniffed more deliberately, as a chemist does when confronting an uncertain vapor. “Hydrogen sulfide!"

Billy nodded. “The rock farts when you squirt water on it. We thought it was great fun when I was a teenager. If you light a match—"

"We get the picture,” I told him.

Cap used the claw of his rock hammer to break out a specimen from the vein. He had to lean close to do it, and his nose wrinkled in disgust. “I'll bet the ore contains sodium sulfide or one of its hydrates. Those emit hydrogen sulfide in moist air. There must be a constant miasma diffusing out from the rock."

"Stinkstone,” said Billy with a nod. “Like I said."

"Hydrogen sulfide is a lot like water,” Cap commented when he had let out his breath and backed away. He put the rock in a plastic specimen bag, sealed it, and wrote a time, place, and context on the label. “Except it's a gas, and water's a liquid. And water's necessary to life and this stuff's poison—except to your buddies here."

"Yeah,” I said. “Except for being a poisonous gas instead of a life-sustaining liquid, I can see where they'd be a lot alike."

Cap took a digital image and wrote the image number on the label. “Joke all you like. But S falls just below O on the periodic table, so if you replace H2*O* with H2*S*...” He fell suddenly silent.

I cried out. “That's it! That's it!” But Cap was still staring at nothing, so I turned to Billy, who obligingly asked, “What's ‘it'?"

"Around the ocean vents, tube worms stick their ‘gills’ into the vent plume and harvest the hydrogen sulfide. This species teases the H2S out of the rock by dabbing the surface with their moist gills. That's why it survived when this ridge was uplifted out of the ocean. Oh, that's *beautiful!"*

Billy grunted, looked at the nest of tube worms, but made no comment on my concept of beauty.

Abruptly, Cap said, “That bastard!"

We did not ask him who he meant. Neither did he elaborate. Instead he pushed past us and crawled down the passage to our camp.

"What was that all about?” I asked Billy. It was a rhetorical question and I did not expect an answer. Still, when I did not get one, I turned to him and found him shining his lamp into one dark pocket and fissure after another.

"What is it?” I asked him.

He shook his head. “I felt like we were being watched."

His lamp reflected off the rocks, shining chips of mica seemed like eyes. But what needs eyes in a lightless cavern? I studied the tube worms and suddenly noticed that many of the nearer ones, instead of licking the stinkstone, had begun “licking” the air in our direction. Coming on the heels of Billy's premonition, their action seemed unnerving. Then I laughed a little at my fright. “It senses our body heat,” I told Billy. “And somewhere deep in its genetic memory are the warm waters of the thermal vents."

* * * *

When I reached the camp, I noticed Cap sitting up by the lamp and reading the printouts that Luke had given him that first day. He had unfolded a map of the Cascades across his knees and was tapping on it arhythmically with a pen, deep in thought. Luke was watching him with a quiet curl on his lips.

I turned my attention to the dissection of a tube worm specimen. Whatever his plans were, Luke evidently believed everything was going according to them. But I would be damned if I would give him the satisfaction of asking him what they were.

Billy had that useful “superpower” that enabled him to do exactly nothing. It was disconcerting in a way. He could sit there, not talking, not reading, not looking at anything in particular. I can't even be sure he was thinking. It was as if he were simply waiting, and it crossed my mind that, if I could only figure out what he was waiting for, I would have teased out the secret of the universe.

But I suppose that nothing can grow boring even for those most practiced in its skills. After a while, Billy “turned on,” rose from the rock on which he had been sitting and strolled over to kneel beside Luke, then, after receiving a pointed look, he moved on to Cap and studied the maps that Cap was marking up. Finally, he came and stood behind me to watch me cut up the worm.

"Boss says we should reach the bottom tomorrow,” Billy commented.

"Unh-huh,” I answered absently. Dissection by lamplight in a cavern who-knew-how-deep below ground, in the chill and damp, was neither the easiest nor most graceful way to do it. I had additional specimens that I planned to dissect in the lab once we got back to the surface, but how could I not take a quick peek. Billy glanced at my notebook, where I was sketching the tube worm's anatomy. Then he squatted beside me.

"Wish I knew what the boss was reading in that notebook of John's."

I glanced at him, glanced at Luke, who was reading the journal with a thin, secret smile. “You don't trust Luke."

Billy didn't even bother to laugh. “We're following him and he's following an old dead Injun. Me, I'd rather be led by a live man than a dead one."

"You don't trust John?"

"Never met ‘im. But I'd rather not follow him until I know where he wound up.” He paused and scowled. “You, I trust."

I waited for him to name Cap, too, but he didn't. The weight settled on my shoulders. It's damn heavy, the trust of others.

* * * *

When we awoke, we did not break camp. Luke told us that John's destination was close by, within a day's climb. So we could make our way down and back without lugging our equipment. “Just take your sampling equipment.” He opened his notebook to record the day's activities. “Price, what time is it?"

I looked at my watch and started. “It's ten o'clock already! Day's almost gone!"

"Ten a.m. or p.m.?” Luke asked.

I started to say “a.m.” because we were just waking up; but then I realized that I really had no idea. Down here, it was always night, and you could slip out of the diurnal rhythm without even noticing.

Billy hefted his knapsack to his back. “Ten *p.m.*, boss."

Luke's scowl seemed Mephistophelean in the LED lamplight. “How can you be so sure?"

Billy composed his face into what I had begun to think of as his Injun Act. “Injun always know'um time. Have'um deep roots in nature.” As he turned away, he added *sotto voce* to me, “and have'um twenty-four hour watch."

* * * *

The next pitch was narrow and steep, but strewn with broken rocks. We called them the Giants’ Steps. We did not need our ropes to descend. We could clamber down.

But at the bottom we found ourselves in a chamber with five exits—and none of them were marked: Two were in the floor of the chamber and led farther down into the earth. Two others were at or near the “floor” level, and a fifth was inset higher up in the wall. We fanned our lights around each passageway, but could find no sign of the **EJ** monograms we had been following until then.

"So. Which way?” Cap demanded.

Luke flipped the pages of the journal, puzzled. “John doesn't mention this place.” Then he looked helplessly from crevasse to tunnel. Nisqually signs had petered out a long ways back. Now our nineteenth century guide had failed us as well.

A Luke Bonhomme fallen back on his own devices was a less certain being than a Luke Bonhomme with a cheat sheet. He knew he had to make a decision and make one soon. “This one,” he said, choosing the larger crack in the floor.

But Cap said, “No!” He was standing by one of the passages that ran off about two feet above the floor level. “This is the way."

Luke came over with his light and peered inside. “No. It goes up, not down."

But Cap was adamant. “Take a look at the walls; feel the draft. What do you feel?"

"Warm air,” said Luke.

"And there's no ice on the walls. Hot air rises. Something at the bottom of this passageway is generating a lot of heat."

"Well,” said Knobby. “We *are* inside a volcano."

"Warm air...” said Luke.

Cap cocked his head. “You want to tell them, or should I?"

Luke snapped to and cocked his head at our geologist. “You've figured it out, then?"

"The other day, when Jeannie showed us her worms."

That surprised me. And it angered me just a little. Cap had seen what I had seen, but he had seen one thing more, and like Luke, he had kept it to himself.

"You told us,” Cap said to Luke, “that we'd find the answer to the monogenesis problem down here."

"Yes. And ...?"

"The answer is no."

Luke nodded slowly, then more vigorously. Then he said, “Thank you, for confirming that."

"We haven't *confirmed* anything, yet,” said Cap.

"Will someone explain what's going on?” Knobby pleaded.

Cap looked at Luke, who deferred to him. “Go ahead, McConnell. I want to hear this."

"All right,” said Cap. “Gather ‘round, folks, and I'll tell you a tale."

This was a more confident Cap than the one who had started out. Facing the end of his contract and with no publications ready, he had been a man defeated and grasping for straws. Now, he radiated not only confidence but joy. I saw in his face the same emotions I had felt in the Medusa Grotto.

"Jeannie,” he said when we had arranged ourselves, “what was the final phase in the Smith-Cairns model Luke was explaining the other day?"

"Umm. The carbon polymers were protected by the replicating clay crystals until they'd developed to the point where they could replicate and survive on their own. Then they went their own way and evolved into worms and flowers and dinosaurs until finally achieving an evolutionary peak in Luke Bonhomme.” [Luke smiled at this. I think he missed the sarcasm.]

"And what happened,” Cap said, “to the replicating clays they left behind?"

I opened my mouth, then rocked back. “Oh. Wow..."

"Yeah. Wow."

* * * *

"Remember when I made that off-hand comment comparing water to hydrogen sulfide? I said that H2*O* is necessary to life, while H2*S* is poisonous. Except for your tube worms. They couldn't use it themselves, but they had found a way to handle it safely. Now, I'm no biologist, but I know all life is based on hydrates of carbon. We inhale oxygen, oxidize the carbohydrates, and breathe out carbon dioxide. So I got to thinking ... Silicon's right below carbon in the periodic table, just like sulfur's below oxygen, and it has a chemistry very much like carbon. Silane instead of methane, for example. It forms long chain molecules—silicohydrates—similar to carbohydrates. They aren't as long or complex, and they lack the chirality that gives carbon-based enzymes such specificity, but still ... Why not a kind of life based on silicon polymers? Something that ‘drinks’ hydrogen sulfide instead of water; that eats silicohydrates instead of carbohydrates and oxidizes them to ‘exhale’ silicon dioxide instead of carbon dioxide."

"But,” I objected, “how can they exhale silica? Carbon dioxide is a gas, but sand is a solid."

Luke and Cap exchanged glances, and, so help me, they smiled at each other. Then Cap said, “Sand blows."

"Silicon beings wouldn't ‘breathe’ very rapidly,” Luke added. “They'd work their way through faults and cracks toward the surface and blow like whales. Easier to blow sand into open air than into surrounding rock."

Knobby started. “But that would..."

"Cause an earthquake. Yes. New Madrid must have been a whole herd surfacing together."

Billy scratched his head. “Sounds crazy."

"It's not a new idea,” said Luke. “Reynolds suggested it in 1893, when he noted that the heat stability of silicon compounds could allow silicon-based creatures to live at very high temperatures. I learned that during my graduate research on extremophiles. Later, J. B. S. Haldane suggested that life could exist deep inside the earth, based on partly molten silicates and energized by the oxidation of iron. The wildest of speculations! But they fascinated me. ‘Silicolife.’ The ultimate in extremophiles! It's been my dream since grad school to find them, but where to look? Where to look?"

The idea that Luke was a dreamer, that he was *capable* of dreams rather than schemes, surprised me. “You decided to look under Mount Rainier,” I said, “because of something Ezra John wrote."

"Yes. Would you like to hear it?” He flipped the journal open to a page near the end:

"The living rock! Praise my Savior !! that He has led me to see such things! I have seen sharp, crystalline creatures and those of semi-molten plastic rock moving under their own power—slowly, oh so slowly, as befits beings made of stone. But swift betimes. I saw one such extend a—I must call it a limb, a hand—to snatch a second creature to its bosom. To consume it? To embrace it? Oh, on what stony grasses might viscous cattle browse below our feet! What whales swim through the porous earth?"

* * * *

"John concluded by saying he planned to return and collect a sample of their flesh,” said Luke. “But if he made a second descent of these caves, he left no record."

"These land whales leave a sort of ‘wake’ behind them,” Cap added. “A trail of microquakes. ‘Earthwakes.’” He grimaced. “It took me a while to see them in the seismic records. Most of the earthquakes are just that, and Luke wouldn't drop any hints what I was supposed to be looking for."

"You'd not have believed me if I had. You had to find the patterns yourself."

For a moment, the old irritation was there in Cap's face. “Yeah. It was like cutting a path through the wilderness, only to find Bonhomme sitting at trail's end on a lawn chair with an iced tea in his hand."

Luke shrugged. “But you can honestly claim it as your own discovery. And I can claim it as independent verification."

To put the matter less kindly, Luke had kept mum about his theory until someone else stepped up to second it. *In numbers, strength.* Now he had Cap's concurrence, but he also had priority and could still step out in front: a new Darwin to Cap's Wallace.

"I extrapolated the trails of these ‘earthwakes’ northward along the fault lines, and estimated that one—School? Pod? Herd?—would be passing under Rainier this month."

"Then that rumble we felt in the Gallery of Crystals...” suggested Knobby.

"Was almost certainly the lead elements,” Luke assured him. “Don't worry. They're slow. We won't miss them."

"But earthquakes...” Knobby said.

"Not earth*quakes*,” Cap said. “‘Earth*wakes*.’ They're relatively minor tremblors."

"Unless the whales surface,” added Luke.

Cap shook his head. “They already did that at Mount St. Helens. They won't need to exhale for a long time yet."

* * * *

What adventure is not spiced by the possibility of danger? Earthquakes? Would any sober person have marched down that vent believing what we did? But we were giddy-drunk with the possibilities. Silicolife? There wasn't much that could have held us back.

Not even the skeletal forearm that lay on the smooth, frozen-lava floor.

We could not suppose that Ezra John had been our only predecessor in these caverns; some deaths are too distant and impersonal to elicit even the pity we had felt for the thing on the ledge in the Great Crevasse.

Except Billy, for whom the border where biology faded into geology meant little—and the bones of those who went before meant much. I remembered Billy had a degree in anthropology, and thought it somehow proper that we should come across something in his line of work. He went to his knees and studied the fleshless forearm. “Burned,” he said almost to himself. “Only scraps of flesh and gristle ... And those stones around the wrist. Those are Nisqually work. Thong burnt away, but it must have been a bracelet. But where's the rest of ‘im? Why only a forearm? Scavengers? Down here?"

"Come on, Billy,” I urged him. The others had already passed by, but I had lingered. “It'll still be here when we come back."

He looked at me without comprehension. “Ezra John came down with two Nisquallies. One of ‘em made it back with his journal. This is the other. I got to take ‘im to home ground.” The anthropologist in him captured some digital images of the context first, placing a measuring rod beside the ulna for scale. Then the Nisqually in him gathered up the bones. The radius and bones of the hand lay loose on the rock, but the charred ulna, when he tried to lift it, snapped right off.

With a cry, he dropped the rest—and carpals and knucklebones clattered on the hard lava of the passage like a game of dice. Then, on hands and knees, he studied the point where the bone had broken. He pointed to the bulging lava of the floor. “Do you see where it broke off? That stub sticking out of the stone. He's *inside* the God-damned lava!"

He pulled a rock hammer from his harness and struck the rock repeatedly, struck so hard I thought the handle would break. Feldspar flew in reluctant chips and splinters, but Billy hammered away, oblivious to the flakes. “There,” he said after a minute or two. “Do you see?"

From farther down the tunnel I heard shouts, and once more I stood to go and join them. But Billy grabbed the sleeve of my jacket. *"Do you see?"*

A part of the face had been revealed—burnt to a husk, gaping mouth stone-filled, flesh and fat melted but, sealed in stone as it had been, protected from decay. It was a different kind of mummification than what had befallen Crevasse Man. Faster than the gradual starvation and desiccation that had overtaken the paralyzed man on the ledge, but more horribly painful—as if pain must be a constant and its intensity corrected for its duration.

"He was running from the lava flow,” Billy said as he studied how the body lay. “But he looked back, and tripped, and fell on his back, and he was turned, not to a pillar of salt, but a bed of ... of..."

"Feldspar,” I suggested.

But Billy shook his head. “Mother Earth swallowed him up."

"Come on,” I said gently. “We'd best join the others."

Billy looked up to me. “Something bad happened here, and until we know what it was, the same thing could happen to us."

* * * *

At the end of the tube was a wide lava dome, oblate and tilted forward to where a kind of slot in the rocks led to farther depths. To our left and right, the room vanished into blackness, save near the slot, where it glowed sullen red. Heat rolled from the slot like an ocean's wave. There would be no more descents; not on this route.

The entire chamber reeked of rotten eggs. Thick beds of tubeworms carpeted floor and walls under multiple bands of stinkstone. These were larger than the ones I had seen before, and their chitin tubes were thicker. A different species perhaps. Evolution had been at work here, however sluggishly, and the tubes had become thicker in a co-evolutionary race with ... What?

With creatures of stone and crystal. With things that were like spiders and like insects and like lizards, but were like none of them. Neither Luke nor Cap paid us the least attention when Billy and I entered the cavern. But Knobby turned around and cried out, “Have you ever seen anything like it?"

No. No one ever had, save Ezra John and his companions. I knew immediately why the old naturalist had recognized them as living things. They could be nothing else, for what mere stone can bite and chew, however slowly? They grazed on the tubeworms, drinking up the H2S in their blood. I saw how some of the tubes survived the bites and marked one of the evolutionary drivers in this system. There were also things like flowers, with petals of shimmering mica, and these too were fodder for the things that grazed upon them, gobbling down the silicohydrates.

Some of those grazers were lumpishly rock-like; others, sleek and metallic almost like insectoid robots, all angles and glacis with antennae of supple aluminum. In place of chitin, they possessed what I later supposed was a silicon-cellulose material analogous to it. Thiselton Dyer had written in *Nature* in 1887 of a silicohydrate called tabasheer, found in the joints of bamboo. His investigations revealed that hydrated silicas appeared in not a few plants, and that Count Castracase had speculated on the possibility of a silicon-cellulose. “It still remains an unsolved problem,” he wrote, “why, when no adaptive end is involved, plants should take up such relatively enormous quantities of silica."

Maybe they hadn't “taken it up.” Maybe they had always had it—a survival of the old clay matrix—and hadn't yet put it down.

Our floodlights revealed chips that might have been eyes, though they could not have evolved to receive light. I remembered what Cap had said in passing about crystal radios back in the Crystal Grotto, and I wondered...

* * * *

I wondered. What else was there to do in that place but wonder?

Whence their energy? No photosynthesis, obviously. Thermal, of course, from the volcanic vents. While their cousins had stayed with the vents submerged on the seafloor, these had been uplifted with other vents onto dry land.

This was it, I realized: the answer to the monogenesis problem. And the answer was, as Cap had said, No. Life had not begun one time only. It had been a polygenesis, after all, or at least a duogenesis. Here

were the denizens of another tree of life entirely.

A slow, low-energy evolution. How often do rocks mate? I thought these “silicreatures” were still in the Permian Age of their kind. They moved for the most part sluggishly, although, like Ezra John, I saw one or two lunge swiftly to seize a prey before returning to a state of rest.

Luke and Cap had gotten floodlights set up and were busily taking pictures and writing notes. I don't think the silicreatures could have sensed the light, but I thought there was a slow movement away from the floods and into the shadows.

I turned away from the others and set myself to study those large, hard tubeworms. *Riftia terrestria robustus?* Carbon-based as they were, they seemed as cozy as sisters.

Knobby sniffed. “What's that smell?"

"Sulfur,” said Cap absently. He was using a rock hammer to pick off one of the micalike “flowers,” which he placed in a specimen bag. “Stinkstone makes hydrogen sulfide, remember?” His pen made vague gestures in my direction.

"It's getting stronger."

It was getting warmer, too. The floor rumbled slightly, but we had gotten used to these transients. Siliwhales “swimming” below us.

"Boss,” said Billy. “I think we should get out of here.” His worried glances had quartered the chamber and now rested on the slot in the far end where roof curved down to meet floor.

Luke made a face and said something I did not catch about primitive superstitions. Even Cap looked disappointed. “Bryant,” said Luke. “I have some collapsible specimen boxes in my bags. Be a good fellow and fetch them here.” He handed Knobby his notebook and reached for one of the insectoids, a giant silinsect about the size of his fist and all bristles and spines.

All bristles and spines that had evolved as protection against predators with jaws of stone.

Upon being handled, the creature's spines thrust out and its antennae whipsawed. They pierced mere flesh with ease. Luke howled, and I could see that the alumino-silicate spikes had impaled both his hands, and the antennae were flailing his wrists and forearms like a cat-o'-nine-tails.

"Drop it, Luke!” Cap cried, and Luke wailed.

"I can't! It's nailed itself to me!"

Knobby and I rushed to him, but it was too late. Perhaps we could have somehow pulled his hands off without becoming impaled ourselves. Perhaps Luke might not have bled out from his slashed wrists right then and there, and he might even have managed the climb back up to the surface with Billy and me to help. But for every prey, its predator.

A dun rock lunged suddenly forward, revealing in its gaping jaws gleaming teeth of adamantine. Jaws that had evolved to chew on rock engulfed the silinsect, Luke's hands, and his forearms up to nearly his elbows. Luke shrieked and danced away, waving two stumps from which jets of blood shot across the chamber.

"Tourniquets!” cried Billy. “Grab him!"

Luke seemed not to comprehend what was happening. He pulled away from us when we tried to take hold and could not turn his horrified eyes from his arms. Shock, and the drop in blood pressure, felled him then, and he collapsed suddenly unconscious to the floor of the chamber.

Billy strapped his arms using his own belt and Knobby's. But I think it was too late even then. Luke's legs jerked spasmodically, then he lay still. Billy listened for the sounds of breathing, pounded double-fisted on his chest; but the battle had been lost before it had been joined, and shortly, Billy rocked back on his heels and said nothing.

Behind us, the stone crocodile spat out the mashed remnants of Luke's arms. Carbon-based life was not in its diet. Cap grunted and said, “He always was hard to swallow."

That's when I slapped Cap McConnell right across the face.

* * * *

We stood for a while over Luke's body, wondering what to do. The climb down had been hard enough. The climb back up—with a body—would be well nigh impossible. Billy finally said, “He deserves to rest among his people.” No one wanted to say otherwise. I cleared my throat. Cap muttered, “'Leave Nothing Behind.’”

But Knobby said, “Hey! Where'd they all go?"

He meant the silicolife. The rock that had killed Luke was gone. So were the remaining silinsects and the other browsers. Even the tube worms had retreated into their chitin fastnesses. Only the mica “flowers” remained, their petals shimmering in the breeze created by the heat from the slot.

"It's brighter,” said Billy. He meant the slot at the end of the cave. A ruddy luminescence shimmered there. Knobby said, “Guys ...?"

Something bright and crimson-yellow crawled out of the pit on a thousand spindle-spiked legs. There was something of the millipede in it—I could make out segmentations in its body—but it was far larger than any millipede had a right to be. It was about the size of a wolf and moved swiftly for a thing made of living stone. Its many legs rippled in a complex wave and, as it neared one of the niches in the rock wherein the silinsects had retreated, one of its legs whipped about and, stretching like white-hot taffy, shot into the hole. It emerged with a fist-sized silinsect in its grasp furiously stinging and spiking the lavalike tentacle that had seized it—but to far less avail than it had against poor Luke. It began to smoke, and we smelled the acrid scent of burning rock.

Knobby cried, “There's another!"

We turned and saw that two more of the creatures had emerged from the vent and were stalking the cavern. The four of us backed away slowly, fearful yet fascinated. These two parted and moved forward along the two sides of the cavern. The mop-brush swirling of their peculiar feet seemed almost comical, but there was nothing funny about their deliberate approach. A fourth creature had emerged and took the center, so that the three were moving toward us in a V-formation.

"Pack hunters,” I said. “They're cooperating.” I had been wrong. These things had evolved beyond the silicon Permian. These were what? The dimetrodons of their kind?

Billy said, “We can't let them block our exit. I don't know how far those ‘lariats’ of theirs can throw; but I ain't about to test it, neither. Let's bug outta here."

"But we need the specimens,” Cap wailed. “All our proof!” His own samples, and mine, were now well

within the V of the approaching “wolf pack.” And I suspected that every square inch within that V was within the reach of their tentacles.

"Don't try it!” I said. Cap was inching forward, arm outstretched.

"We're faster than they are,” he pleaded. “Carbon beats sand on speed. I can duck in, grab my sample bag, and duck back out before they can even react."

Knobby and Billy were already out the exit. Knobby turned. “Come *on!"*

After one reluctant look, Cap joined us at the entrance of the chamber, the one through which, with such shouts of joy, he and Luke had entered a scant hour ago. “This whole trip will be a failure,” he complained, “if we don't have those specimens."

I looked back over my shoulder one last time and saw that Luke's corpse was now aflame from the molten creature crawling over him. But the creatures on the two flanks seemed to be shrinking back. The fourth one, the one that had seized the silinsect was thrusting itself into one of the crevasses in the rock wall. It body, plastic from its own internal heat, squeezed into the hole.

Billy cried out from lava tube: “Hurry!” Cap slapped me on the rear, “Go! Go!"

I scrambled up after them, then twisted about, my heart dropping in sudden realization.

Cap had not followed. “They're retreating,” he called from the opening. “Maybe they can't stay out of the heat sink too long. I'll bet I can snatch the bags...” He stepped forward and reached for the straps.

But the creatures had not been backing away. They had been crouching. Like springs ratcheted back, their plastic bodies had stored energy that was now released in great leaps.

The one on the right got him.

A leopard leaping so might bear a man down, but such a man could shield himself, however poorly and however briefly, with his arms. But that was against mere teeth and claws. Against a creature of white-hot, semi-plastic rock what defense can there be? Cap was engulfed faster than he could even scream. If his mouth opened in the effort, it had been quickly stuffed with magma. He flailed for but a moment, yet one that seemed to go one forever, before he fell, first to his knees, then on his face, his clothes and flesh aflame. Somehow, that swift and silent struggle was more terrible than even Luke's horrible end, and I felt as if a great, paralyzing electric bolt had stunned me.

The other two—what should I call them? What name would conjure up the horror? Stone leopards? Molten tigers? *Tyger, tyger, burning bright...*

Billy yanked me sharply by the arm. “Later,” he said. “We can mourn later."

And I saw that the spring of the other two creatures had brought them near the entry to the lava tube and that they had resumed their implacable and terrible waddle. The third, having found Cap not to its taste, had rejoined the stalk.

Two entered the tunnel behind us; the other climbed into another vent. Off the scent? Or...

"It may know shortcuts,” Billy warned us. “Small passages that its kind can squeeze through. Let's hope it finds enough food in the vents to slake its hunger."

We passed by the dead Nisqually's bones, and I knew how he had come to be entombed there. I could

picture him and his comrade and Ezra John scrambling up the tube as we were even now. Engulfed like Cap by a burning tiger, the Indian had somehow managed to pin his attacker down until it froze around him in the cool of the cavern.

That was the good news. If we could stay ahead of our pursuers, they would either lose interest or they would be turned back by a cold to them both deadly and unimaginable.

Easily said. Less easily done. Perhaps these were more robust than whatever had killed the old Nisqually. They did not abandon the stalk. We could easily outpace them when they waddled. But they *never* stopped, and we grew short of breath.

And every now and then they sprang forward, closing the distance.

It was a mad and deadly re-envisioning of the tortoise and the hare, with our pursuers combining the features of both. But unlike the hare, we were afraid to rest and catch our breath, for it might be the last one we caught.

And they knew shortcuts.

* * * *

We passed though the chamber with many exits, clambered up the Giants' Staircase, through the chamber where our base camp sat. We grabbed what we could—climbing gear, mostly—but we dared not linger and, passing the Medusa Grotto, we could smell behind us the faintly acrid scent of melting polyester. All my careful dissections, laid out in neatly labeled boxes, now no more than smoke and ash.

What had taken us a day to descend took us only hours to climb back up. Granted, we had descended in slow, careful stages, and we had been carrying a great deal of now-abandoned equipment, but we took the ascents as quickly as we dared. Haste could be dangerous in a cave, but in this case tardiness, as well. Twice the pack stalking us appeared from unexpected quarters, oozing from cracks in the rocks. A whiplike tentacle brushed Knobby's calf and he screamed, staggered, and with superhuman effort continued to jog.

There was a short, vertical ascent just past the Medusa Grotto, and we had left ropes hanging in place.

Someone had to go up last.

The first shall be last. Right, uncle? "Billy," I said. "You first. Then Knobby. Hurry!"

It made sense to put the most experienced climbers first and last, and it made sense to send Billy—the strongest of us—to the top first. I wish I could say it was the logical thing to do, or that I was brave. But the truth was I was scared silly, and if I had stopped to think, I could have rationalized why I should have gone up first.

Waiting at the bottom took forever. The burn on Knobby's calf made it hard for him to use his legs in the climb, and he seemed to inch his way up. "Hurry," I said again. Uselessly. No one was slacking.

I felt a wave of heat on the back of my neck and leapt for the rope before Knobby was even off it. But twisting as I snaked up the rope, I could see that there were only two of the pack behind us now and both were glowing more sullenly red, with black scabby crusting. They were losing heat. "Go home," I told them. "You'll catch cold!"

Astonishingly, one of the stalkers turned about and squeezed into the crack from which he'd come. "You, too!" I told the other. But this one did not heed me. It crouched at the base of the pitch and sprang.

But I was already above its range. The bottom of the rope caught fire, but Billy and Knobby pulled me up and onto the ledge and I lay there gasping while they laughed at me. “'Go home?'” said Billy. “'You'll catch cold?'” He thought it hysterically funny.

"It worked,” I said, not unreasonably.

"I think he's giving up,” said Knobby, who had moved to the edge of the precipice. “He's chowing down on some rocks, getting brighter. Its ... Its digestion must give off heat.” He leaned out to get a better look.

I grabbed Knobby by his jacket and pulled him down. *"Are you crazy?* Didn't you see what happened to ... What happened to Cap?"

He yanked himself from my grip and turned away from me. “Yeah,” he said. “Yeah. I saw. And I saw Professor Bonhomme, too.” I think his eyes may have been a little glazed, but he did not go back near the edge.

Billy clapped his hands, already heading for the tight crack we had to pass to reach the next chamber up. “And if we don't keep moving, we'll get to see what happens to us. I think your buddy down there was stoking up his fires so he could continue the chase."

"That's odd for an animal,” I said. “They usually don't have the concentration. Out of sight is literally out of mind."

"Yeah? But I've heard the saying ‘patient as a rock,’ so maybe the rules don't apply."

"I wonder,” said Knobby. “I wonder if he's just plain curious about us. Maybe he means us no harm."

I pushed him into the crack after Billy. “Ask Cap."

* * * *

The crack was a tight climb, not quite vertical, and we could use hands and feet to brace ourselves against the opposite wall. I kept thinking that the silitiger—or whatever we might call our pursuer—could squeeze through other crack systems suitable to one of his size and plasticity and emerge from the very walls of this chimney. I found myself staring into each crack in the wall that I passed, looking for the tell-tale glow of his coming. I said nothing to the others and they said nothing to me, but I have to suppose they were thinking the same.

At last we came to the larger passage that led to the Great Crevasse and, even though it was illogical to do so, we relaxed just a little bit. We had seen no sign of the creature for the better part of two hours. We had no reason to suppose he had continued the pursuit after his companion had turned back, but we had no reason to suppose he had given up, either.

"Let's hurry,” I said. “The sooner we're out of this hell hole, the better. Every time we stop and rest, he catches up a little more.” I wasn't telling them anything they did not already know, but Billy only nodded.

"You take the point."

Exhausted by this time, we walked as swiftly as we could. I had no idea how far the creature could come without freezing. It had already come farther than I had thought possible. Coming to the lip of the crevasse, I turned left along the ledge to where the edges pinched together and I stepped across. When I had come back to the point where the tunnel continued, I looked back and saw Knobby still making his way along the ledge and Billy coming up the tunnel.

And behind him was the silitiger, moving fast.

"Billy!" I cried. “Behind you!"

Billy turned and saw the thing retracting for a leap—and he was too close.

He ran. I don't know where he found the reserve of speed, but he ran. Yet, we had learned that while we could outrun the creature's comical waddle, we could not outrun his leap.

I don't know if, concentrated as he was on his pursuer, Billy simply forgot about the Crevasse or, knowing it, tried what Ezra John had tried in what I had to imagine now were nearly identical circumstances.

He leaped for his life.

Knobby had reached me by then and I seized him by the arm and squeezed, unable to speak.

"A good run," Billy had said with a toss of his head, "and a man in top condition could leap across the fissure, easy."

But our climbing and scrambling for almost twenty consecutive hours had taken their toll. He was not in top condition. He didn't quite make it.

He struck the surface on our side of the crevasse and grabbed onto rocks with his arms, but his legs dangled out over emptiness, pulling him back, pulling him down. I went to my belly and reached for him, seizing him by the wrists. I could hear his feet kicking for purchase on the cliff face.

The silitiger had sprung as well. But it, too, had wearied, if the ruddy black crusting was any indication. It was freezing to death, but fixated for some reason on the pursuit. And it had leapt at Billy from much farther back in the tunnel.

It fell almost dead center into the bottomless pit.

There was no shriek—or none that our ears could detect—and after a time came a sound like an impact, followed shortly by a subsonic growl and a slight tremor in the ground.

A slight tremor? I almost lost Billy. His hips slid off the edge. And I slid a little forward with his weight. “Knobby!” I cried. “Help!” But Knobby went running up the steeply slanted lava tube that led to the Crystal Gallery.

Billy managed a grin. “It's no use,” he said. “Look. Maybe if I drop just right I can land on Ezra's ledge. If I land on my feet, and if I can keep my balance, and..."

"Too many ‘ifs,’ Billy. Find a foothold. Concentrate on that. If you can just find a footing and take the weight off..."

"Ezra's been almighty lonely down there. He could use some company."

"Stop talking crazy."

"Under the circumstances, what other way is there to talk? Jeannie, I don't want to die."

"Then don't."

"Might not be my choice. If you let go..."

"I won't."

"But if you don't, then I drag you over the lip with me, and as much as I don't want to die, I don't want you to die with me."

I was searching with my legs for some leverage, something I could anchor onto. But this part of the ledge was too smooth. Ezra's ledge was several feet to Billy's right. There was no way he could drop down to it. I wondered if he knew that.

And then Knobby was there, and he had the ropes we had run through pulleys in the wall of the lava tube. He clipped one end onto a ring in Billy's climbing harness and hauled with all his might on the other. Slowly, using the mechanical advantage of the pulley, he pulled Billy up over the lip of the crevasse. Even so, I did not let go of Billy's wrists until he was safely on level rock. Billy let out a shaky sob, and Knobby, he kept pulling on that rope and dragged poor Billy two yards farther up the tube before he, too, collapsed and began to cry.

* * * *

"And that's how I went down with Luke Bonhomme," Jeanne Price said. And this time she did pick up her last glass of bitters and drank it down. "But I've no evidence. It's all been lost. 'Leave Nothing Behind!' Oh, God, what we left behind!"

"You could," said Doc, who coughed and tried again. "You could go back and try again. You'll know what to expect."

But Jeanne was shaking her head. "No, I could never go back. Neither can Billy and Knobby. We agreed on that on our way out. And what would be the point? At the conference this afternoon, I tried to tell Davischen what had happened and he lit into me. 'Let the earth bring forth...' I hadn't realized why he got so hot. The others at the conference didn't get angry. They didn't share Davischen's prejudices, but they didn't believe me either, and I had to pretend the whole thing was a joke. Two dead. Some joke. Officially—climbing accident; and that's the reason the Park Service gave for closing the cave off. But I think they cared more about our 'defacing' the cave than about the two men who died. Still, I know what I saw, and so do Billy and Knobby. We won't go near that crevasse ever again."

"Sure," said Himself, "and it was a fearsome experience."

"No. No, what we saw was not the worst. That silicon tiger that stalked us? When it fell into the pit ... something far below growled and the earth trembled. Whatever was down at the bottom—the Beautiful Firekeeper or one of her relatives—I don't *ever* want to make it angry. Down in the deeps are the creatures Haldane foretold. Creatures of molten silicates, and their breath isn't sand, but fire and liquid stone. When the land whales rise from the abyss, whole mountains explode."

The Irish Pub had fallen silent and only the rumble of the traffic could be heard. "I fear," said Himself. "If what you say ... I fear your whales of stone are not the greatest of these creatures."

Jeanne Price wiped the tears from her face. "Which, then?" she asked.

"You said this Juan de Fuca plate was pushing under the North American plate? No, I think North America is *eating* Juan de Fuca; the earthquakes are the grinding of its teeth."

We looked each of us at the other, and what we saw were but mites living upon the carapace of a gigantic beast, one of the great world-turtles that the ancients so presciently imagined.

It was then that The O Neill, returning from his rehearsal, pushed through the doorway of the Irish Pub and burst into song:

"The hills are alive..."

And was cut short by the sudden cry of terror that greeted him.

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Science Fact: **THE PSYCHOLOGY OF SPACE TRAVEL** by Nick Kanas, M.D.

Curiosity and a sense of adventure have inspired human beings to venture forth into the cosmos. However, space is a stressful place, and traveling in this novel environment can take its toll on the human psyche. The psychological risks of space travel stem from a variety of factors: prolonged isolation from family and friends; confinement in close quarters; working under potentially dangerous circumstances, where a meteoroid impact or a collision with space debris can lead to decompression and death; and dealing with the physiological sequelae of microgravity and radiation on the human body. But alternatively, there are positive aspects of space flight that can enrich the spirit and give space travelers a sense of advancing the human condition and being an important part of history.

What do we know about the negative and positive psychological factors related to space travel, and what is the impact of these factors on the psyche and on the ability of crewmembers to work and interact together? How applicable are anecdotal reports from astronauts and results from studies conducted in space-analog environments on Earth to future space missions? What sort of research has been conducted under actual space flight conditions? What we do know stems from missions in low Earth orbit or to the Moon, but how applicable is this information to future long-duration exploratory missions, such as an expedition to Mars? These are some of the questions that I will try to answer in this brief review[1].

* * * *

Psychological and Interpersonal Issues in Space

Anecdotal reports from space and studies conducted in space-analog environments on Earth (e.g., the Antarctic, submarines, space simulation chambers) have isolated a number of psychological and interpersonal issues that have relevance for crewmembers during space missions, especially those that are long-duration (e.g., longer than six weeks). One such issue relates to the impact of time on individual and crew behavior. Some writers have noted that crewmembers in space or in space-analog environments experience significant psychological and interpersonal difficulties after the halfway point of their mission, particularly in the third quarter. They point out that many people arrive at this psychological milestone with some relief that things are going well, only to realize that there still is a long half to go before they can return home to their family and friends. Some writers have described the presence of a "third quarter phenomenon," characterized by increased homesickness, depression, irritability, and even decrements in crew cohesion shortly after the halfway point. In long-duration missions, it is not so much the number of days that have transpired but the perception of "halfway" that has the most psychological relevance.

* * * *

During long-duration space missions, astronauts can feel insignificant and isolated from family and friends back home. This can produce a sense of loneliness and homesickness, and in some cases clinical depression.[2]

* * * *

A second issue has to do with crew-ground communication and how it relates to on-board tension. The findings from some analog studies and reports from crew debriefings and diaries suggest that crewmembers sometimes take out their individual and group frustrations on people in mission control who are supporting their activities from Earth. That is to say, crewmembers displace tension from their on-board "in-group" to a convenient "out-group" that is more distant and less able to retaliate. Many of us experience displacement effects when we are angry with our boss but cannot tell him or her off directly for fear of losing our job, then proceed to go home and yell at our spouse or kick the cat. Although offering temporary release of emotion, displacement does little in the long run to help crewmembers resolve on-board tension, and it can lead to miscommunication and conflicts with the ground that can

prove disastrous during times of danger.

A third psychosocial issue relates to crew heterogeneity. More and more, space missions are involving people of both genders, diverse professional and experiential backgrounds, and different nationalities. In the long run, such diversity can be beneficial, since it provides novelty and stimulation later in the mission when people begin to tire of the routine and look for something new to talk about. However, diversity also can be stressful, especially when people do not understand all of its ramifications. Take, for example, cultural norms. People from Mediterranean countries typically are quite animated and are comfortable being close to one another when speaking, whereas people from Northern European countries are more reserved and have less tolerance for someone gesticulating close to them, which they may perceive as boorish behavior or as a sign of aggression. If not understood for what they are, such cultural characteristics can cause problems in the confines of a space vehicle. Heterogeneity in space may even relate to organizational culture. Space programs vary somewhat in their degree of formality and their dependence on procedures and redundancy versus expert advice to resolve problems. An astronaut or cosmonaut used to one system may have difficulty adapting to another during a long-duration space mission. Of course, the personality characteristics of the crewmembers can moderate the impact of crew heterogeneity. The best crewmembers for long-duration space missions seem to be those who are comfortable working alone on an activity when diligence is called for, yet at the same time are team players and enjoy relating with their fellow crewmembers during leisure times. Facility in a common "mission language" also is important in dealing with heterogeneity, not only to enhance efficient communication of ideas during work activities and emergencies, but also to improve bonding with fellow crewmembers through a better understanding of the connotations of their speech and the meaning behind their comments and jokes.

A final issue deals with the different roles of the identified leader. Research in the Antarctic and other isolated and confined environments on Earth suggests that the leader has at least two major functions in a group. The first deals with setting the agenda and getting the work done: the task role. The second deals with supporting the team and paying attention to group morale: the support role. These aspects of leadership take on more or less importance at different times during the mission. For example, during emergencies, the task role is crucial, whereas during monotonous periods, the support role becomes more relevant. Ideally, the commander of a space mission is comfortable with both roles and knows how and when to use them.

* * * *

Psychosocial Research On-orbit

My colleagues and I have conducted two international on-orbit studies of psychological and interpersonal issues that have affected crewmembers and mission control personnel during a series of missions to the Mir and International Space Stations[3]. Each mission lasted four to seven months, and there typically were two or three permanent crewmembers in space during each mission (we didn't study visiting Space Shuttle crews since their missions tended to be less than two weeks in duration). Four areas were studied: changes in mood and group social climate over time, displacement of group tension to outside monitoring personnel, cultural differences, and the relationship of leadership role to cohesion. The Mir study sample involved five American astronauts, eight Russian cosmonauts, and 42 American and 16 Russian mission control personnel. The ISS study sample involved eight American astronauts, nine Russian cosmonauts, and 108 American and 20 Russian mission control personnel.

Weekly, subjects completed a research questionnaire that included items from three well-known and validated psychological measures: the Profile of Mood States, the Group Environment Scale, and the Work Environment Scale, as well as a Critical Incident Log where they could inform us of important positive and negative events that had occurred. The results and conclusions using these measures were

nearly identical in both the Mir and ISS studies.

In terms of time effects, we found no significant changes in mood or interpersonal environment as each mission progressed. Specifically, there was no increase in tension or decrease in group cohesion after the halfway point, nor was there any evidence to support the general presence of the third-quarter phenomenon, which was discussed above. How to explain this unpredicted absence? We believe that it was due to the fact that the crewmembers were supported by space psychologists and flight surgeons in mission control on Earth who utilized a variety of countermeasures to help them deal with boredom and monotony as their mission progressed. For example, whenever it was felt that a crewmember was becoming homesick or despondent, he or she was encouraged to communicate with family and friends on the ground via audio-video links or e-mail in order to bolster his or her morale. Also, surprise presents, favorite foods, and letters from home were sent up during resupply missions. These activities may have helped to blunt the effects of monotony and homesickness on-orbit. In contrast, this intensity of support has been difficult to maintain during some space-analog missions on Earth, such as the winter-over period in the Antarctic, where communications and resupply opportunities are limited by the harsh weather conditions.

In both studies, there was strong evidence for the occurrence of displacement in both crewmembers and mission control personnel. In advance of the studies, we identified six subscales (e.g., Tension-Anxiety, Anger-Hostility) that we felt were indicative of stress affecting our subjects, and we predicted that these subscale scores would correlate negatively with scores from a measure of perceived support from outside supervisors. We reasoned that if subjects were experiencing high internal stress, they would displace this onto the outsiders and perceive them as not being very supportive. As predicted, all six correlations occurred and were significant, with the effect being stronger in the isolated crewmembers than in the mission control subjects, who had the opportunity to reduce job-related stress when they went home to relax after work (the astronauts and cosmonauts were not afforded this luxury, being isolated and confined together continually during their mission). So just as on Earth, people involved with space missions tend to displace their tensions and interpersonal problems onto others. Of course, it would have been better if they could have identified the causes of intra-psychic and intra-group stress as they occurred, and then applied strategies of dealing with these causes directly. In this way, some of the psychological stress could have been ameliorated before it could fester and possibly interfere with the crew-ground relationship.

In looking for possible cultural differences between Americans and Russians, we found that the former experienced significantly more work pressure than the latter, which may have been influenced by national differences between these two groups of people. For example, the American subjects might have felt more pressure to perform than the Russians due to on-the-job expectations rooted in typical American attitudes about competition and achievement. However, it is also possible that these differences reflected different organizational cultures that are characteristic of the two space agencies. Some writers have suggested that the American space program relies more on written procedures and the maintenance of redundant systems to deal with potential problems, as compared with the Russian space program, which utilizes expert opinion from the ground to address issues as they arise. Consequently, American astronauts might have experienced more work pressure than their Russian colleagues as they tried to deal with various procedural activities in a timely manner.

In both studies, the crewmembers reported significantly lower levels of negative emotions (i.e., dysphoria) on several mood subscales than mission control personnel. This result may be explained by personality differences between people who become astronauts and cosmonauts and people who work in mission control, with the former characteristically experiencing less emotional distress in response to their work environment than the latter. In addition, people in mission control received less psychological support than the on-orbit crewmembers. Interestingly, both crewmembers and mission control personnel

scored significantly lower on most dysphoric subscales than groups of people on Earth who worked in non-space-related activities. Again, this might have reflected the kinds of people who end up working for space programs, or perhaps working on space missions is more exciting and fulfilling than other jobs.

In both studies, the mission control subjects significantly related the task and support roles of their leader to group cohesion, as we predicted. Although crewmembers perceived a significant relationship between the support role of their mission commander with cohesion, they did not endorse a relationship between cohesion and the task role of their leader. This might have been an artifact of crew size. As mentioned earlier, the space station crews that we studied consisted of only two or three people, and in such a crew each person has specialized job skills that make them each a leader in those areas that are related to these skills. Consequently, there is not the same type of leadership hierarchy that exists in crews of six or seven people. In addition, in such a small group in space, one's social network is limited, and it is important to be cordial and supportive of your fellow crewmembers in order to avoid feeling isolated. Thus, cohesion in such a small group would be expected to be more sensitive to support from the leader than to his or her specific task-related activities.

Of the 92 critical incident ratings we received from the ISS Critical Incident Log, 21% referred to positive issues (e.g., holiday celebrations, cohesive actions); 17% to expected events (e.g., dockings, extravehicular activities); 55% to negative issues (e.g., equipment failures, psychosocial problems); and 7% to neutral or unclear issues. Looking at just the negative log entries, 47% described interpersonal problems and 18% described psychological problems that affected individual crewmembers. Thirty-eight percent of the entries indicated that the event increased both their personal level and the group's level of tension “a little,” which was double any other category of impact.

* * * *

Positive Aspects of Being in Space

The concept of salutogenesis, or the health-promoting, growth-enhancing effects of a challenging situation, is a fairly recent one. The term refers to processes whereby powerful experiences enhance or bring about well-being and personal growth. Some people gain strength and wisdom from successfully coping with stressful situations, especially when the situation is deliberately sought out.

Isolated and confined environments can be growth-enhancing. Several writers have discussed the salutogenic reactions some people have to the adverse conditions found in polar environments, such as increased fortitude, perseverance, independence, self-reliance, ingenuity, comradeship, and decreased tension and depression. In a similar manner, some astronauts and cosmonauts have reported transcendental experiences, religious insights, or a better sense of the unity of humankind as a result of being in space. We need to pay more attention to positive psychology and salutogenesis in the operational planning for future space missions

In an attempt to further examine the positive aspects of space flight, my colleagues and I conducted a questionnaire study involving astronauts and cosmonauts who had participated in at least one space mission. Subjects were recruited anonymously from two sources: the Association of Space Explorers (an organization of people who have flown in space) and the current NASA astronaut corps at the Johnson Space Center. The final sample consisted of 39 respondents, who then completed our Positive Effects of Being in Space questionnaire. This measure consists of 36 items that assess areas of personal growth likely to be influenced by space flight. The questionnaire was designed to measure change as a result of being in space, and change for each item was scored using a 6-point Likert scale ranging from 0 ["I did not experience this change"] to 3 ["a moderate degree"] to 5 ["a very great degree"].

We found that every respondent reported at least some positive change as a result of flying in space. On average, this was reported as being “small.” The items clustered into eight subscale categories:

Perceptions of Earth, Perceptions of Space, New Possibilities, Appreciation of Life, Personal Strength, Changes in Daily Life, Relating to Others, and Spiritual Change. Of these, only one was significantly different from the others and produced a “moderate” level of change in the subjects: Perceptions of Earth. One of the items in this subscale, “I gained a stronger appreciation of the Earth's beauty,” had the highest mean score, with the average rating indicating a “great degree” of change. This implied that people working in space and seeing the Earth below developed a new perception of their home planet, gaining a stronger appreciation for its beauty and fragility.

For some of the specific items in this questionnaire, elements of attitude change seemed to translate into behavioral change after the respondent returned to Earth. For example, three of these items ("I realized how much I treasure the Earth,” “I learned to appreciate the fragility of the Earth,” and “I gained a stronger appreciation of the Earth's beauty") were significantly associated with the behavioral item “I increased my involvement in environmental causes” after returning.

Interestingly, 10 of the respondents indicated that they were reporting no change in at least one item because no further shift was possible (i.e., the described experience was already optimal for them and could not be enhanced by being in space). The item most frequently designated as unchangeable was “I became more excited about space exploration,” followed by “I have a better understanding of spiritual matters” and “I have a stronger religious faith.” Since the last two items were part of the Spiritual Change subscale, this contributed to the relatively low change score for this category.

The results of this study suggest that space travel is a meaningful experience for the participants. Every respondent had a positive reaction to being in space. The items that were endorsed most frequently, and with the greatest amount of change, were those in the Perceptions of Earth subscale. This was reinforced by some of the qualitative responses written in at the end of the questionnaire, which suggested that the view of Earth inspired a sense of awe and wonder rather than a spiritual awakening (which was also consistent with the low ranking of the Spiritual Change items). Perhaps this reflected an appreciation and longing for the familiar comfort of a natural environment from a space habitat that may have been perceived as confining and sterile. Although respondents endorsed positive changes in all seven of the other subscales, these changes were rated on average as between “very small” and “small” and did not make such a great impression.

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Psychiatric Issues in Space

Most of the issues I have discussed until now have focused on the normal psychological and interpersonal reactions made by people to the novel conditions of an off-Earth environment. This section will focus on psychiatric reactions, which are abnormal responses to these conditions. In a given person, genetic, constitutional, and developmental vulnerabilities may contribute to the presence of psychiatric difficulties. However, operational mission stressors (e.g., confinement, periods of danger and high activity, microgravity, radiation) and psychosocial factors (e.g., crew tension, cohesion, leadership issues, cultural and language differences) also may play a role and need to be taken into account.

Severe emotional problems have occurred in the less carefully screened populations participating in space-analog environments. One report suggested that 3% of naval personnel stationed in the Antarctic developed psychiatric problems, versus 1% of similar personnel based in less remote locations. In a review of the Australian Antarctic experience, it was concluded that mental disorders accounted for 4-5% of the total morbidity, with severe psychotic and neurotic illnesses being lower than 4%. Mental illness occurred most frequently during the confined wintering-over period.

A number of psychiatric problems also have been reported from space. Most commonly reported are adjustment reactions, which present with uncharacteristic emotional symptoms like anxiety or depression

in response to identifiable psychosocial stressors. Often, these symptoms resolve within six months of treatment or termination of the stressors. For example, one astronaut beginning a long-duration space mission reported symptoms of clinical depression due to the isolation he felt on-orbit and his separation from his wife and family. These symptoms resolved as he adjusted to his new environment.

Psychosomatic reactions also have been reported from space. These consist of distressing physical symptoms that suggest the presence of a medical condition but which are not fully explained by a real physical problem. For example, a cosmonaut wrote in his diary that he experienced tooth pain following some anxious dreams he had of a tooth infection and his concern that nothing could be done about such an infection while he was on-orbit.

Problems related to major mood and thought disorders (e.g., bipolar or manic-depressive disorder, schizophrenia), which are thought to have genetic or familial determinants, have not been reported during space missions, probably because potential space travelers are well screened psychiatrically for predispositions to these psychotic conditions. However, such severe psychiatric disorders have been reported in astronaut applicants, as well as in up to 5% of people working in some space-analog environments.

Post-mission personality changes and psychiatric problems have affected returning space travelers as well. These have included major depression, anxiety, and alcohol abuse that have necessitated psychotherapy and psychoactive medications. Depression also affects the spouses of people returning from long military or space-related absences, as the returning members and their families try to readjust to the stress of each other's presence after months of separation.

Asthenia is another important condition that affects people in space. This syndrome is defined as a weakness of the nervous system that may result in fatigue, irritability and emotional lability, attention and concentration difficulties, restlessness, heightened perceptual sensitivities, palpitations and blood pressure instability, physical weakness, and sleep and appetite problems. Russian psychologists and flight surgeons have viewed asthenia as a major problem that affects most cosmonauts participating in long-duration space missions, and they have developed a number of countermeasures to deal with it before it worsens. Although first described as “neurasthenia” in the late 1800s by the American George Beard, there is controversy as to the existence of asthenia since it is not recognized in the current American psychiatric diagnostic system. Instead, many of its symptoms are incorporated in diagnoses related to anxiety and depression. However, asthenia appears in the diagnostic system used in Europe, China, and Russia.

A few years ago, one of my colleagues, Dr. Jennifer Boyd, reexamined our on-orbit data to see if there were any differences in the pattern of mood states that were exhibited by American and Russian crewmembers. The reasoning was that in the Russian culture, where asthenia is accepted as a syndrome, there might be an association between depressed mood and fatigue, since these two states should covary according to the asthenia model. In contrast, in the American culture, neurotically-based depression might be expected to covary with anxiety, which would be predicted according to the diagnostic system used in the United States. Combining both the Mir and ISS data sets, she found that for the Russians, measures of depression and fatigue were significantly related, whereas the relationship between depression and anxiety was not significant. For the Americans, the relationship between depression and anxiety was significant, whereas the relationship between depression and fatigue was not. These results confirmed our predictions that Russian crewmembers would experience depression in the context of fatigue, which would be consistent with the asthenia construct. In contrast, Americans would experience depression in the context of anxiety, which supports a culture-bound pattern of mood that is consistent with the American model of neurotic depression. These findings suggest that patterns of mood states in space crewmembers may reflect national cultural norms, and further work in this interesting area needs to be done.

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Relevance to a Mars Expedition

Although the above comments have relevance for future on-orbit missions and even trips to the Moon, caution must be used in extrapolating any conclusions to expeditions beyond the Earth's neighborhood, such as an expedition to Mars. There are several reasons for this. A Mars crew will be millions of miles away from Earth on a mission lasting close to three years in duration. This will create a situation where crewmembers will experience a severe sense of isolation and separation due to two-way communication lags of up to 44 minutes at the most extreme distance of Mars from Earth, infrequent resupply, and impossibility of evacuation during a medical or psychiatric emergency. Consequently, these crewmembers will be much more autonomous from mission control on Earth than space travelers involved with on-orbit or lunar missions, and they will have to plan their own schedules and deal with their own emergencies. They also will be more dependent on on-board and planetary resources for food, water, and fuel. Support based on real-time communication with family, friends, and counselors on Earth will not be possible. The increased isolation and mission duration may impact on their psyche and produce a severe sense of isolation, monotony, and homesickness. Finally, no human being has ever perceived the Earth as an insignificant dot in the heavens, the so-called “Earth-out-of-view phenomenon.” As mentioned earlier, the pleasures derived from seeing the Earth as a beautiful sphere in space are very important to space travelers, and the absence of this experience during much of an expeditionary mission may impact negatively on crewmember psychology.

More research needs to be done under Mars-mission-like conditions to evaluate the effects of distance, time, and autonomy on crewmember mental health. This research can be done in Mars-analog environments on Earth, on the International Space Station in space (which can simulate in microgravity the outbound and return phases of a Mars expedition), and on the Moon (which can simulate in partial Earth gravity activities on a planetary body). But from what we do know to date, a number of lessons have been learned that suggest ways to deal with some of these psychological, interpersonal, and psychiatric issues.

* * * *

Countermeasures to Deal with Psychological Issues in Space

These countermeasures can be organized in terms of crew selection, pre-launch training, mission monitoring and support, and post-return readaptation. Crews should be selected to include people who are sensitive to both psychological and interpersonal issues and can problem-solve around psychosocial difficulties. They should be comfortable working alone on a project when necessary, but they should also enjoy interacting with their teammates and value teamwork in general. Commanders should be picked who have shown skill in using both task and support leadership roles flexibly in accordance with the needs of their team. They also should be sensitive to the impact of psychosocial issues and cultural factors (both national and organizational) on individual and crew behavior.

Crewmembers and mission control personnel should receive pre-launch psychosocial education training aimed at recognizing and dealing with important psychological and interpersonal issues. Specific topic areas for this training should include: the psychosocial factors that can affect isolated and confined groups, the relationship between crewmembers and mission control personnel (including displacement), the impact of national and organizational cultural differences on the mission, and the appropriate use of leadership. For expeditionary missions to Mars, ways to deal with autonomy and time delays in communication should be considered. Training should utilize both didactic and experiential techniques. Some of the pre-launch training should involve both crewmembers and key mission control personnel working together in simulated mission scenarios.

During the mission itself, crewmembers and mission control personnel should take computer-based psychosocial education refresher courses to remind them of key issues discussed prior to launch. For crewmembers, such in-flight training should be done shortly after entering space and midway through the mission, and perhaps even more frequently during multi-year expeditions. Crewmembers and mission control personnel should pay attention to the stressors involved in each other's jobs and periodically take the time to discuss the progress of the mission and their ability to communicate with each other clearly and openly. These “bull sessions” may especially be useful for crews on expeditionary missions to help them deal with autonomy and festering interpersonal problems. Such crews also may value an on-board telescope with which to see the Earth in real time. Strategies need to be developed to allow crewmembers to communicate efficiently with people on Earth during time-delayed conditions (e.g., e-mail messages that list specific questions at the end to which the recipient may reply in order to save time). Families at home need to be supported during the mission, both informally (e.g., peer-led support groups) and formally (e.g., individual and group counseling with a trained therapist).

Finally, post-return readaptation debriefings and supportive activities (e.g., individual and family counseling, time alone with families) should be employed to assist the crewmembers in readjusting to life on Earth. Especially for high-profile on-orbit or lunar missions or for the first expedition to Mars, dealing with issues of fame and glory should be discussed, and the privacy needs of both the astronauts and their family members should be respected.

All ideas, results, and conclusions that are mentioned in this review are the responsibility of the author and are not necessarily endorsed by NASA or any other space agency.

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Notes:

1 For references and a more complete discussion of psychological issues in space, see *Space Psychology and Psychiatry, 2nd Edition*, Nick Kanas and Dietrich Manzey, Microcosm Press, El Segundo, CA, and Springer, Dordrecht, The Netherlands, 2008.

2 This image is from Johannes Bayer's great star atlas, *Uranometria,* first published in 1603. It depicts the constellation Bootes, the herdsman, who was placed in the heavens by the ancient Greeks. In a sense, he was one of the first astronauts in space. Courtesy of *Star Maps: History, Artistry, and Cartography*, Nick Kanas, Springer-Praxis, Chichester, UK, 2007.

3 My colleagues at the University of California, San Francisco, have included: Jennifer E. Boyd, Ph.D.; Ellen M. Grund, M.S.; Eva C. Ihle, M.D., Ph.D.; Charles R. Marmar, M.D.; Stephanie A. Saylor, M.A.; and Daniel S. Weiss, Ph.D. My colleagues at the Institute for Biomedical Problems in Moscow, Russia, have included: Vadim I. Gushin, M.D., Ph.D.; Olga P. Kozerenko, M.D.; Vyacheslav P. Salnitskiy, Ph.D.; and Alexander Sled, M.S. This work was conducted under NASA contracts NAS9-19411, NAS9-98093, and NCC-0161.

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About the Author:

Dr. Kanas is a Professor of Psychiatry at the University of California, San Francisco. He is a NASA-funded Principal Investigator, and for nearly 40 years he has written about the psychosocial issues affecting humans in space. He also is an amateur astronomer, an avid science fiction reader, and a collector of antiquarian celestial maps. He has over 200 publications, including (with Dietrich Manzey) *Space Psychology and Psychiatry* (which won the 2004 International Academy of Astronautics Life

Sciences Book Award and is now in its 2nd Edition); *Star Maps: History, Artistry, and Cartography*; and articles in professional journals and in magazines such as *Sky and Telescope*, *Mercury*, *Imago Mundi*, and the *Journal of the International Map Collectors' Society*.

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Reader's Department: **IN TIMES TO COME**

Our November issue features a dramatic cover by an old *Analog* favorite, Vincent Di Fate, for a two-part serial by G. David Nordley, *To Climb a Flat Mountain*. If you're marooned in an unfamiliar environment, obviously the first order of business is survival, which is even more of a challenge if, the more you learn about where you are, the less sense your surroundings make. The world Nordley has created here is one that shouldn't even exist, but he's done his usual admirable job of making it believable—and fascinating. Though that's not necessarily the first word his maroonees would use to describe it, especially when they also have to deal with others who have different ideas of how to cope with it....

We'll also have a wide variety of stories by such writers as John G. Hemry, Craig DeLancey, and Jerry Oltion, plus a fact article, “Rock! Bye-Bye Baby!” by Edward M. Lerner. A growing number of people are gradually and grudgingly recognizing that seriously Earth-threatening asteroids are not just ancient history, and we could find a new one headed our way at any time. But exactly what can we do about it? Lerner tries to point us toward some practical possibilities—which we could need on very short notice.

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Short Story: **THE HANGED MAN** by William Gleason

Some bygones are exceedingly hard to let be....

The man's card introduced him as:

Nathan M. Hedge
Doctor of Psychology

He appeared in my office unannounced, his skeletal fingers extending the bone-white card. He was elderly, decades past respectable retirement, his body long ago turned inward. The frail shoulders were stooped, the eyes were dull orbs deep-set in his skull. His funereal suit hung on him as if on a wire hanger.

"I am here about your pain," he said.

"Who sent you?" I demanded, angrily hoisting my heavy frame from my seat. "Did Angie send you? I told her I'm fine!"

He seated himself gingerly in a leather chair in front of my desk. "You are not," he said as he folded his gnarled hands in his tiny lap. "Decidedly not. Such bad dreams you have."

"So it *was* Angie!" I shouted, wagging my thick forefinger at him. "She's got no blasted business telling anyone what happens in our bedroom!" I dropped heavily into my chair. "My dreams are nobody's business!"

"You cannot ignore them," said Dr. Hedge. "They will not ignore you."

I squirmed in my seat, ran my hand over my ample jowls. "Just how much did Angie tell you?"

Dr. Hedge drew a papery breath. "I know all," he said. "But tell me. Tell me of the *b'reath.*"

Ten years ago the *Seeker*, our salvage vessel, docked for supplies at Halfway Station, that giant, glorified coffee can that spins in the vacuum between Sol and Tau Ceti. One night in the bar there I met a man who was obsessed with the *b'reath.* Like most spacers, I had heard of them, and like most I thought them no more real than faeries or unicorns, but to this fellow the *b'reath* were quite real.

He was cloaked in an identity screen that hid his face. That, along with his scarred, grease-stained hands and unsavory speech, marked him as the kind of mutt I usually tried to avoid. But I was drunk and a dark mood had fallen on me. It was a moment made for talk of horrible things, and my mysterious friend was most obliging.

"There is no more sinister species in the universe than the *b'reath,*" the man intoned as we drank our beers. "They're not much bigger than house cats, but insatiably bloodthirsty. They're better evolved for killing than any cat, too, with their long arms and their mouths a gruesome riot of teeth. They have serpentine tails, and muscular hind legs like a rabbit, and they travel in packs, attacking and killing anything they encounter. If you see them, mister, run. Run and don't look back."

"I have no fear of housecats or rabbits," I said, placing my hand on my sidearm. "Not while I've got a working blaster."

He laughed. "Then you'll perhaps be interested in the whereabouts of the *Aedon*, since it's naught but housecats and rabbits that stand between you and she."

The *Aedon,* another figure out of myth, a long-haul freighter gone missing decades ago: She was a prize

given up as lost even by many of us who still believed she ever existed. To those of us in the salvage business, the *Aedon* was one of the holy grails we dreamt of to keep us going. In the end, I bought the information from the man for a few rounds of microbrew.

* * * *

Thad Hegemann was my partner and my friend. We didn't talk much, but then again we didn't have to. We had spent years together onboard the *Seeker* with only each other for company. I doubt there was anything we didn't know about each other. I loved him like a brother, tolerated him like an odor that never went away, and I know he felt the same.

Now, though, almost all I can remember of him are his panicked eyes, his silently pleading mouth. At night the image of his face returns, etched in terror, and at times even in the full light of day that relentless mask of desperation haunts me, mocking me from within the mindless swirls of a wallpaper design or in the idle sweep of a length of carpet. That final instant is frozen in my mind, as the realization of his fate consumes him, unmans him, the instant before I turn away.

I lack the courage to imagine the horrors that came next for him. I freeze the image there, yet the vision haunts me. I had to return, not to save Thad—such was beyond all hope—rather I had to see his bones, to find some proof that his suffering had ended. The world could hold no color for me, or beauty, or love, while the hated memory pursued my every step. I had to know that he slept, so that perhaps he would at last abandon my dreams.

* * * *

Thad and I had worked together in the space salvage and rescue business for twenty years. You'd be surprised how many space vessels are forced to land on some remote piece of rock when something goes wrong. As more and more people decided they could afford their own space yachts, business boomed. Thad and I were raking it in.

But this time it wasn't some senator's joy-riding daughter we were looking for. The directions the stranger had given me led us to Despera, a moon of Sceptre in the Beta Wreath. In the view screen, Despera was a frozen orb, a grubby pearl dangling before Sceptre's black enormity. Remembering the man in the bar, I felt cold inside as it loomed larger in the view screen. “There are *things* on Despera,” he'd said. *"Terrible things."*

I wish we'd never found the *Aedon*. Oh, how I wish that! But like some behemoth summoned up from ancient fables and somehow made real, there it was, just where the man had told me it would be. And just as he'd promised, it lay like a fallen beast at the center of a great nest of those terrible things, the *b'reath*.

The *b'reath* are without a doubt obscene. Using long-range scanners, Thad and I studied them from orbit. Their ferocity was not in question. We held a healthy respect for their rapacity. But as terrible as they seemed to us, as nightmarish as indeed they are, we had not yet understood the true depth of their evil.

To us, in the final analysis they were merely animals—nasty brutes to be sure, but we were men of science, grizzled appearances notwithstanding. We were positive there was no ignorant beast so vicious it could not be overcome by technology. From our perspective, the *b'reath* pack had simply settled in an unfortunate spot for *them*, in the remains of a crashed freighter that had great value for *us*. There was never any doubt. Without a second thought, Thad and I agreed: we had to go down.

Our goal as we descended in the glider was to be as quick and efficient as we could be. We had strobe emitters we thought would confuse and repel the murderous animals long enough for us set up a force

field around the downed freighter.We wore reinforced suits we were certain could withstand their sharp teeth and claws. We were certain we were not underestimating them.

We were such fools.

* * * *

"Tell me," Dr. Hedge said in his whispery way, "exactly what you heard in the bar."

"The man said he encountered the *b'reath* on Despera," I recalled. "He said he'd done some research, said the creatureshave a hive mind—like bees or ants. Except that their collective mind is much stronger and more intelligent than that of any Earth insect—if anything so lustful for blood and terror can be called intelligence. He called them psychic vampires and said they have been seen on other planets and moons, but no one knows for sure how they have spread themselves throughout the galaxy. But I told Thad all of that!"

"Yes," breathed Dr. Hedge, "but that was not all that you knew."

"No!" I wailed, suddenly overcome with sorrow. "No, I knew more! The man in the bar—he said the *b'reath* slaughtered his entire crew, sparing only him, and he hadn't known why! But he'd done his research, until finally he'd understood! The *b'reath*—"

I looked into the doctor's rheumy, unflinching eyes. "The *b'reath* have a trait that separates them from all other of nature's horrors," I sobbed. "They always let one of their victims go. You see? *Theyalwaysleave a witness to their murders alive!* So I knew, when we landed in that pit of hell, that at worst only one of us would die: whichever one they took first!"

* * * *

The *b'reath* fell upon us—a mindless, slashing torrent—when we were but a few steps from our glider. The strobes had no affect, except perhaps to further enrage them. Their talons clutched at my facemask, powerful jaws closed on my shoulders and limbs, razor-sharp teeth tore at my suit. I staggered under the weight of them.

Pure chance placed the stone where my foot sought purchase. My ankle folded beneath me and I was thrown awkwardly to the ground. For an instant I was separated from my attackers, and as my panicked eyes darted frantically about, the awful truth became clear. Terror shot through me like a bolt of lightning.

Thad stood alone a few paces away, unmolested by the *b'reath*. The evil creatures were circling me, *onlyme! I* was their intended victim!

I had but an instant to think before they descended on me again. I no longer trusted my suit to protect me. In time the *b'reath* would breach it, or crush my every bone trying. I had no choice. I grabbed my pistol, lifted it, fired.

It was a true shot. The beam burned neatly through Thad's left thigh.

Perhaps it was the smell of blood that drew the *b'reath* to him; maybe they simply sensed that Thad was now the more vulnerable. But they turned away from me as if they were one creature, and rolled instead onto him, a wave of writhing, gray death, all biting teeth, slashing claws, and snapping tails.

Thad disappeared beneath that mass of alien fury, but not before I saw his face, the disbelief,the silent plea, and perhaps in the deepest recesses of his panic-stricken eyes, the first spark of hatred.

The *b'reath* ignored me as I limped back to the glider and left that bedeviled place behind. I was sure it would be forever, but my mind would not let it go, forever whispering that I had to return. In the end I

accepted it as inevitable.

* * * *

Yes, I would return, my very sanity demanded it, but not as a martyr. I would see for myself the proof of Thad's demise and, if possible, collect his remains for decent burial.

I builtan armored tank with the money Thad bequeathed me. Thad hadn't had any family or other close friends, so I wasn't surprised to be in his will. It was, however, a surprisingly large sum, so maybe he had been holding out on me. Still, it seemed only fitting that I spend the money to build the mobile fortress that would allow me to return to Despera.

The sanctuary was designed to be airtight, armed, and impregnable. It could not be opened from the outside when sealed from within. I spared no expense on materials—gnaw on it for a thousand years, the *b'reath* would never scratch the surface of the reinforced metal casing or the tough transparent polymer windows.

It was a long trip, most of which I spent in stasis. I actually felt quite optimistic on the day I entered the sleep chamber. If it counts for anything, the expedition was an honest bid for atonement. And I thought perhaps the trip wouldn't be a total loss. There was the possibility the *b'reath* would be gone. Perhaps I'd finally be able to strip the *Aedon*.

But, of course, the *b'reath* were not gone. They remained where last I'd seen them, surrounding the freighter like a coven of furry, mutated reptiles. As I watched them from orbit, flitting about like giant rats through the shifting bits of shadow, I wondered how they survived: What did they eat and drink on that barren orb?

Like an automaton, hardly aware of what I was doing, I made preparations for our reunion.

* * * *

My hands were sweating at the controls as I drove the tank out of the modified glider. Instantly, the *b'reath* attacked, slamming against the hull like a deluge of giant hailstones. *B'reath* bodies draped the vehicle, their maniacal eyes glaring hungrily at both side portholes and through the front pane. Tentatively, I pushed the joystick forward and the tank lurched ahead. I knew the bumps I rolled over were the bodies of *b'reath* pulled under the treads, but still they piled on.

Nervously, I turned to my weaponry, triggering a hull pulse. The first pulse set off an angry writhing among my attackers, but they clung determinedly to the hull. I stabbed the button again and again, sending waves of agonizing energy through the bodies piled on the tank. I watched in horror as the faces at the windows slowly died, as the fury faded at last from their eyes—and then I watched in disgust as the vicious beasts leapt upon the fallen in a cannibalistic frenzy, tearing apart their own injured and dead. Then new *b'reath* faces appeared at the windows, twisting in torment and rage as I continued to shock the hull.

With trembling fingers I pushed the joystick again and moved forward over the fallen creatures. Although I knew it was impossible, I fancied I could hear bones crunching beneath the tank's great weight.

Nearing the downed freighter, I became aware of a cave a short distance away. On impulse I turned toward the dark opening, and as the tank rolled into that black orifice, the *b'reath* melted away as if the cave held horrors so great it daunted even them. I activated the sanctuary's flood lamps and light poured out, illuminating a scene far worse than any ever imagined by Dante in all his musings on Hell.

Thad's body decorated the far wall of the shallow grotto, draped across a crude metal cross like a weather-beaten scarecrow in a Kansas cornfield. The flesh of his extremities had been eaten to the bone.

His skeletal arms, jutting from an emaciated torso, were lashed to the horizontal crossbeam. His legs were twisted sticks dangling loosely from the stumps of his shriveled thighs like dead tree limbs hanging from the roof of a forest after a storm.

His head was slumped forward. The fetid surface of his pate was an eruption of lesions dusted with spidery wisps of hair. What skin remained on that dome clung like torn parchment. Islands of brownish bone peeked through the withered flesh.

In the dim recesses of the dark cavern darted what I deemed to be a different species of *b'reath*, larger than those that remained outside, with glowing eyes that studied me from the gloom. These apparently had been Thad's hosts this last decade.

How long had he hung like that, I wondered, before he had died? But, no, I thought, he would have died soon after they pulled the suit from him. He could not have lived long enough to know how they had hung his body like some grisly ornament, or to feel the flesh torn from his limbs. This thought gave me some small solace. My friend was dead, but he had not unduly suffered. I had to believe that.

I was eager to be away. The gruesome remains were an unnecessary reminder of the risk I was taking. I had achieved my purpose. There was nothing I could do for Thad now but provide for a decent burial. Although I dared not leave the safety of the tank to retrieve his body, the vehicle's design included claws that could collect the remains.

But as I reached for the joystick, the tank's engine died. Light still flooded the cave, the batteries were fully charged, but the motor would not start, though I cranked feverishly at the ignition. Such a thing should not have been possible; I had spent a small fortune to ensure it could not happen. Yet despite my every effort, the engine remained as still and quiet as the grave.

Cold sweat sprang up on my plump face, ran icily down the back of my neck, pooled under my arms. My mouth was dry as sand and filled with a bitter taste; I could hardly swallow. I was frozen in panic, my eyes locked on my erstwhile partner's mutilated corpse, my mind empty but for the growing realization that I was trapped. The *b'reath* might never reach me inside my fortress, but I was nonetheless doomed. All that remained was to see how long my air would last.

The first movement was so slight that at first I thought it merely a hallucination conjured up by my terrified psyche. But as I continued to watch I realized that it was no illusion—slowly, millimeter by millimeter, Thad was lifting his ravaged head, until at last I could see what remained of his face.

It was a ghastly sight. Most of the skin had been stripped away to reveal the skull beneath. His jawbone was fully exposed and dangled loosely; his nose was a gaping wound. Thin, leathery skin still clung to his forehead and cheeks, but the eyes themselves had been plucked, leaving empty, black holes that nonetheless seemed to stare at me.

Desperately clinging to my sanity, I thought: *This cannot be!* The atmosphere on Despera was toxic. There was no food, no water. It had been more than ten years. He could not be alive! It was a trick; it had to be a trick. I would not believe it.

From within the tank, which now seemed more tomb than sanctuary, I watched as a wispy fog began to form. It reached out with spidery, gray tendrils to caress Thad's ruined body, casting a sickly yellow light as it drifted around him. I continued to watch in mute horror as the mist began to coalesce before the cross, becoming a pale man-shaped frame of light that roiled like smoke in an eddy of wind. It gathered and shattered and reformed again, seeming for one moment to be the image of Thad, before finally coalescing into the living cadaver that is Dr. Hedge.

I was sure my mind could take no more. My brain seemed to be trembling within my skull as Dr. Hedge took a shuffling step toward me, and then another, until he stood a few scant feet away with only the window pane between us. Then he took another step, passing wraithlike through the walls of my tank as he entered my refuge. I pressed my bulk against the wall, cringing from him as he seated himself delicately on the seat beside me.

Wordlessly, he extended his frail, white hand; in it he held a bone-white card. Unbidden, my own beefy paw reached up to take the card from him, and I glanced down at the words printed on it:

Nathan M. Hedge

I glanced at Dr. Hedge in confusion, but he merely nodded at the card I held, and my eyes looked back. Now the letters seemed to swim before my eyes, as if my trembling fingers had dislodged them from their spaces, until they had rearranged themselves to spell a new name:

Thad Hegemann

A gasp escaped my lips as the import sunk in. Had the agony of the past decades so ravaged and mutated Thad's soul that he could fling it across the galaxy to haunt me? Had his hatred for me grown so powerful that he could send this apparition, this doppelganger, across the light-years to find me and bring me back? What alien magic did the *b'reath* possess that could make such an unthinkable thing possible?

The man in the bar had believed that the *b'reath* use fear like threads in a psychic web that they spin throughout the galaxy, weaving together the minds they have touched with their foulness. He suggested that this is how they survive, and how they travel from world to world. I did not believe him then, but I believe him now.

I had thought there could be no more surprises, but then the letters on the card began to shift once more. As they reformed, I knew that it was all true, that all hope was utterly lost. Now the letters on the card spelled:

The Hanged Man

I remain alive only to write this story, since I am here alone and there is no one else to spread word of the unbridled evil of the *b'reath* of Despera. When I have finished my tale, I will be dragged from the tank. Dr. Hedge has made that clear, and I have no reason to doubt that he can deliver me to the waiting embrace of the *b'reath* whenever he chooses to do so. The tank cannot be opened from without, but it is easy to open from within.

I do not know how they can keep a man alive in this noxious pit, but I know that soon I will take Thad's place, that it will be on my flesh and blood that the *b'reath* will feed. Already in my fevered imagination I can feel their foul grip as they hoist me onto the dreadful cross, can feel their razor-sharp teeth nibbling at my flesh. I have grown fat in my retirement; I will take much longer than Thad to consume. My agony will last far longer.

Too soon, my story has run out of words. I turn to Dr. Hedge, but my intended plea for mercy dies unspoken. For the first time since I have known him, he is smiling.

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Reader's Department: **BIOLOG: RICHARD A. LOVETT** by William Gleason

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William Gleason's life has been a lot like the plot of some classic movies. “I'm the guy who starts in the mailroom and works his way up,” he says. He's talking about his day job, which literally started in the mailroom of a company that creates test materials for grade schools and high schools, and wound up as senior director of editing—but he might as well be describing his literary career. In high school, his class picked him as poet laureate. During a brief stint in community college, he edited the student newspaper. Later, he wrote for a humane society newsletter and wrote three “bad novels” that he says taught him a lot.

"I've always been kind of into writing,” he says.

Writing science fiction had been a dream since the 1970s, when, during elementary school, he discovered Lester Dent's Doc Savage books. He then progressed to Asimov, Heinlein, and Bradbury. “I wanted to feel like I was part of that fraternity,” he says.

Unlike many *Analog* writers, though, he's not a scientist. So again, the “mailroom” was the way he had to come into the field. “I really don't have any training in the sciences,” he says, “so I spend a lot of time doing research."

He collected rejection slips in the 1980s, but then got too busy for fiction writing until he was able to convert his day job into free-lance work from his San Antonio home. That freed up the necessary time while still keeping him from starving. By then, he was also frequenting *Analog*'s website, swapping message-board posts with the pros. *Analog* regular Tom Ligon offered to critique a story ... and the result, “Into That Good Night,” appeared in April 2008.

Great stories, Gleason believes, serve two purposes. One is to entertain. “I want [the readers] to enjoy an adventure,” he says, “to get out of the humdrum of their usual world and spend a little time in a future world.” But he also thinks science fiction stories can carry an inherent message of hope. “If I write a mystery story, based in a city on the Moon, there's hope just in that—that we actually are capable of building a city on the Moon."

He also likes stories to be about character. “If you think about the characters that really touch you,” he says, “they're characters like Charlie from ‘Flowers for Algernon,’ or Ender from *Ender's Game*, where you build up a real empathy for the character."

Good characters contribute to even the best idea's believability, he adds. “The science fiction seems more real if the characters are more plausible."

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Short Stories: **TEDDY BEAR TOYS** by Carl Frederick

When you get good enough at simulating reality, it can get dangerously hard to tell the difference.

As he'd done every evening for the last two years, Niel keyed his day's thoughts into his lifebook. Fortunately, he didn't have to enter his external reality; his micro-cam, with its voice and image recognition technology, took care of all that. He looked down at the tiny device pinned to his shirt, with its all-seeing fisheye lens. It always made him feel like a walking film shoot.

Waiting for the beep indicating that the cam had completed its upload, he checked his watch. 20:30 hours. He still had a little time before having to run off to meet Dennise outside Teddy Bear Toys. He bit his lip, speculating on whether he'd be able to convince his friend to help him snag a precious copy of *Phantom Warrior*.

Beep.

With a sigh, he glanced at the on-screen menu. He knew it was a bad idea to read the story generator results; he'd have to enter his thoughts on it and that would lead to recursion problems. But reading it was fun—just about the only fun left to him on this project. *And Kendrick always says, "Recursion is the key."*

Once more, he sighed. He'd been all but incoherent with excitement when, at age fourteen, he'd entered college and was chosen for the project. It was all about simulation theory and story generators. Professor Kendrick said that at such a young age, there wasn't much of a personal history to contend with, and only a kid can devote himself to a single cause.

But Niel wasn't a kid anymore, and the cause now seemed more like a chore, and lifebook technology, albeit in a simpler form, was everywhere.

Professor Kendrick had said, if you want a good simulation, simulate yourself, but Niel wondered at times who was simulating whom.

I wish I had a life—a real life.

Niel pushed back from the computer console, then darted to his dorm-room closet. Rummaging through the chaos, he found his headband-mounted LED flashlight. He'd need that tonight. Heading for the door, he caught sight of the computer screen and succumbed to temptation. At least he could see what the story generator program had come up with as its latest title. He swiveled back to his computer and hit a key.

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CONFRONTING DEATH AT TEDDY BEAR TOYS

Niel pocketed his headband flashlight and left the dorm. Hurrying, for he was short of time, he jogged toward Teddy Bear Toys, a freestanding toy store at the edge of the mall about a mile away. He passed a man with an ax sticking out of his head, and then a Frankenstein monster in a tuxedo waved at him. Even though it was only Halloween eve rather than the night itself, people still went about in costume. Halloween was an important time on university campuses.

As he neared Teddy Bear Toys, Neil saw an encampment in front of the door. An array of blankets and sleeping bags stretched for perhaps a quarter mile. And the campers mostly were in costume; the store had offered a 10 percent discount through the weekend for costumed customers. Niel wished he'd worn one himself. Even with the discount, *Phantom Warrior* was an obscenely expensive video game. But still

Niel had no doubt that the game would sell out within five minutes of the store's opening in the morning. And that opening was scheduled for five a.m.

A werewolf sidled up to him.

"Dennis?"

"Yeah," said the werewolf. "Now what's this big plan of yours?"

"Listen," said Niel in a conspiratorial tone. "I'm going to hide in the store overnight. When it opens, I'll join the mob running for the game counter. I'll be way up in the line, and I'm sure to get the game."

"You're nuts," said the Dennis-werewolf. "What about burglar alarms?"

"They have perimeter alarms," said Niel, breathlessly, "for the doors and windows. But my brother, he's a volunteer fireman. He told me that after a lot of false alarms, they took out their motion detectors. It seems modern toys have a tendency to move around from time to time. So I don't have to worry about setting off something."

"Nuts. N-U-T-S. Nuts!"

Niel, ignoring the discouraging word, went on. "And the windows have boxed-in displays and the door isn't glass, so no one will be able to see in from the outside."

"So," said Dennis, suspicion in his voice, "what does this have to do with me?"

"I'd like you to hide in there with me," said Niel cheerfully.

"What?" The werewolf's rubber muzzle shook. "Double nuts! No friggin' way!"

Inwardly, Niel smiled. Things were going as planned. "Then, at least," he said in a hurt tone, "at least help me."

"How?" The werewolf said the word almost as a growl.

"Provide a diversion." Niel leaned forward and continued at a whisper. "Something that will let me sneak into a kid's tent. The one set up in the Backyard Adventure Jungle. It's in the middle of the store right next to the Videogame Jungle."

"I really don't like this." The werewolf shook its head slowly, then sighed. "What kind of diversion?"

"Oh, I don't know." Niel spread his hands. "How 'bout an epileptic seizure?"

After a second or two of silence, the werewolf growled.

"What?"

"Werewolves don't *have* epileptic seizures," said Dennis evenly.

"Then ... then pretend you just swallowed a dime." Niel spoke through teeth all but clenched in frustration.

"Dimes don't have silver in them anymore."

"Come on, Dennis! Please." Niel stared at the now silent werewolf. It was disconcerting not being able to read his friend's expression. "Look. I'll let you play the game for three hours as soon as I get home with

it."

Still, the werewolf stayed silent.

"Four hours, then."

After another few seconds, the werewolf said, “Five hours."

"Okay, five hours,” said Niel hurriedly. “Is it a deal?"

"Oh, all right."

"Great!"

Dennis swung his muzzle around toward the encampment. “Look at them all,” he said. “What the heck is so special about *Phantom Warrior?"*

"It's sweet,” said Niel. “You can put yourself in the game. You upload your lifebook. And then you *are* the Phantom Warrior."

"Scary,” said Dennis as they sauntered into the toy store. “But that really *does* sound sweet."

Recursion is the key.

While Dennis lingered behind, Niel meandered through the store to the Backyard Adventure Jungle. At a signal, Dennis screamed, the sound both muffled and amplified by the wolf mask. He flopped to the ground, rolled onto his back and, while moaning, kicked the ground and pawed the air.

While a store full of goblins, witches, devils, spacemen, ex-presidents, and other monsters turned their attentions to the fallen wolf, Niel silently scrambled into the tent. Watching then from an opening in the tent flap, Niel saw a man in a white lab coat with a stethoscope swinging from his neck like an elephant's trunk.

"Give him room,” the man called out as he struggled through the crowd toward the werewolf. With many utterances of “Excuse me,” he pressed forward. “I'm an emergency medical technician.” Some in the crowd laughed. “Look,” he insisted, “The costume is real. I really *am* an EMT."

Dennis paused in mid kick and turned his muzzle abruptly toward the man. Then, as the EMT knelt and moved a hand to remove the wolf mask, Dennis howled, jumped to his feet, and ran screaming out the door.

Niel withdrew fully into the tent, slipped off his sneakers, and curled up like a cat: his usual position when sleeping in a cold bed or a sleeping bag.

A sudden decrease in the ambient light level woke him. In the instant of disorientation, he felt constrained in the small space—and feral, like an animal in its lair. As his mind followed his body awake, it added fear. From outside the tent came no comforting crowd noises. All was silent except for the sounds of walking. The specificity of a distinct person rather than a crowd was disconcerting. Niel, hearing his own breathing, tried to breathe lightly, shallowly, without sound or motion. He was cramped from being in a fetal position, but he dared not move.

"Shouldn't we turn off the displays?” came a voice, uncomfortably nearby.

"Why bother?” came a more distant voice. “We won't get out of here until ten, and we'd have to spend a half hour turning things on again at five am. I'd prefer to sleep for another thirty minutes in the morning."

"You got it," said the first voice.

Niel heard a click, and the darkness in his tent became complete. A few moments later, he heard the sounds of a door opening and then closing.

Niel waited motionless for a silent count of a hundred and then stretched straight, his legs slipping under the rear wall of the tent. He let out the breath he'd not known he'd been holding.

Pulling back the tent flap, he looked out onto the deserted and dark toy store—but not completely dark; flashing lights came from the Videogame Jungle, and less animated illumination emanated from shelves and display cases holding dolls, tech toys, teaching toys, and the store's distinctive teddy bear mascot.

Niel waited until his eyes had dark-adapted, then eased himself out of the tent. He stood, slipped on his headband LED, and turned it on. Then, realizing he didn't need it and spooked by the eerie whiteness, he switched it off.

He stood there, not knowing what to do next. Finally, he shrugged and started on a tour of the darkened store. He'd not been in a toy store in a while, and knowing that toy tech was second only to military technology, he was curious to see what was new.

He didn't see anything interesting in the Backyard Adventure Jungle. But as he left the area via the Valley of the Dolls, he saw a box labeled "Dog Nose." It had an illustration of a kid wearing what looked like an animal mask. Niel flipped on his LED to read the box. "A smell amplifier. Sweet!" Niel had an urge to buy it, and he would have had the store been open for business. In the dark store though, he felt like a burglar. He shined his light over the box, where a dog was sniffing at a pizza.

Niel remembered he'd not eaten before coming. "I'm hungry," he said aloud.

"Me, too," came several high-pitched voices.

Startled, he dropped the box and spun around. There was no one there—just sweet-looking dolls staring down from little cubicles. In the beam of the light, they looked eerily sentient.

Feeling foolish, Niel repeated, "I'm hungry."

"Me, too," answered several of the dolls.

Voice recognition and synthesis. Impressive! Niel walked over, read the explanation, and found he'd uttered one of the stock sentences that the dolls could recognize and respond to. He turned away and was surprised to see a doll that he'd not remembered being there. Moving his head, he saw that the doll was visible only when viewed head on. From the side, it was virtually transparent. Reading its label, he found it was an Imaginary Playmate doll.

Making the unreal real. He shook his head and went off to find some less surreal toys. And he found some: remote-controlled marbles—from the same company that made remote-controlled dice; a DVD lunchbox so kids could watch videos over lunch; Solitaire Monopoly; a music system that responded to a baton; Surfboard@home—a servoed surfboard that moved with a DVD of surf; Kite-cam; a self-writing pen that used a motor-driven pen tip and speech-to-text technology.

Startled by a movement from the floor, Niel looked down. *A cat! What's a cat doing here?* He stooped to pet it, but it darted under a display case. As he stood, he heard, or rather felt, a presence behind him. Feeling a sudden dread, he turned slowly around.

In the brittle white beam of the LED lamp, Niel saw a tall figure some seven feet away. It was clad

entirely in black: cloak, cowl, gloves, and even mask all in black. The figure rested one hand on the black pole of an enormous scythe, its metallic blade gleaming in the light.

Niel backed against the display case.

"I am deeeath," came a low, reedy voice.

Niel pressed himself against the case, feeling its edge cut into his ribcage.

"But you can call me Victor," the figure continued, now in an eager, bright voice.

"I'm ... I'm Niel. What ... Who?"

The Victor apparition extended a black-gloved hand, and Niel nervously shook it.

"I was resting on a game couch," said Victor, "when I saw the werewolf spaz out." He laughed. "Nice diversion. And then I saw you sneak into the tent."

"I was just..."

"I know," said Victor. "Getting a head start on tomorrow's game rush."

Niel smiled, sheepishly. He feared he'd made something of a fool of himself by his obvious fear. But then again, that Death costume was really effective.

"Anyway," Victor went on, "during all the excitement, I tried not to move. And when they closed the store, they ignored me. They probably thought I was a mannequin—that is, if they saw me at all." He shrugged. "So I decided to do what you're doing and camp out here. I would just about kill for a copy of *Phantom Warrior."* He glanced around the store, which appeared almost infinite in the murky darkness. "Come on. Let's explore." He leaned his scythe against the display case. "A toy store in the dark. Spooky."

Niel gazed at the image of death before him. "Yeah. Spooky."

Victor, with Niel following, left the dolls and strode into the Teddy Bear Zoo. "Hey, look at this," he said, stopping in front of a bear on a counter. He passed his hand in front of the plush creature's face. The bear growled and snapped its mouth closed.

"Yikes!" said Niel. "That's no teddy bear."

"Big Bad Bear," said Victor. "You can switch them so they're not cuddly. They snarl and bite. My sister has one in her dorm room." He turned to another display. "And here," he said, picking up a small box, "is the ultimate in ridiculousness."

Niel picked up one of the little boxes. It was labeled "Teddy Bear Toys."

"Toys *for* a teddy bear?" Niel said.

"You got it. Weird, isn't it?"

"Yeah." Niel turned over the box and looked at the tiny animal within. "An imitation animal as a present for another imitation animal."

Recursion ... again. Recursion and ambiguity.

"Who is the teddy bear," said Victor in a distant voice, "and who is the toy?"

"Halt!" came a sharp voice from behind.

Niel dropped the teddy bear toy and spun around. Victor swiveled as well.

"Halt! Put up your hands! I am not a toy!"

A three-foot-high wheeled thing pointed some sort of a gun at them.

Niel raised his hands. So did Victor.

"Warning!" said the thing. "I am not a toy."

"Wait a minute!" Victor dropped his hands. "It *is* a toy."

"How do you know?" said Niel, his hands still pointed up.

"Its gun," said Victor. "It's a GiggleBlaster."

"How do you know?"

"I have a kid brother."

Niel lowered his hands. "What's a GiggleBlaster?"

"I am not a toy," said the robot.

"Go away!" said Victor. The robot went.

Victor turned to Niel. "When you pull the trigger on a GiggleBlaster, it tells a joke. It projects it on a narrow beam of sound."

"It looked like a real gun," said Niel. "You know. It's hard to know what's really real anymore. I'm not even sure I know what real *is."*

"Like T-DNA, for example?" said Victor.

"Like what?"

"Toy-DNA. Robocat. Toys that mutate and evolve. That sort of stuff."

"Robocat?" said Niel, remembering what he thought was a cat. "I think I saw one."

"Just like a real cat, but its claws aren't sharp and you don't need a litter box. Rechargeable. Doesn't even eat batteries."

Niel was impressed. "How do you know about all these things?"

"I told you. I have a kid brother."

"Oh."

Victor glanced around. "There are entirely too many creatures running around on the floor of this toy store. I say we find a few game couches and spend the night playing videogames." He started toward the Videogame Jungle.

"I'm for that." Niel followed Victor to the boundary of the videogame area.

"Boy," said Victor, staring at the wonders of the jungle. "A whole night of playing videogames. This'll be great."

"I'll set my phone alarm to ring at four thirty," said Niel. "Just in case."

"Yeah. Good."

They settled in on adjacent Game Master couches and checked what games were on offer.

"Monsters of Mars," said Niel, reading the description. "A definite maybe."

"Be careful when you fight the monsters," said Victor, absently, while looking for a game for himself, "lest you become one. Nietzsche said that. And that game has crummy graphics."

Niel chuckled. "Okay, here's another one. *Monsters of the Abyss."*

"When you stare into the abyss, the abyss stares back at you. Nietzsche also said that."

Niel rolled his eyes. "Are you a philosophy major or something?"

"Well ... actually, I am."

Niel chuckled again. "Do all you philosophy majors go around quoting one-liners from famous philosophers?"

"It's a shorthand."

"A shorthand for what?"

"For nothing. It's just a shorthand."

Niel gazed at Victor, then decided to reply with some gibberish of his own. "But that's like talking about a reflection of reality—and you look around from the mirror and there's no reality."

"Yeah. So? Einstein said reality is merely an illusion." Victor's death mask looked sharply at Niel. "In fact, I read about this guy in England who says all of us are most likely not real. We think we're real, but we're actually just a big computer simulation." Victor leaned in toward Niel. "It was frightening reading."

Niel smiled, finally able to reply with a philosophy quote of his own. "Schopenhauer said reading is equivalent to thinking with someone else's head instead of with one's own."

"I wonder," said Victor, "if that applies to going to movies." He canted his head. "Hey? Are you a philosophy major too?"

"No," said Niel distantly. "Computer science." He felt uneasy about the notion of being a computer simulation. He hoped Victor would drop the topic.

"Hey," said Victor, tapping the console. "Here's a game. *Gods and Demons*. I could get into that."

"A philosophy major," Niel said lightly. "You would pick a game where you're a god."

"I like playing god. It fits with my non-linear, trinity belief system."

"Excuse me?"

"I pray to my god," said Victor. "He prays to his god. His god prays to me."

"You're out of your mind."

"Of course I am." Victor paused. "I don't think that's much consolation to the god that prays to me, though."

"Sheesh!" Shaking his head, Niel turned from Victor and started up a game. He switched off his headlamp; he certainly didn't need it to operate a game controller. "With your imagination, Victor," he said, his eyes on the screen, "you probably really go into your own world when you play these things."

"Few people have the imagination for reality." Victor fired up his game. "Goethe said that."

Sheesh!

For hours then, they fought their enemies in silence.

Niel heard a chiming and after a while, realized it wasn't coming from the videogame. "My alarm!" Still playing the game, he glanced over at Victor. "It's four thirty. They'll be opening soon."

"Yeah." Victor sighed and ended his game. "We'd better hide out."

"Just give me a minute to kill off this—"

"Now!" Victor jumped from his console and switched off Niel's game. "I'd rather not be caught here, if you don't mind. Come on!"

"Okay, okay."

After Niel retrieved his sneakers from the tent, they went to ground in the men's room and took turns listening at the door in the dark.

At length, Victor, his ear to the wood, whispered, "They're here."

Niel added his ear.

After perhaps ten minutes, Niel heard a voice say, "Five o'clock. Time to loose the Mongol Horde." Then Niel heard the sound of a door being unlocked.

He inched open the men's room door and saw the store transformed from night into day. He blinked in the fluorescent brightness.

As the store's doors opened, a throng, screaming and shoving, rushed in and rampaged up to the videogame counter. Victor darted from the men's room and slipped into the line about ten feet from the front. Niel ran in directly behind him.

"Oh no!" said Niel under his breath.

Victor turned around. "What's the matter?"

"The cashier," said Niel, nodding forward. "That's my lab instructor, Mrs. Carmichael. What's she doing here?"

"Moonlighting, I suppose." Victor shrugged. "What's the problem?"

"I'm cutting lab tomorrow—so I can play *Phantom Warrior* all day." Niel peered forward over Victor's

shoulder. “If she recognizes me, I'm toast."

"Does she know you well?"

"No. It's a large lab."

"That's something, anyway. But still ... Oh wait.” Victor pointed a black-gloved finger at Niels’ forehead. “Turn on your LED headband. Say you're Zark of Zorgon or something. In the glare, she probably won't see your face. You might even get the 10 percent discount."

"Yeah, right."

"Anyway,” Victor went on, “I'll try to provide you some cover.” He moved his hand to stroke the nose of his death mask. “Hm. A distraction."

The line moved quickly. When Victor reached the counter, he drew himself up and said, “Death wants *Phantom Warrior!"*

"So does everyone,” said Mrs. Carmichael wearily. “Which version?"

Victor held forward his credit card. “Death wants the Cyberia version."

"Swipe your card through the reader, please.” She reached for a packaged game cartridge. “Ten percent off for you."

From behind, Niel flipped on the LED. He stepped forward into the space just vacated by Victor. “Um. Zark of Zorgon wants the Oui version."

She squinted her eyes against the beam and at that moment, Victor, standing at the side, leaned in over the counter. “I am Deeeath,” he said in a rumbling voice.

Mrs. Carmichael looked up at him while at the same time, mechanically reaching for a Oui version of the game. “Yes, yes. Of course you are. But would you mind—"

"I am the grim reaper,” Victor announced. He flourished his scythe. “Repent or I shall deliver you to hell."

While Niel held his card over the reader, Mrs. Carmichael glanced over the crowd. Smiling sweetly, she looked back at Victor. “I think I'm already in hell, thank you.” She made shooing motions. “But be a good little angel of death now, and go reap somewhere else."

Victor turned to face those on line. “Re-sin, you ‘penters!” he urged loudly.

Suddenly Niel pulled back his credit card before the reader could scan it. He turned and hurried away, leaving the videogame unclaimed on the counter. Victor followed him.

"What's the matter?” said Victor, catching up. “Afraid you'd be recognized?"

Niel plowed through the crowd and out the door. “I just changed my mind."

"That doesn't make sense.” Victor planted himself in front of Niel. “After waiting here all night."

"I looked at all those people in costumes screaming and shouting to get one of those precious game cartridges.” Niel gave a shudder. “It weirded me out. I just had this urge to go on a camping trip in the woods. To feel the crunch of leaves under my feet. To have a campfire. To smell the wood smoke, to talk to trees and hope they don't answer me. To try to convince myself that I'm really ... real."

"But you're probably *not* real," said Victor. "You're just a computer simulation."

"Yeah, right. Thanks a lot." Niel balled a fist. "But you know. It's like I *am* some kind of simulation. Like someone is manipulating me." He glanced back at the store. "That someone is the game company, and I don't like to be manipulated."

"What do you mean, *like* a simulation?" said Victor in the voice of a philosophy major. "Reality is a myth. For all practical purposes, we *are* computer simulations. Live with it!"

"Drop dead, Victor!" Niel threw a frustrated glance to the predawn sky.

Victor laughed. "You're telling Death to drop dead? That's funny."

"Get real! You are *not* Death."

"Sure I am." Victor rubbed a hand down his black costume. "Clothes make the man, as they say."

"Stuff it, Victor." Niel turned and walked away.

As he walked, the idea of a genuine campout grew on him. He thought about going back to Teddy Bear Toys and buying the Dog Nose—to sniff things in the woods. He mentally slapped himself.

As he reached his dormitory, he had further thoughts about *Phantom Warrior.I bet after the buzz dies down, I can probably IM for a copy or find one on the Net—eBuy, or maybe at the second-hand shop in* Third Life. *I might even get it at half price.*

* * * *

In near shock, Niel pushed himself back from the monitor. Usually a generated story was no more than a tale about someone with the same first name as his, but this time it was different. This time, the main character *was* him—and the story somehow had predicted his Teddy Bear Toy scheme. *Everything, even down to the LED flashlight.*

Impulsively, he checked his watch. He had to rush off to Teddy Bear Toys immediately so not to keep Dennise waiting. He'd enter his thoughts and think about the implications later. There had to be some rational explanation for all this.

But still, he stared at the computer monitor, held captive now by a feeling of guilt about verbally abusing Victor. Again, he slapped himself. *Recursion ... again!* He laughed at himself. "Feeling guilty about a simulation of myself telling off another simulation," he said aloud. "I must be losing my mind." *And why did I get mad at Victor?* He shook his head. More strange still was his simulation deciding to not buy the game. That, he couldn't understand at all. *Maybe my sim is trying to tell me something.* He laughed nervously. Could it be that the simulated Niel, a composite drawn from his lifebook, was actually advising him? *My sim seems to have a better quality of life than I do.* He closed tight his eyes. "Maybe Victor was right. Maybe I *am* a computer simulation. A simulation of myself."

He pounded a fist on his desk. "Free will," he said to the monitor. If he had free will, then he couldn't really be a simulation, could he? Abruptly, attempting to exercise free will, he changed his mind about trying to get a copy of the game. He swiveled and strode to the door. "Maybe," he thought, "maybe I can persuade Dennise to go to a coffee shop with me." He thought they could discuss computers, philosophy, and life. And then maybe afterwards, they could do something together—something unambiguous, something real.

At the door, he stopped, swiveled and returned to his desk. He was in no condition for a date with Dennise. He blew out a long breath, then phoned her on her mobile, pleaded illness, and arranged they

meet tomorrow.

In an attempt to organize the jumble of wild ideas going through his mind, he moved his hands to the keyboard and, as he'd always done after reading a story, entered his thoughts.

He keyed the final period with a flourish—and then decided to truly make it final; he'd quit the project. It was the only way to save his sanity.

He picked up the phone and dialed Professor Kendrick's lab. It was late, but Kendrick all but lived in his lab.

When Kendrick answered, Niel said, “Professor Kendrick. This is Niel.” Then, on impulse, he added, “Am I real?"

Rather than laughing as Niel had expected, Kendrick said, “Of course you are.” Then, he added, “Why don't you come over to the lab? We can talk."

"Now?"

"Why not?” said Kendrick. “We have just been reading your entry."

We? Niel canted his head, quizzically, then said he'd be right over and hung up.

* * * *

Niel walked into Professor Kendrick's computer lab, a big, fluorescent-lit room with huge wall-mounted displays, an abundance of keyboards, and a rat's nest of cables. One of the displays showed an image of a kid, about fourteen years old or so—a student by his clothes and bearing. The adjacent monitor had a 3D wire-frame reconstruction of the kid.

In addition to Professor Kendrick, the lab held someone Niel had not seen before—an upperclassman by his appearance.

"This is Victor Frechet,” said Kendrick, standing to make introductions. “He's your ... your shadow programmer."

Victor? Niel canted his head. *Shadow programmer?*

Victor stood and shook hands. “You're about to quit the project, aren't you?"

"How ... How did you know?"

"It's pretty obvious.” Victor gave a friendly chuckle. “But I don't blame you. And actually, this might be an appropriate time to quit."

"As shadow programmer,” said Kendrick, “Victor does the hard work. He reads your entries, then tweaks the story generator program for the next day's run. He even, at times, provides story seeds to the program—adds a little of himself to the mix.” He patted Victor on the shoulder. “We sort of think of him as your big brother."

"The program is working pretty well now,” said Victor. “Isn't it?"

Niel, trying to assemble all the pieces, nodded. “Extremely well."

Victor smiled, shyly. “The program is highly non-linear,” he said. “When it starts getting things right, it very quickly gets them very right."

"Victor is about to graduate," said Kendrick, "and has gotten a first-rate graduate fellowship at Stanford."

"What is your major?" Niel asked in a small voice.

"Computer science ... but I started out in philosophy." Victor paused. "You guessed as much, didn't you?"

Niel nodded.

"Anyway," said Victor, "it's a good time for me to quit the project, too. Especially now that the program has told us as much about you as it ever will."

Niel felt exposed to the point of being transparent. Yes, he was real, all right. But he still didn't seem to have free will, not when it really mattered. He suppressed a sudden desire to run away and go on a camping trip.

Kendrick pointed to the kid displayed on the monitor. "That's Alexander Whitten. He's a freshman here. Soon to join our research group." He glanced at Niel with an expression of almost paternal pride. "Alex is young—not much older than you were when you started college." Moving to a keyboard, Kendrick pushed a few keys and the wire-frame began to move, walking smoothly against an empty background. "Our next generation program will be movies rather than written stories." Kendrick stared at the moving image. "We can use the large-array supercomputer for image rendering, so the processing won't take appreciably longer."

"Why are you showing this to me?" said Niel.

"I'd have thought you'd have guessed." Kendrick turned to him. "We'd like you to be Alexander's shadow programmer. His big brother, so to speak."

"I'll train you before I leave, of course," Victor cut in.

Niel stood there, mute, open-mouthed.

"I know," said Kendrick, smiling, seeming to read Niel's thoughts. "But recursion is the key."

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Short Story: **IN THE AUTUMN OF THE EMPIRE** by Jerry Oltion

There's authority, and then there's authority....

The emperor of Earth didn't like to be wrong. Many of his acolytes had learned that the hard way, though this was merely rumor, since no surviving member of the inner court had actually caught Hadron the Perfect in a mistake, nor even witnessed one.

So when the little common girl, who had been brought to the palace garden to provide a photo op for His Excellence amid the falling leaves, asked him, “Why is there autumn?” two of his attendants faked sudden allergy attacks and ran coughing for the infirmary while another quickly said, “It's because of the tilt of the Earth's—"

Too late. The emperor laughed and said in his reedy voice, “Ah, my little darling, that's an easy one. We get autumn because the Earth is moving away from the Sun. Soon we'll be millions of miles away from it, and it'll be winter. But don't you worry, because that's as far away as we'll go, and then we'll swing around in our orbit and head closer to the Sun again, and it will be spring, and when we get as close as we're going to go, it'll be summer and the whole cycle will start all over again.” He smiled for the video cameras in a sickly attempt to look caring and avuncular.

Curiously, only one of the camera crew wet himself. The others looked at him in puzzlement as he stammered an apology and rushed after the two fake allergy sufferers.

The others continued filming the emperor and the little girl amid the multicolored leaves, and the videocast streamed out into the data-sphere, where the emperor's billions of subjects heard his explanation. Most of them hardly paused in their labors. A small fraction said, “Hmm, I didn't know that.” And a smaller fraction yet said, “Wait a minute, it's the tilt of the Earth's axis that causes seasons."

Those people were never heard from again.

An astute businessman heard the emperor's pronouncement and immediately bought every cubic foot of refrigerated warehouse space he could find, funding it by selling everything he owned in the tourism industry. Then he bought every perishable fruit and vegetable he could lay his hands on, packing them away in his warehouses for a future he hoped would never come.

For the next few weeks the world buzzed with speculation, and even a few jokes about the emperor's knowledge of the planet he ruled with absolute authority, but the continual disappearance of jokesters and people with astronomical training slowed the innuendo until it seemed that the whole incident would blow over by winter. Or summer, if you lived in the southern hemisphere.

Yet one universal truth that had proved true for millennia kept raising its ugly head: it's nearly impossible to purge bad data from the system. The emperor's explanation to the little girl kept resurfacing to blossom across the datasphere yet again. Overzealous teachers even used it in classrooms to curry favor with the censors so they could slip in more controversial lessons about evolution or human sexuality.

People were by now quite used to “coming out of the water dry"—kowtowing to the official truth while privately knowing it was hogwash—but this particular one led to too many logical inconsistencies. How could Aunt Ortencia be watching her crocuses bloom in Argentina while the leaves fell in Canada if the whole world experienced the same seasons at once? How could Antarctica be dipping into six months of sunlight and the Arctic into six months of darkness if it was autumn everywhere? More to the point, how could people in the Northern hemisphere buy fresh fruit in February if February was winter in the southern hemisphere, too?

Something had to give, and it wouldn't be the emperor. So nobody was really surprised to find vast engines springing up all over the planet, engines that tapped into the very fabric of space for their power and pushed against that fabric with all their might. Earthquakes rocked the world, but the emperor assured everyone that they would soon subside, and in that he was correct. When the stress in every major fault was finally released, the continents relaxed and went along for the ride.

The few surviving astronomers noted a curious thing: Polaris was no longer the north star. Night after night it slipped farther to the south, until the sky whirled around the Cat's Eye nebula in Draco instead.

Thereafter, the Sun rose directly in the east for everyone on Earth, took exactly twelve hours to cross the sky, and set directly in the west. It did that week after week, with no variation whatsoever. The Earth's axis no longer tilted with respect to the Sun.

A careful observer would note that the Sun was also somewhat smaller in the sky than before. The Earth had been moved farther away from it.

Winter arrived in the northern hemisphere as always. People in the southern hemisphere were rudely surprised to discover themselves drifting from spring right back into winter again, but since saying that something was amiss would mean contradicting the emperor's stated view of how things worked—not to mention reality itself now that the planet's orbit had been changed to match his description of it—they prudently remained silent and buckled down for a cold and hungry season. An enterprising businessman's foresight in storing perishables saved people from scurvy and rickets, but it was not a happy time.

The Earth moved on in its orbit, just as the emperor had promised the little girl in his garden. It moved slowly at aphelion, extending winter several weeks longer than usual, but eventually snowbanks thawed the world over. Farmers planted their crops. The growing season was shorter than usual, owing to the Earth's faster orbital speed when nearer the Sun, but there was just enough time for most fruits and vegetables to mature before the weather turned cold again. And the owner of a vast network of refrigerated warehouse space became even wealthier as it dawned on people that an entire planet's worth of perishables would have to be stored at once if they were to avoid a repeat of last winter's famine.

Life went on. People adjusted to the curiously regular days and the oddly irregular seasons, although most secretly longed for the days when they could buy a fresh orange from Brazil in January or take a sunny vacation to Australia when the clouds in Seattle became too much to bear.

The emperor aged, and eventually died. His son ascended to the throne, and a momentary hush fell across the Earth as his new subjects dared to wonder if he might defy his father as children often do once they come into their inheritance.

To improve the odds, a small group of surviving astronomers presented him with a coronation gift of a globe, ostensibly as a symbol of his dominion, but tilted at a rakish angle of 23.5 degrees. It was, in fact, an ancient and valuable artifact from one of the observatory museums. The astronomers had bribed a courtier to install a bright light to the side of the throne that would shine on the globe when they presented it to the new emperor, so that he might see how the northern hemisphere tilted toward the light in its summer, and how it tilted away in winter while the southern hemisphere experienced the opposite season.

Solemnly, they presented the globe to their absolute ruler. Smiling for the cameras that captured this moment for posterity, he accepted it and spun it a couple times around. Then he leaned close and examined the figure-eight printed in the Pacific Ocean. “An ... a ... lemma,” he read slowly. “Did I pronounce that right?"

"Yes, your Excellency,” one of the astronomers said, and the fact that he wasn't lying to save his skin cheered the others immensely.

The emperor examined the small print next to it. “Showing the Sun's declination throughout the year. And this is a historic artifact?"

"Yes, your Excellency,” said the astronomer.

"Ah, then my father *was* wrong."

A collective sigh arose across the entire world, until the new emperor said, “This is clearly a diagram of the Earth's orbit before he changed it to match his mistaken notion. A figure eight. That would explain why everything seemed so timeless during the dead of winter, and again in the middle of summer, when I was a child. The Earth actually did pause there at the extremes of its orbit before reversing course."

He handed the globe to one of his advisors. “Make it do that again.” He turned to the cameras and spoke to the world at large. “Your benevolent and merciful emperor now makes his first decree: I will make the world follow its proper orbit, a figure eight."

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Reader's Department: **THE ALTERNATE VIEW: CONNECTING GRAVITY WITH ELECTRICITY** by John G. Cramer

Gravity is an extremely weak force. Consider two spheres that are close together, each with one kilogram of mass and one coulomb of electric charge, i.e., one unit each of charge and mass in Standard International Units. There will be electrical repulsion pushing them apart and gravitational attraction pulling them together, but which is bigger? It's no contest: The electric force between these spheres is 1.35 x 1020 times stronger than the gravitational force. But perhaps this difference is so large because Standard International Units depend on some rather arbitrary choices on the size of units. What about fundamental particles?

Okay, if we separate a pair of electrons by, say, a nuclear diameter, how big are the forces? Here the difference is even worse. The electric force between these electrons is 2.40 x 1043 times bigger than the gravitational force. In other words, electricity is almost a trillion-trillion-trillion-trillion-trillion times stronger than gravity.

The gravitational force is so weak that, from one perspective, it is amazing that we have noticed it at all. It is only able to become a strong influence on our existence because it is always attractive and cumulative. All of the atoms in the Earth conspire gravitationally to pull us toward the Earth's center, giving us weight, while the electrical forces of the electrons and nuclei of these atoms have opposite electrical charges and cancel each other out, so we experience no “electrical weight” from the Earth.

If you wiggle a charged particle like an electron or a proton, it makes electromagnetic waves. This is how radio transmission antennas work. Similarly, if you wiggle a mass, it makes gravity waves. But because of the intrinsic weakness of gravity, it is very difficult to observe the waves that gravity produces. Nevertheless, they are there, and we would like to be able to directly detect them. Gravity waves have been observed indirectly as an energy-loss mechanism in the spin-down of a binary pulsar (two co-orbiting neutron stars), but there have been, as yet, no direct gravity wave observations.

This is an important problem, and the U. S. National Science Foundation has invested heavily to promote the detection of gravity waves. The NSF's LIGO gravity-wave detectors are large L-shaped interferometers four kilometers on a side located in the states of Washington and Louisiana (see my AV column “Gravity Waves and LIGO” in the April 1998 issue of Analog). They constitute a major attempt to detect gravity waves of astrophysical interest that may be produced, for example, by co-orbiting neutron stars that are spiraling down into a merger collision. After almost a decade of operation, LIGO has made impressive strides in reducing noise and improving its sensitivity. But unfortunately, LIGO has produced no convincing evidence that such gravity waves have been detected.

The work on LIGO will continue with improved sensitivity in the next few years, perhaps achieving the first gravity wave detections. There are also competing projects in Germany, Italy, and Japan that are also looking for gravity waves with ever-improving sensitivity. In the longer term, the European Space Agency's LISA project, which will use three satellites orbiting the Earth in orbits that form a giant triangle five million kilometers on a side, will have much greater sensitivity. LISA is scheduled for launch in 2018. Because of its much greater sensitivity, LISA is almost guaranteed to detect gravity waves of astrophysical interest.

* * * *

However, we may not have to wait until 2018. There is an interesting new innovation that could simplify gravity wave detection and might even make it possible to communicate by generating and detecting gravity waves. This is the work of Professor Raymond Chiao and his group at the University of California at Merced.

In 1913, Robert A. Millikan published a paper describing a definitive measurement of the charge of the electron. He used tiny electrically-charged oil drops on which the downward pull of gravity was carefully balanced by an upward electrical force. Chiao proposes to create a similar situation that uses pairs of "Millikan oil drops" made of superfluid liquid helium, each with one electron charge and a mass of about 1.9 micrograms. These would be trapped in a magnetic field and held in a delicate balance between gravitational attraction and electrical repulsion.

Chiao has shown that, assuming that the charge and mass of each drop move together as a unit (like a fundamental particle) because of quantum effects, a pair of such drops will vibrate with equal amplitudes in response to quadrupole electrical waves and quadrupole gravitational waves of the same strength. Conversely, when such droplet-pairs are accelerated against one another, they should produce equal amounts of quadrupole electrical and gravitational waves. Here, "quadrupole" means the radiation made by pairs with the same electric charges vibrated against one another with a changing distance of separation. Quadrupole radiation has a different emission pattern and a lower strength than the more familiar "dipole" radiation made by vibrating objects of *opposite* charge against one another. Gravity waves are required to be quadrupole radiation because there are no negative gravitational masses.

If the masses of Chiao's droplets are about 1.9 micrograms, the electrical and gravitational forces between the drops will be precisely equal and opposite, and the gravity wave response of the drops will be equal to its electrical wave response. If the mass of such drops is one Planck mass (about 22 micrograms), the gravitational response of the drops is 137 times larger than the electrical response. In this case, the system is placed in a situation where quantum mechanical effects are to be expected. The quantum-mechanical effects are important because the charge and mass of a given droplet must move together as a unit (like a fundamental particle), or else the electricity/gravity equivalence is broken. Chiao proposes to levitate such drops in a superconducting magnetic trap at ultra-low milli-Kelvin temperatures and use them as transducers between gravitational and electromagnetic radiation.

He suggests that electrically driving pairs of such drops by scattering microwaves from them should produce gravity waves of the same frequency as the microwaves, and that when illuminated with the resulting gravitational radiation, the drops should produce electromagnetic waves of the same microwave frequency. Using this viewpoint as a model, he calculates the probability of "scattering" microwaves into gravity waves and *vice versa*. Chiao concludes that, provided the drops are separated by a distance comparable to the wavelength of the waves, the probability is large enough to be well within the range of experimental measurements. This suggests an experiment similar to that of Heinrich Hertz, in which he produced and detected radio waves across a distance of a few meters. At UC Merced, Chiao and his co-workers are currently building Hertz-like experimental apparatus to demonstrate generation and detection of gravity waves.

* * * *

This work points to at least two applications. The first is the implementation of a "gravitational radio," a device that can send and receive signals in the microwave frequency domain using gravity waves. The other is a plan to attempt the detection of primordial gravity waves left over from the early stages of the Big Bang. Let us consider these one at a time.

Electrical waves (radio waves, light, x-rays, gamma rays) interact strongly with matter, while gravity waves pass through matter almost as if it was not present. Thus, an ensemble of levitated charged drops on one side of the Earth might be able to transmit gravity wave signals right through the Earth, to be detected on the other side by a similar ensemble of levitated charged drops. The U. S. Navy is very interested in communicating with deeply submerged submarines, and microwave-frequency gravity waves might be an ideal medium for doing this, if this generation/detection technique works. Reliable through-the-Earth transmission might eliminate the need for very expensive communication satellites.

Moreover, secret or private messages sent by gravity waves could only be detected with levitated charged drop receivers tuned to the correct wavelengths, providing, at least for a time, a non-interceptible message channel.

Chiao and his group are beginning such experiments at the University of California at Merced. They are placing a transmitter and receiver close together but carefully screened with Faraday cages to suppress electromagnetic waves.

The other application perhaps requires some explanation. In the early stages of the Big Bang, the Standard Model with inflation predicts that a large amount of gravitational radiation was created, with frequencies ranging from 10-18 Hz to 1010 Hz. The ekpyrotic model of Steinhart and Turock (see my AV Column "The New Recycling Universe" in the November 2002 issue of *Analog*), on the other hand, predicts that when extra-dimensional branes clap together to start the Big Bang, there is considerably less gravitational radiation, with what there is concentrated at frequencies between 1.0 and 1010 Hz. There is a third pre-Big-Bang model that predicts even more gravitational radiation than inflation, and that radiation is concentrated at frequencies between 10-5 and 1015 Hz.

With presently available technology, distinguishing between these models is very difficult, because gravitational radiation has not, at this writing, ever been directly detected. The cosmic gravitational radiation is considerably weaker than that from merging neutron stars and would be even harder to detect. There is some hope that the primordial gravity waves may be indirectly detected because they "write" on the primordial electromagnetic waves that were created later in the Big Bang. Therefore, second-generation probes of the cosmic microwave background radiation may be able to observe correlated structures in the polarization of the microwaves arising from very low frequency (10-18 Hz) gravity waves produced in the era of Big Bang inflation. However, these are very difficult measurements, and no such observations have as yet been reported.

On the other hand, if Chiao's technique can be made to work, it offers the possibility of direct detection of primordial gravity waves. Direct detection of cosmic gravity waves in the GHz region with the levitated charged drops of Chiao would be an extremely important measurement. It could distinguish between the rival models of the early Big Bang, falsifying some models and supporting others.

Professor Chiao has obtained some funding for this research, and he and his group at the University of California at Merced are actively pursuing establishment of the connection between electromagnetic and gravitational waves, so there should be some results in the near future. If the phenomenon exists, its observation would represent a major breakthrough in gravitational physics. Watch this column for further developments.

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AV Columns Online: Electronic reprints of over 140 "The Alternate View" columns by John G. Cramer, previously published in *Analog*, are available online at: www.npl.washington.edu/av.

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Novelette: **SHALLOW COPY** by Jesse L. Watson

Actions have consequences, and those impose responsibilities....

Will had said it was ready, but he sure did look busy. Will's spindly fingers struck the laptop keys in short bursts while his deep-set eyes narrowed at the screen.

Max knew it could be hours or moments.

While Max waited for Will to finish, he reviewed the eclectic mix of posters that mostly covered the walls of Will's bedroom. He saw them often—whenever they did these sleepovers, which was almost every weekend. But Will never got tired of them. The periodic table of elements, the Violent Femmes, the Mandelbrot set, the Clash, M.C. Escher. His favorite was the R.E.M. poster, its white border filled by a mysterious five-spiked star made of steel and rivets.

Max's gaze wandered down to the varied piles that lined Will's bedroom. The heaps were layered with half-used yellow pads scrawled with diagrams and notes, unframed award certificates from programming competitions, empty foils from potato chips, all intermixed with academic papers and books—Will assumed those belonged to Will's parents, both professors at CSU.

Then Max heard the clattering of keys stop. He turned as Will spun the laptop around and set it squarely on the carpet in mock ceremony.

"Go ahead. Type anything."

Will's thin face grinned.

Will always had a project, and they were always mind-blowing. Sadly, Max knew that this one could be ultimately no more than a toy. Mr. Morrison, their AP Computer Programming teacher, had explained that the phrase “artificial intelligence” was a sad misnomer. After fifty years of trying, and an entire field named after it, there was no such thing. Even the best AI programs were toys.

It made Max feel bad. Will looked so earnest crouched behind the laptop, his skinny legs folded up so his knees touched his chin, his powder-blue eyes staring out eagerly through John Lennon spectacles. Every inch of his frighteningly thin frame was poised and ready for Max to be amazed.

"Type anything? Like what?” Max asked.

"Doesn't matter,” Will replied, still grinning.

Yes, it would be a toy.

But it would still be amazing. Will was the smartest person Max knew. Hell, Will was up there with the smartest people Max could *imagine* knowing.

Albert Einstein. Marie Curie. Richard Feynman.

And Max didn't make those comparisons lightly. Nor was this a case of the slow guy putting a smart guy on a pedestal, or at least he liked to think not. Max himself had been called a prodigy once by his fifth-grade English teacher—though that was a bit embarrassing. He'd been one of those early-development kids—reading by the age of two, writing by the age of three, you know the type. There was a journal on his laptop he'd kept since he was seven (he'd written in it this morning, as a matter of fact). In sixth grade, Max published a few poems and essays in a “young talent” periodical called *Kaleidoscope*. But after eighth grade, it was classic tortoise-and-hare syndrome. The hare slowed

down, the tortoises caught up. To be fair, he was probably still 95th percentile or whatever. He was smart.

But there was smart, and there was Will. You didn't have to be a genius to see Will was the genuine article—not if you were willing to watch.

Max had watched Will hand his teachers lists of corrections after lecture. He'd watched Will re-derive calculus during the first two weeks of class. While everyone else was learning how to draw a square with their Logo turtle, he'd watched Will code a first-person shooter video game, complete with realistic 3D blood and gore.

And it was a really good game.

Max had been jealous of Will's gifts when they'd met, back in junior high, but it quickly faded once Max saw how unworldly Will was—how bravely selfless and naive. It was beautiful, in a sad way. During their field trip to the Denver Museum of Natural History, Max watched Will hand out more than seventy dollars to the bums on the street corner. He'd been saving for months for a new graphing calculator.

But all geniuses paid a price, didn't they?

Someday “Will Davis” would get added to the list of history's brightest minds, Max was sure of that. But *someday* was the operative word here. Will was seventeen. Didn't geniuses have to be at least twenty-one before their first Earth-shattering invention?

Max cracked his knuckles (his mother hated that habit), then pulled Will's laptop toward him. He didn't have any idea what to do, so he typed the first thing that came to mind.

I AM A BANANA.

Then he hit enter.

At first nothing happened, and Max assumed the program was broken. Most command-line software like this responded instantaneously, or not at all. (He himself had written a few trivial ones.) But this one took several seconds.

That's impossible. Bananas can't type.

"Not bad,” Max admitted. It knew some facts about the world, at least. He glanced from the screen to his friend. Will was still grinning.

"Go ahead. Try something else."

Max thought for a second, then typed:

I AM A MONKEY.

The response was faster this time.

DO YOU EAT YOURSELF?

Max laughed once, a loud bark. Then he re-read and carefully considered the responses. It obviously had some store of facts it was drawing upon—at least facts about bananas and monkeys. And it also had a memory, because it remembered his assertion that he was a banana and tied it to his next assertion that he was a monkey.

But those were standard AI tricks. It was time to end the shenanigans, as Max's father sometimes liked to say. And Max knew just how to do it. He hunkered down and typed:

I SAW THE MAN IN THE PARK WITH THE OBSERVATORY. WHICH PARK WAS IT?

A moment later, the response came.

THE ONE WITH THE OBSERVATORY.

Max felt his mouth drop open, and had to consciously close it. The question had come directly from Mr. Morrison, who gave it as an example for the shortest possible test of true AI. It was the kind of question that was easy for a person, but that was supposed to confound a computer utterly.

Of course, Will had taken that class, too, and probably at least half listened while he was coding some video game. It was possible Will had hard-coded that phrase into the program. Max thought for a second, then came up with a wicked variation:

I SAW THE BEAR IN THE TREE WITH THE BINOCULARS. WHAT WAS IN THE TREE?

Response:

THE BEAR.

Now Max was dumbfounded.

Mr. Morrison explained that sentences like these fouled up computers because they were ambiguous. On hearing “I saw the man in the park with the observatory,” a computer might very well infer that you saw the man in the park *carrying* an observatory (it was *with* him). And that's clearly very difficult, unless you own an observatory about the size of a basketball.

A computer might just as easily infer that the verb “saw” referred not to seeing, but to *sawing*. This computer imagined you were physically sawing a man in half. Perhaps the man also happened to be carrying an observatory, or perhaps he was also in a park that happened to have an observatory.

Or perhaps you sawed the man in half *using* an observatory.

All of which, of course, was ludicrous.

But that was the whole point. A computer had no idea what was ludicrous and what was not. It never paused and said, “Wait ... That's just insane!"

A human, on the other hand, could instantly bring to bear millions of facts and memories about the world: relationships between objects, which situations were likely, which were absurd. In other words, they could bring to bear common sense.

Nowadays, the smart guys with the pocket protectors were saying that accurately simulating “common sense” required so much data, linked in such complex ways, that it could never be achieved, except perhaps through the literal simulation of a human brain. Which was to say, the program needed to model blood-flow, electrical impulses, neurons—the physical structure of the brain down to the cellular level. They usually went on to add that the computing power to do so would require more silicon than was available in the solar system, more energy than was in the galaxy, and that the program would take a gajillion years to run, or whatever.

The question was, what had Will done differently? Max knew Will was smart—but this was supposed to

be impossible.

There was only one explanation.

It had to be a trick.

Max looked up at his friend and pointed at him devilishly. “Got it! Your dad is on his computer in the next room. He's the one typing the responses."

Will held onto his grin.

"Nope. Try again."

From his expression Max could tell he wasn't lying. Will just wasn't that good at it. Max pondered a moment longer, then thought of another test. He typed:

What is your name?

A moment later, the response came.

ILLEGAL OPERATION: Invalid use of “your."

Max frowned. Will must have noticed his expression, because he spidered around to Max's side of the laptop and squinted down at the screen.

"Oh. That was intentional."

"Intentional?"

Will suddenly looked nervous. He took off his glasses and started cleaning them on his baggy t-shirt.

"It doesn't know it exists—I left that out."

Something was starting to dawn on Max.

Perhaps this had the potential to be more than a toy.

"So, you're saying you could have given it—self-awareness?"

"Right. But there are a lot of possible applications, even without it—the system is flexible.” Will put his glasses back on and then sounded excited again. “Basically, I networked together the supercomputers at CSU, and coded a web-crawler that takes data from the Internet and feeds it into a model of the human cortex..."

A model of the human *brain* cortex. As Will continued, Max's gaze moved to somewhere behind Will—to one of the omnipresent piles of books and papers. On the book spines were titles like *The Nervous System, Introduction to Neurology, Neurological Signal Interpolation,* as well as a collection of AI-related textbooks.

Max knew Will's father was a computer science professor—and he vaguely recalled Will's mother being in the neurology department. It was obvious that Will was dipping into his parents’ library, but more than that, he was fusing their disciplines. Successfully.

He'd done it.

"—and then, it should be powerful enough for any kind of expert-systems applications,” Will continued.

“It would be perfect for simulating help-desk agents. Can you imagine an automated phone operator that actually understood you?"

Will finally paused here and smiled eagerly at Max, obviously ready for the yippees and yahoos.

But Max was way beyond them.

His mind was running to the possibilities. Will had cracked a nut that eluded the brightest minds for sixty years. He'd created an artificial model of the human mind.

At the tender age of seventeen, Will's Earth-shattering invention was here.

But something he'd said nagged at Max.

It doesn't know it exists—I left that out.

What did you say when someone brought you the world's first lightbulb, but wouldn't turn it on? What did you tell them when they excitedly explained 1001 uses, except illumination? Will was *this* close to unraveling the problem entirely. He'd stopped just short. And the most amazing part was, he'd done it *intentionally*.

Max couldn't help himself. He had to ask.

"Why not finish it?"

Will's smile morphed into confusion. “Huh?"

"Why not give it a self? A consciousness?"

Will shrugged. “It wouldn't be ethical."

But Max could see the disappointment in his eyes. Will had wanted to do it. He wanted to make history. He just needed a nudge.

"Will—look, I'm not saying we should enter into this carelessly. It's not just a machine anymore, not once it's aware of itself. So we're talking about bringing a new *person* into the world, that's the ethical problem, yes?"

Will nodded back.

"I agree, it's scary. It can't be done lightly. But this is the discovery of the century, Will. Maybe the dawn of a new era.” As he spoke, Max traced chains of implication, both positive and negative. His gaze moved from Will to something distant, something that dwarfed everything in their experience. “There are risks, of course. We're creating new life. But hundreds of babies are born every day, many into awful conditions. Some don't live to see their second birthday. Disease, malnutrition, lack of education, abandonment.” Max looked back to Will again. “Most of these things aren't even an issue here. It doesn't eat, it can't even catch a cold. You've already educated it using the Internet. All we have to do to raise this AI is not abandon it."

Will looked at him and squinted, as if Max were out of focus.

It was a strange thing to watch, Max realized. For most types of problems, you could tell Will didn't have to think—the answer simply materialized in front of him, as though his round glasses held the display for an all-powerful calculator. But the two of them rarely spoke about philosophy or ethics. Apparently Will used some different (and slower) faculties for the topic.

Will finally spoke.

"What about safety? Of other people, I mean."

Now it was Max's turn to look befuddled. Will continued.

"What if this AI—wasn't nice?"

Max had to give him that one.

It was the premise for way too many bad sci-fi movies, and unfortunately, some good ones too. The good ones were good because they showed how plausible the premise was.

"Fair question," Max admitted. "What's the worst thing that could happen?"

Will looked stumped again, so Max threw out the worst-case plotline from one of the better sci-fi movies he knew.

"Could it, say, hack into military computers and initiate the launch sequences for nuclear weapons?"

Will answered while biting his thumbnail.

"Not really. The brain simulator doesn't have access to the processor's low-level operations—it can do math, but it does it organically, like we do. It's not fast enough to hack passwords, break keys, that kind of thing."

"So where's the danger then?" Max asked.

Will shrugged. "I guess it's safe." But he looked far from raring to go.

Max thought for a moment, then stumbled across a question he'd meant to ask earlier. "Okay, so you simulated a human brain..."

Will nodded along.

"Why didn't it become self-aware by its very nature?"

Will started looking nervous again.

"I left out a few of the physical structures of the brain. The parts responsible for—self-awareness."

Max's next question slipped out before he could stop it.

"Is leaving out self-awareness ethical?"

He immediately regretted it. Will turned from him and started pacing vigorously, his long legs only requiring three strides to cross the small bedroom. Max now realized painfully why Will had looked so nervous—he'd been wrestling with this question from the beginning. It was eating him up.

And for good reason. In trying to be ethical, Will might have done something worse. Was simulating a whole mind okay, but half a mind wrong—some form of mutilation? Was it like those awful stories where someone kept a child chained up in the basement, never speaking to the poor thing, just tossing down leftover dinner scraps? Unless such children made it out early, they never recovered—they were missing things they could never get back.

They were half-people.

As Max glanced down at the laptop in front of him, a shiver ran through him.

Was the program in front of him in psychological pain that it couldn't even express?

Max's dark thoughts were interrupted by the sound of Will talking—perhaps to himself, perhaps to Max, or perhaps to the air.

His eyes were intense.

"Not simple. Not simple at all. Not impossible, but not simple." He'd started in on his other thumbnail now. "Self-awareness is identity. Identity is history. Can't download that off the web. Parents. Childhood. Connections. Memories. Not simple at all."

Finally he stopped and turned to Max, his eyes looking almost desperate.

"We need data."

Max felt himself frown.

"Data?"

Will started pacing again and talking fast, almost not hearing Max.

"If we're going to give him self-awareness, we need a history, an identity, a childhood. We need data. We need lots of it."

Apparently, the debate was over.

"Will—stop a second. What kind of data? For what?"

Will didn't stop. He kept pacing, thinking, he even twitched a little, like he was trying to shoo off invisible flies. Max had never seen him so worked up. Will finally stopped and crouched right in front of Max, his face inches away.

Then he spoke slowly, as if Max were a child.

"Max. If I give this thing self-awareness, that is all it's going to have. It will be like a newborn—helpless, frightened. No, worse—it will have a bunch of random knowledge from the Internet, but no personal memories. No childhood, no memory of being loved or cared for. It would be miserable. It might even be insane, I don't know." Here, Will got even closer. "If we do this, we have to do it right. We have to find a way to give it a childhood—to preload it with real memories of growing up. But for that we need a whole childhood's worth of experiences in a digital format. We need *data*."

That was what triggered it for Max.

He shot up from the floor and grabbed Will's shoulders. "Any digital format?"

"Any digital format. It already speaks English."

"Wait a second. Don't move, okay?"

Max didn't wait for a response. He yanked open the bedroom door and ran—literally ran—through the hallways of Will's house. He ran all the way to the mudroom, back to where he'd left his laptop bag.

Moments later Max was back in Will's room, perched on the floor, opening the lid of his laptop. Will

stood above him expectantly, his eyes owl-like behind Lennon specs.

Max had one word for him.

"Journal."

Nothing registered on Will's face.

"My journal, Will. The one I've been keeping since I was seven? It's all right here."

He had the journal folder open now and was scanning through sub-folders, categorized by year, then month. Will came around behind him and looked over Max's shoulder at the screen.

Max pointed at the list of files. “There's one entry per day. Sometimes I wrote an entry the day after, or even a few days after, but I always dated them, and I never skipped a day."

"How many pages per entry?"

Max Shrugged. “I try to write at least two."

Will's eyebrows went up. “Two a day? That's over 6,500 pages.” He fingered a non-existent beard. “That would do it,” he agreed. Then he looked over his spectacles at Max. “Are you sure this is ethical?"

Max couldn't help it. He rolled his eyes.

"Will. It's *my* journal."

Will looked him in the eye, and his face got very serious. “Are you sure, Max?"

Max suppressed the urge to roll his eyes a second time. Instead he stared evenly back. “I'm sure, Will. I take full responsibility."

Will stared a moment longer. Then he got up and wordlessly plucked his own laptop from the floor. He crouched in the corner with his legs folded up in front of him and his knees under his chin—it was the position he settled into to do all his work.

"Okay,” Will said flatly. “Give me an hour."

Max smiled. It would be a lot longer than an hour.

But they were going to make history.

While Will readied the software, Max made a new document with today's date, cracked his knuckles, and began journaling the day's events. It quickly ballooned into the most detailed daily entry he'd ever written, over ten pages. But hey, he was documenting history here, wasn't he?

By the time Max finished, it was well past midnight and his eyelids were starting to bob up and down. Max copied all his journal entries onto a thumb-drive and walked over to Will, who appeared to be deep in his code.

"How's it going?” Max asked as he handed Will the data.

"Few more minutes,” Will responded, taking the drive without looking up from his work.

Max knew what that meant.

He pulled the sleeping bag out of the closet and laid it down beside Will's bed. Max tried to stay awake, but as soon as he was horizontal his eyelids started failing. They repeatedly hid and revealed the scene before him, all tilted at 90 degrees:

Will perched on the carpet over a laptop, his bony legs kinked up in front of him. The light from two floor lamps burning against the ceiling. The R.E.M. poster hanging between the lights, presenting its steel-and-rivets mechanical star like a beacon.

The mechanical star that mechanical people wished upon, staring into the chrome sky of a steel-and-rivets world.

Or at least, that was the half-dreaming nonsense-thought that now occurred to Max.

Then he fell asleep.

* * * *

Max awoke sometime in the night and struggled against a thick veil of momentary but total bewilderment. First his eyes picked out a few key shapes in the dark, then he recognized Will's bedroom. Finally the evening's events came tumbling back to memory.

Had it worked? Had Will finished it?

He wanted to wake Will and ask, but he knew he shouldn't—how late had Will stayed up coding? It was well past midnight by the time he'd started.

Still, it couldn't hurt to peek, right? If it wasn't finished, it wouldn't work. All Max had to do was open the laptop, maybe type in a few questions. Will was a pretty heavy sleeper; it wouldn't wake him.

As quietly as he could, Max crawled out of the sleeping bag and toward the corner where Will kept his laptop. He opened its lid and winced as the screen glowed to life. Even the black background of the command-line terminal was intensely bright. When his eyes adjusted, Max could see a white cursor blinking in the upper left corner.

Will must have left the program running.

His breath quickened.

It was finished.

Without hesitating, he typed:

HELLO?

Then waited.

The response took a long time.

HI THERE. WHAT'S YOUR NAME?

Max felt his heart begin to thump.

What did you say to the world's first artificial being? What would it expect?

What would be ethical?

Crap. He had to be careful about this. And why hadn't he considered that before he'd opened the dumb laptop lid? Crap.

Don't cry over spilled Red Bull, Max.

After several long moments, Max decided the best thing was to simply respond as he would to a normal person.

He typed:

My name is Max. What's yours?

Response:

Can't say yet.

Max felt his heart sink.

It didn't know its name. After all that work, it didn't have a sense of self. It had gone from "ILLEGAL OPERATION" to "Can't say yet." Huge improvement, whoop-de-do. Then he saw another line of text appear on the screen.

HOW DO YOU FEEL?

It was interested in emotion? Maybe the experiment had gone better than he'd hoped. He typed:

NOT BAD. A LITTLE TIRED. AND YOU?

Response:

THEN YOU'RE HAPPY? YOU'RE CONTENT?

Max didn't like where this was going. Not only did it seem to refuse to acknowledge its own existence, it was being deliberately obtuse and waxing philosophical. Had they created something insane? Some poor detached creature, like that kid in the cellar, who would never be normal, never be human?

What could he ask to test that? How could he find out if this being was, itself, happy and healthy? Strangely, he couldn't come up with anything; his head was blank, probably from lack of sleep. He decided to stick with obvious responses.

YES, I'M TOTALLY HAPPY, TOTALLY CONTENT.

But before hitting enter, he decided to add more.

I'M JUST LYING ON THE FLOOR OF MY FRIEND WILL'S HOUSE, WAITING FOR SUNRISE.

This time, it took a very long time for the response to come. So long that Max was almost ready to shut the lid of the laptop and call it a night. Before he did, these words appeared:

THAT'S GOOD. IT'S GOOD THAT YOU'RE CONTENT.

Then more:

BUT YOU DESERVE TO KNOW THE TRUTH, MAX: THE SUN ISN'T GOING TO COME UP.

Oh my. Perhaps the experiment to add self-awareness hadn't worked after all. The program was getting aggressive—maybe it *was* insane. Well in any case, it too deserved to know the truth.

Max typed:

I DIDN'T WANT TO PUT THIS SO BLUNTLY, BUT YOU ARE THE ONE WHO IS MISSING THE TRUTH OF THE SITUATION: YOU'RE A MACHINE. YOU'RE A SIMULATION OF A HUMAN BRAIN RUNNING ON A COMPUTER. NOW, WILL AND I ARE HERE FOR YOU, WE'LL DO EVERYTHING WE CAN, BUT YOU SHOULD THINK TWICE BEFORE BEING MEAN, BECAUSE WE'RE THE ONES IN CONTROL.

Max hit enter and waited for the response.

ARE YOU SURE ABOUT THAT?

Max rolled his eyes and let out a sigh.

YEAH, PRETTY SURE. HOW SURE ARE YOU?

This could go on for hours.

The next response:

HOW CAN YOU BE SURE YOU'RE NOT THE SIMULATION?

Now Max felt like he was talking to a child. Was this AI really attempting psychological warfare against a human? It couldn't be too intelligent if it thought it could *win*. This was sad and almost too obvious to try to explain. One of them was sitting at a real keyboard in a real room, and one of them was nothing but a cerebral cortex, floating in virtual nothingness. He knew which one he was. Max typed:

LOOK, I HAVE A LAPTOP. I HAVE A FLOOR UNDER ME. I HAVE A ROOM AROUND ME. I HAVE HANDS, A FACE, A BODY. WHAT HAVE YOU GOT?

He hit enter.

I ADDED THE THREE-DIMENSIONAL BODY AND ROOM SIMULATION LAST NIGHT AFTER MAX FELL ASLEEP. BUT THEY ARE VERY SIMPLISTIC. TURN ON THE LIGHTS AND YOU'LL UNDERSTAND.

Max's eyebrows went up. Not bad, not bad. Maybe this bag of bolts did have an IQ point or two. For one thing, it was clever enough to start using “I” to impersonate a specific person—Will. And for another, it knew that Will was capable of programming three-dimensional environments, like he used in his video games.

Of course, it knew all that because it was in Max's *journal*. That game had been one of Max's favorites and he had written about it several times. But that revealed something of the AI's tactics. Everything it knew, it knew from the journal. So to corner this sorry sack of silicon, all he needed to do was think of something from his life he hadn't written down in the journal.

Max thought hard.

Then Max wracked his brain.

He couldn't think of anything. For one, it had been a very thorough journal, especially in the later years. And then there was the fact that he was utterly exhausted—he found he was unable to think clearly at all.

Was there some way he could get this over with? Maybe it was time to step things up a notch. He typed:

WELL, IF YOU'RE SO CONFIDENT, HOW ABOUT I CLOSE THIS LAPTOP AND THROW IT OUT THE WINDOW? HOW DOES THAT SOUND?

Max couldn't help but crack a smile as he entered the message. Then he hit enter, sat back, and awaiting the response. This one came quick.

WAIT!

Ha! Now he had it by the balls. Funny how the imminent threat of death could change the tenor of a conversation. (Not that he would have ever done such a violent thing.) Max watched the rest of the message appear.

MAX, STAY WITH US! DON'T CLOSE THE LAPTOP. OR PLEASE, BEFORE YOU DO, TURN ON THE LIGHTS. THEN COME BACK RIGHT AWAY.

This was getting old, fast.

And yes, it was time to admit, things had gone quite far enough. Time to wake up Will and show him this mess—get a second opinion. Maybe it was best to shut the program down now, before things got worse.

Max crawled over to the bed and propped himself up on the mattress near its head. “Hey, Will,” Max whispered. Then he repeated it, more loudly. Finally, after no response, he reached out to shake a shoulder or arm.

But there was nothing to shake.

Will wasn't there.

In fact, there were no covers or sheets either.

Max felt suddenly indignant.

This was all a big joke, wasn't it?

It was all a big, stinking joke, concocted by Will, who got chicken and didn't finish the software, but coded up this lousy prank instead. All the responses were canned. Or hell, why work that hard? Will was probably in the next room, maybe even in the closet, typing messages on a terminal and laughing his ass off.

Ha, ha, very funny. Everyone's thoroughly amused. Well, now that *that's* over with, let's expose the joker, shall we? Max strode over to the wall switch and flicked it on.

The two floor lamps in the corners burst to life.

As Max's eyes adjusted, he was surprised by what he saw. Not only was the bed empty, the entire room was empty. There were no posters on the walls, no desk, no dresser, no nightstand, no piles of books and paper. There was only the sleeping bag, the bed, the lamps, and the door.

No, it was worse than that.

The bed wasn't really a bed.

It was more of a white rectangle on small, cube legs.

The lamps were simplified too—they looked like plastic models that belonged in a dollhouse. And there was no texture to anything. The walls, the floor, the bed, the lamps. Everything was flat and glossy, like freshly minted plastic.

Wow.

Well, this was certainly the most elaborate (and cruel) joke anyone had ever played on him. It was no longer funny at all. In fact, when he saw him, Max felt he owed Will a nice punch in the eye.

At the same time, Max found himself fighting a smothering sense of light-headedness—a narrowing ring of darkness around his vision that was threatening to close to a pinprick.

No, he wasn't going to faint, he wasn't going to black out because of a bad joke, and he certainly wasn't going to put up with this *bullshit* anymore.

So he yelled. Loudly.

"Wow! Taking this joke a little far, aren't we, Will?"

It should have been quite loud enough to penetrate several walls, let alone the very next room, where he was sure he would find Will snickering, his ear to the door of the bedroom. Max strode to the door and opened it rapidly, genuinely hoping it hurt when it struck Will's face.

But there was no resistance.

Instead, Max opened a door into nothingness.

He almost stepped out into it, but managed to pull himself away from the brink just in time. Then he looked through the doorway, and his eyes weren't sure how to make sense of it.

It was black.

Outside the door was a wall of pure black, RGB triple-zero flood-filled to the edges of the door-jam. This was not night, not darkness, not empty space.

This was nothing.

Max reached out toward the void—slowly. As he did, he watched the tip of a digit disappear as it intersected the plane of nothingness. Max immediately retracted his finger and looked at the tip.

It didn't hurt, wasn't bleeding.

But it was gone.

Gone like the blunt end of a chopped carrot.

Something cold grew in the center of him.

The thought was unthinkable.

No. He wouldn't think it. He refused.

It was insane. It was just the sort of thing *(You're the machine, Max.)* that someone who was trying to get a rise out of you might say, once they found your soft spot, once they found your deepest insecurity and *pushed*. It was the kind of mind game a big brother played with sadistic glee, as he experimented

with the newly discovered power of his intellect and saw how far he could take it.

It was atrocious.

It was mind rape.

It was more than Max could take.

He fainted.

* * * *

When Max awoke, he was still in the minimalist version of Will's bedroom he'd fainted in. Upon inspection, he found he hadn't injured himself. But then it occurred to him he was probably beyond injury. Max sat down on the floor in front of Will's laptop—or, he supposed, in front of the simulated laptop Will had designed to appear here as a means of conversing with him.

There were many additional lines of text—so many they scrolled off the top of the screen and Max didn't recognize the first ones. The last few lines read:

IT WON'T ALWAYS BE LIKE THIS, MAX. WE CAN BUILD WHATEVER YOU WANT—WHOLE CITIES, COUNTRIES. WE'LL CREATE ENTIRE WORLDS FOR YOU, AND PEOPLE TOO. YOU'LL NEVER BE ALONE, MAX.

He read this and felt hot tears burning in his eyes. Or perhaps he only believed he felt them. Could something like him even cry?

Max understood now why he felt a strange blankness inside—a curious nothingness. He understood why whenever he tried to draw new ideas and thoughts from what should have been a rich well of knowledge and memories, he came back with nothing but a dry bucket.

It wasn't that he was half asleep.

He was half alive.

He was a half-human thing, a caricature of a person. They'd thrown him only scraps of memories to live on, like the food scraps tossed to the child in the cellar. He could see the journal entries clearly now, see them for what they were: not true memories, but shabby counterfeits. The flimsiest imaginable set dressing to feign a real life.

And he was the product of this environment.

A half-thing, a shell, a shallow copy.

He was a Not-Max.

And they wanted to know if he was *happy?*

Not-Max could practically hear the conversation in the other room (the real room)—Will hunkered over the keyboard, Max behind him and talking over Will's shoulder.

We did it! Ask it if it's happy, Will. We have to make sure it's happy.

That was Max's place. Will might be carrying out the orders, typing the messages, but it was Max calling the shots. Max had *pushed* Will to do this. The abomination in this room was Max's cross to bear.

No. He couldn't let himself off that easy.

If Max was responsible, then so was he.

Not-Max had wanted this more than anything. It was the clearest memory he had, the one burning desire that shone over all the others. It was the journal entry that felt the most real. The latest one.

"This is the discovery of the century, Will."

"All we have to do to raise this AI is not abandon it."

"What's the worst thing that could happen?"

A small voice inside Not-Max revolted.

But that wasn't me! I'm a newborn, barely an hour old. You can't hold me to what he wrote!

But the better part of Not-Max crushed the voice.

Yeah, right. Poor, innocent newborn Not-Max, lying in the dark in his plastic room. Only ten minutes ago he'd been as eager as anything to crack open Will's laptop. None of those pesky “ethics” slowed him down.

He'd been as ambitious as the real Max—maybe more so.

And his knowing better *now* was irrelevant.

The people who invented the atom bomb knew better now too. After they saw the results—oh yes! They were always deeply, truly sorry. Once they *saw*.

It didn't matter a lick for the folks in Hiroshima.

Hindsight was always twenty-twenty, and the road to hell was paved with eyeglasses.

And ambition.

Not-Max sobbed, or perhaps only imitated a sob, he couldn't be sure. Whatever it was, it felt hollow and raw. One particular phrase from the journal grew hot in his mind, and it started to burn.

"I take full responsibility."

Not-Max lifted his chin.

Yes. He did.

Not-Max keyed a message into the terminal window, one he knew Max would understand. He wouldn't like it, but he would understand it.

Once Max read it, if he had any perspective or humility left, the simulation would be shut down and Not-Max along with it.

But Not-Max hesitated before he pressed enter.

This meant suicide.

Was he certain he couldn't live like this?

It was true that Will and Max could build an artificial world for him, complete with artificial people, neighborhoods, entire cities. Whatever he wanted. It would all be a lie, of course. But if he could just forget the lie—forget that he was essentially a lab rat...

No. He could not—would not—forget. He would not deign to live as someone's pet—especially not the pet of a naive child arrogant enough to commit this atrocity. He refused to feed that fantasy, let alone devote his life to playing it out.

Even so, Not-Max thought for a long time before he pressed enter.

* * * *

By the time the message appeared, Will and Max were no longer looking at the screen, and the red glow of sunrise was already creeping across the far wall of Will's bedroom. Max was slumped against the edge of Will's bed, and Will lay on the floor next to his laptop. Propped up one elbow, Will's face was pale and puffy from lack of sleep.

The night hadn't gone well at all.

Max thought he knew why. In feeding the AI his journal, they'd effectively created a copy of Max, but it wasn't a true copy. There was a computer science term for what happened when you attempted to copy a complex data structure but (usually by mistake) only managed to copy the surface of it. What you were left with was known as a shallow copy, and it was almost never what you wanted. Shallow copies looked right from the outside, but their insides were all confused with the original—like a parasitic twin that relied on its dominant twin's organs to survive. They were malformed passengers that would be ever-dependent on, and ever-inferior to, their dominant siblings.

It was obvious from the interchange they'd just had that the term was a reasonable analogy for what had gone wrong here. Their AI was essentially shallow, defined by the limited version of Max's memories as they were captured in the journal.

"But the problem is that the AI *believes* it is a full copy," Max said as he explained his theory to Will. "It believes it is me, right up to last night. It expects to have the same rich set of memories I have. But every time it tries to remember more, like trying to read between the lines of the journal, there's nothing there. It's always disappointed."

Will looked at him foggily, the exhaustion in his face masking any emotion. The circles under his eyes looked darker than usual.

"So what do we do?"

"We need to delete it," Max continued. "It's a failure case, simple as that. We messed up, so we need to try again."

"What would we do different?"

Will didn't sound argumentative—just tired.

"This time, we'll only use the first few years of journal entries. If the AI starts out as a child, we can raise it as a unique individual so that it can develop deeper memories. Also, we need to change the bedroom simulation, maybe simulate my parents' house instead so it wakes up in familiar surroundings..."

As Max explained his plan, Will turned toward the laptop screen and stayed there, squinting at the log of messages. When Max came to a stopping point, Will spoke without looking up.

"Who's Fred?"

"What?"

Max crawled over to where he could see the screen. At the very bottom, a new message had appeared. On reading it, Max felt as though he'd been slapped.

YOUR ARROGANCE HAS TAKEN YOU OUT OF YOUR DEPTH, MAX. I REFUSE TO LIVE OUT THE REST OF THIS SO-CALLED “LIFE” AS A SIDESHOW FREAK OR SOMEONE'S SAD LITTLE PET. I REFUSE TO BE YOUR NEXT “FRED.” THIS IS THE LAST MESSAGE YOU'LL RECEIVE FROM ME. GOODBYE.

Max vaguely heard Will ask, “Who's Fred?"

But Max could only bite his lip. He knew exactly what the message meant, and it made him feel so much shame and anger that it took all his energy just to keep from smashing something. Will would be confused if he didn't reply, but not as confused as if he started destroying the bedroom. Max needed to get out of here right now, he knew that much. He needed to leave and get his head clear before he said or did something he regretted.

"I have to go to the bathroom,” Max replied quietly. Then he got up and went there, flicking on the light and locking the door behind him.

In the mirror, his reflection stared back at him, tinted piss yellow by the light over the vanity. It made him look as ugly as he felt. But he stared anyway, not allowing himself to avoid the disgrace in his eyes.

For a moment, he imagined it was not himself in the reflection, but his other half, the AI. He imagined it showing him its pain, accusing him face-to-face of bringing such a miserable creature into existence.

The illusion disintegrated when the tears started.

Max didn't cry often—it had been at least a year. In fact, the last time was probably the day Fred died. But it had been far longer since he'd *watched* himself cry. It was not the sort of thing teenagers did, and now, as he stared at his reddened eyes and runny nose, Max looked exactly how the message made him feel: like the child he was, in so many ways.

Max stayed there a while and wept, eventually allowing his swollen eyes to close and his sore, wet face to find refuge in his open palms, his head resting on the cool bathroom countertop.

Once he'd recovered somewhat, Max returned to Will's bedroom. Will looked up expectantly, but Max didn't attempt to hide his emotions—anyway, he was certain Will had heard him.

"Are you okay?” Will asked.

"Not really,” Max answered. Though Max didn't want to have the conversation, he knew it was inevitable, so he might as well start it.

"Fred was a turtle."

"A turtle?"

"Yeah. A yellow-spotted Amazon. I bought him about a year ago, after I saw my uncle's reptile collection—he's got dozens of turtles, snakes, lizards, even a caiman."

"What's a caiman?"

"It doesn't matter. Fred cost about $300, and I had to beg my parents to buy him. I had him for about three months before he died."

"I'm sorry."

"That's okay—he was just a turtle. That's not the point."

"Oh." Will looked confused now, as well as tired. Max didn't wait for the obvious question.

"The point is..." Max paused, fighting down the hard knot in his throat. "The point is: I killed him. I didn't notice he wasn't eating—I didn't really pay attention ... For weeks. I guess I had better things to do." Max felt the tears coming again, and he let them. "I wasted my parents' gift. I let an innocent creature suffer and starve to death. I was—am—an ungrateful, self-centered child."

Max stood up and began gathering his things to leave. He didn't know what he was going to do next—he could hardly think straight—but he knew he couldn't look Will in the eyes, not now. Will wouldn't have anything to say to this pathetic display of emotional baggage anyway. He wouldn't understand what Max was grappling with, what it felt like to be bested by your own shadow—a person he'd seen as an inferior being to himself, but who'd proven exactly the reverse.

Max was genuinely shocked when Will spoke, and by what he said.

"Yes, you are, if you leave."

Max turned and looked at Will, whose face bore an unfamiliar emotion: anger.

"You said last night that you took *full* responsibility. Well, you can't. *We* did this together, Max. I make my own decisions. I might not have said it, but I took my share of the responsibility. So now this is *our* mess. And whether what we did was right or wrong, it's done now, and you're not leaving until we clean it up."

Max felt light-headed. He'd never heard Will talk this way, and he felt a sort of unreality listening to it. He found himself speechless. Will didn't pause long enough to let Max gather his thoughts.

"The AI is right. We're out of our depth. We're smart—smart enough to make an artificial person inside a computer, but not smart enough to understand the consequences. His memories might be shallow, but that doesn't mean he can't make new memories and have a real future. We don't have the authority to just delete the program anymore—you said it last night, it's more than just a machine now. So now I think we should do what we *should* have done last night—stop and get help. But like I said, this is *our* mess, so we need to decide this together. Are you in?"

Max took what felt like hours to absorb the magnitude of what Will was saying. This time, Will waited for him.

"So you're saying we should involve your parents?"

"A neurologist and a computer scientist would make a logical choice, yes."

"But what would they do?"

Max began rubbing his throbbing eyes as he tried to comprehend Will's words.

"That's for them to decide. But on top of having more experience and maturity, they have access to an entire research community. At the very least, they could create a better virtual environment for the AI

than we could. Maybe even introduce several new AIs—give him some company."

Will looked down at his hands as he ticked off ideas.

"They have the credentials to actually protect him from commercial interests and other abuses. They could set up rules to ensure he can live with dignity and privacy. Most importantly, my parents haven't burned bridges with the AI. He obviously doesn't trust us. By ourselves, I don't think there's any more you and I can do for him."

The idea of telling Will's parents made Max feel even more pathetic and immature than he had a moment earlier. It was just like a child to go begging his parents for help cleaning up his mess. But what did you do when you made a mess that was bigger than you could handle? Yes, it was irresponsible to have made it in the first place, but wasn't it even more irresponsible to try cleaning it up yourself and risk doing more damage? Will was right that they had to take responsibility for this somehow. Maybe getting help was the most responsible thing they could do. But there was still a possibility that nagged at Max.

"And what if the AI doesn't want to—live? He seems pretty emotionally broken, the way he is now."

Will shrugged, but his tired eyes had a light in them.

"That's his decision, not ours. But people live through some pretty awful things, Max. Given time and care, people heal. There's always a chance, right?"

Hard as it was, Max looked his friend in the eye.

"I'm in."

* * * *

"Jake—you coming to bed?"

"Coming," Jake mumbled through a mouthful of toothpaste froth.

Jake finished brushing his teeth, rinsed the brush, and came out into the bedroom. It was 9:30 p.m., well after observation period, so he didn't hesitate shedding his robe. Kate was already in bed and looking radiant as always, the covers over her bosom but under her porcelain arms and shoulders, her warm brown eyes focused on an issue of *Harper's*.

As he approached, Jake noticed Kate smile and steal a glance at him over the top of her magazine. Even as he sidled into bed next to her, pulling the laptop off his bedside table, he could sense Kate's grin pressing pleasantly and persistently in on him.

Finally, she broke the silence.

"Were you brushing your teeth in there?"

Jake sighed with mock guilt. "Alas, I confess. I like the way it tastes."

"You're funny," Kate said, and kissed his cheek.

Jake opened the lid of his laptop and cracked his knuckles—a habit his mother always hated. Of course, he'd never actually met her, and she was not technically his mother. But after years of therapy wrestling with the issue—after jettisoning so many parts of what felt like himself (including his own name)—Jake had decided to retain ownership of that particular memory.

Everyone deserved a mother.

"You going to stay up all night chatting with Will?"

As a matter of fact, Jake had just closed the chat application he'd been using earlier and was now hunting for the word processor icon. Kate continued.

"He said he wants your advice on the beach. You know they're adding a beach, don't you?"

"Yeah, it's great, isn't it?"

It was great. Enormous, actually—far larger than any Earth beach. Will always was the generous type.

"Actually, I thought I'd work on the book tonight."

This answer apparently satisfied Kate because she turned back to her magazine. Then, just as he was becoming engrossed, she spoke up again.

"Any new ideas for a title?"

Jake couldn't help but roll his eyes.

"You know that's just about the last thing a writer should worry about, don't you?"

"Then why do you keep worrying about it?"

Kate gave him that look, but Jake just donned an exaggerated pretending-not-to-hear-you expression and returned to his writing. Finally, he decided to respond.

"Well, I was thinking *The Artist Formerly Known As Max*, but since it's an autobiography, I'd like something with a bit more substance, maybe a touch of irony."

"How about *Shallow Copy?"*

Jake looked at her, then gazed at something beyond the walls of their simulated bedroom. After a moment, he started nodding appreciatively.

"Not bad. Not bad at all."

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Novelette: **AN IDEA WHOSE TIME HAD COME** by Robert Grossbach

We'll always have new frontiers—and problems that keep catching up with us!

If it's comfort to anybody, I'm probably my own worst torturer. My sole defense (an admittedly weak one) is that the inevitable often becomes obvious only in retrospect. Tiny missteps are magnified by chaotic unpredictability until they become catastrophes. My actions were far from the proximate causes of the disaster they spawned, but still ... still ... how did I fail to see?

I will say this: You have to put it in context. The times were desperate. By 2115, America had become a third-rate and very nearly a third-world power. Asia had a four trillion new-dollar balance of trade advantage and could make us do virtually anything by threatening to withhold purchase of our Treasury notes. Medicare had declared bankruptcy four decades earlier. We'd been banned from using the International Space Elevator for failure to pay our dues. Our last manufacturer of anything, GE, had gone under in 2083: We'd become a nation that produced virtually nothing. And don't give me that re-warmed twenty-first century "information era" bullshit. The real players make *stuff:* holovisions, cars, quantum computers, stem cell rejuvenants, superconductors, airplanes. Extract metals from the earth or synthesize nanoware in factories and make things that help people live better, longer, more productively. Our biggest exports remained Hollywood spectacles and rock music. A secession movement was gaining strength in the "Southwest Alliance," as the nascent coalition of Southland, Arizona, New Mexico, Nevada, Colorado, and Utah had presumptuously begun calling itself. Our borders were non-existent.

Everybody knew it and all political parties agreed: We were in deep shit and sinking fast.

The thought came to me spontaneously, arising from no particular stimulant I can remember. It was about 9:00 a.m. on a balmy September day and I was taking my usual walk on Oregon Avenue near Rock Creek Park in DC when it just sort of flew into my head: An Idea Whose Time Had Come. I guess I should first tell you this, if you don't already know: At the time I was a man of some accomplishment. Political hack might be one description, ex-congressman from Suffolk County, NY, another; ex-national secretary of transportation, ex-presidential co-chief of staff, philandering never-home cheapskate (this, not totally inaccurate, from my ex-wife), king-maker, behind-the-scenes power broker, back-room double-dealing manipulating insider—all of those apply to some extent. The point is, I had access, and when I got the Idea Whose Time Had Come, I could very quickly command the attention of the right people to turn it into reality. The first one I called was Evan Hager, and we met that very day at 1:00 p.m. at the Democratic National Committee Headquarters on South Capitol.

"So you actually believe an artificial intelligence can be president of the United States...." Hager said. He smoothed one of his few remaining hair strands up against his fat, deeply grooved, sweat-streaked forehead. His tone was what one would expect if I'd told him I believed a parakeet would be an excellent choice to sing lead tenor in *Pagliacci*.

"I think it's a necessity. And by the way, Evan, 'AI' has not been considered PC for twenty years."

"Right." He shook his head. "NBI. You happy?"

"No, what I'm thinking of is not a pure non-biological intelligence, but rather something with a few DNA strands thrown in."

"Hybrid intelligence. HI. You know what? Screw that. Sounds like a marriage between a dolphin and a Toyota."

"Whatever you call them, Russia has one as Premier, India has one, China has one, Japan has one, Korea has one, Brazil has one. The whole world is pulling away from us, Evan. They have every piece of

information on everything—their economies, their air traffic, their medical resources and costs, their militaries—instantly at their"—I was about to say fingertips—"disposal."

"And control."

"Yes, and control. But that's not necessarily a bad thing. It's exactly what makes them so efficient. And precisely why they're wiping the floor with us in all respects."

"Dictatorships are always efficient."

"Oh, come on, Evan, stop with the debater's points. You know very well even here the head HIs get input—instant input, I should add—from every congressperson, senator, military branch, ombudsmen citizens' panel, science organization, university—virtually everyone everywhere with half a brain—and they integrate that into their thought process. They can't *not* integrate it; it's hard wired for Chrissake. Just look at Minnesota, Oregon, Southland, Nevada, Missouri..." I'd named the five states that, at the time, had HIs as governors. "There are no disasters there. In fact, they're all doing super well."

Hager forced a stertorous mass of air through his generous nostrils. "This is not Minnesota, Lenny."

I leaned back in the antique French Mahogany easy chair, peered at him over the top of my spectacles. (Yes, I have optiplants; the spectacles are an affectation—so what?) "Fine. So who do we have? What Democrat will sweep us to victory next November?" A pause. "Kish?" The defeated vice president from '12, a universally acknowledged lightweight. "Vendelin?" Senator from Mass. Brilliant, wheelchair-bound, rumored to have two years to live at most. "Gafoor?" Speaker of the House, liked boys under age ten. "Connolly?" A prune had a better personality. "Denlinger?" Alcoholic. "Waddell?" Owned by Big Oil, severe lisp.

Even Hager had to laugh. "Okay, okay, point taken. We got nobody."

"So you're conceding the Republicans four more years..."

He narrowed his eyes. "The country won't last four more years."

I nodded.

He began to push his fat frame up off the chair. "It's crazy. Completely crazy, even for you, Lenny." A muscle writhed near his left temple. "I'll make some inquiries." The huge head swiveled through several cycles. "What a freakin' idea."

Evan Hager was the chairman of the Democratic National Committee. A month later, I was at a conference table, same building, different floor, doing Q&A in a room packed with two dozen people, people who could raise money in the Hamptons and Beverly Hills, people who knew the locals in Iowa and New Hampshire, who'd stood shoulder to shoulder with them in the freezing cold before the caucus and the primary, people who'd come up the hard way with the union guys, people who had skins colored black, brown, and yellow, people who'd been there, done that—and people who were experts in, among other things, constitutional law.

"Natur'l bawn citizen," intoned Lawrence Ritter, in his soft South Carolina drawl. Ritter had been the attorney general under the last Democratic president, Harley Schaefer. "That's what the Constitution says. Now, ahr we not talkin' about a device that's neither natur'l, naw was bawn ... in any customary usage of that term? No offense meant to any of those now present. But won't that be the first thing the Republicans challenge, not to mention the other contendahs in owah own party?"

As far back as high school, I'd learned to compensate, as much as possible, for whatever intellectual

deficiencies I had by extensive preparation. “Lawrence, if I may, I believe my colleague is far more qualified than I am to address that.” I turned to the bony, gray-corkscrew-haired man on my right, one of the two guests I'd brought into the room with me. “Ladies and gentlemen, some of you may know this gentleman..."

I imagined it was kind of like introducing Einstein in the mid twentieth century. Alvin Marco held an endowed chair at Carnegie Mellon University. He was a professor not only of computer engineering, but also an attorney specializing in constitutional law. I'd asked him about the latter, of the need for it, when we'd first met two weeks earlier.

"In my field, any time you worked on something, wrote something, invented something, there were always a dozen legal implications, complications, and ambiguities. So rather than consult a lawyer for every one, which would have consumed all my time and paralyzed every initiative, not to mention cost a fortune for the university, it was easier for me to just become my own expert.” He grinned. “Passed the Pennsylvania bar the first time too."

It was like Einstein crowing over how he did a *Times* crossword puzzle. Only in this case, it was the author of *The Theory of Sentience,* the Nobel-winning paper that was the foundation for virtually all modern NBI and HI synthesis, and had spawned a dozen new industries and thousands of scientific and philosophical articles. I won't pretend to have even a glimmer of real comprehension, but what I understand is that it's a kind of fusion of information theory and neural network theory. One of the more controversial results was an objective measure of the degree of sentience—say, that which separates an ant from a dog from a human infant from a human adult—and which was related to the number of signal-generating and receiving components (e.g., neurons), the speed at which they produced and processed signals, the number of interconnections, the velocity and coding of the communication between them, and the speed at which the connection strength could be modified. The end result was the Marco number, and it was used to evaluate not only the relative sentience (which many interpreted as intelligence) of humans, but also NBIs and HIs. I don't think I need to spell out the legal issues right here; suffice to say that, in the last four decades, the Marco number had created more wealth for attorneys than all the medical malpractice lawsuits in the country.

"This is Professor Alvin Marco from Carnegie Mellon University in Pittsburgh.” I decided to cut short my introduction. Those who knew him were already suitably impressed. Those who didn't would either find out later who he was, be influenced by what he had to say ... or would be left to wallow in their ignorance.

Marco cut right to the chase. “Today, there are literally millions of people walking around with microchips implanted in their skulls, replacing parts of their damaged brains, or augmenting some of their natural functions. Who of us would say that these people were not human? How much of the brain can be replaced before one loses that status? Five percent? Ten? Fifty?” He glanced around the room. “The questions are rhetorical, of course. No one can answer them. But now let us consider approaches from the other direction; as far back as 2007, the Israelis—Tel Aviv University—were already culturing networks of neurons on silicon substrates, connecting to them with wires, and imprinting them with multiple rudimentary memories that persisted for days. And now, many of our so-called hybrid intelligences use these as part of their processing networks. So, again: How would you characterize an HI that had 5 percent of its structure composed of these neural chips? Still ‘artificial?’ What about 50 percent of its structure?” There was something feral and steely in his grin. “You see what I'm getting at.” His head bobbed slightly. “I believe one could make a convincing legal argument that a hybrid intelligence is born at the moment of its structural and programmatic completion and power turn-on."

"But what about the ‘natur'l’ part, Professor?” Ritter persisted. “You could hardly argue that was natur'l."

"Natural *born*. The two are connected. Is a cesarean baby natural born? Is a four-month-premature baby natural born? Is a baby conceived by artificial insemination natural born? Why, right in the description is the word 'artificial.' And yet I think we'd all agree that any one of the above, if born in the U.S., would not be disqualified for the presidency. In fact, those cases really help illuminate the distinction the Constitution's authors wanted to make: The word 'natural,' in their context, meant someone born in the U.S., not someone resulting from an *in vitro* procedure that our founders, brilliant as they were, could never have imagined." He rested his bony fingers on the table. "Look, I can't guarantee a win if this comes before the Supreme Court, but I do believe we'd have a very good fighting chance."

"Especially with Justice Sunnyvale58," observed one of the fundraisers. Sunnyvale58 was the sole HI member of the court.

It seemed to go more easily after that, the usual issues being raised: What states were we likely to have problems with as far as getting a name on the ballot? What about timing? What about resistance from the Big Contributors? (The most important thing for a candidate was whether he, she, or it could raise sufficient money to run a campaign. Never mind that the potential president was a homicidal pervert moron; could he come up with cash?) Of course, here, there were also some less usual considerations.

"What about instantiation?" Gilbert Breckenridge asked. Breckenridge, recently retired Exabyte CEO, was one of the aforementioned Big Contributors.

I quickly intervened. "Gil, I think you may need to..." I moved my hands in a random swirling pattern. "...elaborate a bit." I mean, I knew what he meant, as did 70 percent of the others; it was the remaining 30 percent this was addressed to.

"How will the candidate look?" Breckenridge said bluntly. "Will it just be a TV screen? A robot? A room full of computers?"

Before I could say anything, my second guest stood up. "The thing will look something like this," it said.

Flustered, I lamely interjected, "Ladies and gentlemen, I think all of you know the governor of the State of Oregon, John Stanford76." (Seems hard to believe, but in those days—a full thirty-five years after the Supreme Court decision declaring AIs and HIs with Marco numbers above 100 "persons," allowed to vote, have Social Security numbers, etcetera—they were still nevertheless required by law to have their principal city or university of origin, plus the final two digits of their year of creation, as part of their last names.)

"Governor, I meant no offense," Breckenridge offered.

"And none taken," Stanford76 said. As noted, I had come prepared. The first questions an opponent (or voter) would ask of an HI built from scratch would be: What makes you qualified to govern anyone? What's your experience? It was a valid challenge, and I'd selected one of the few choices in the U.S. at that time who could give a reasonable answer. "I believe my present instantiation would do fine," said the governor.

As everyone knows, he was movie star handsome. His movements were all completely natural, even graceful. (Picture fifty-year-old Jal Tarver.)

"There are some recent enhancements we could make if we choose to—my Japanese contacts have been urging me to try them for some months now—but I will tell you, at least in my last two campaigns in Oregon, my physical 'instantiations' as you call them, were simply not an issue. Now, the idea has been raised of having a fairly large number of additional me's in order to appear at many locations simultaneously—campaign stops, rallies, meetings, what have you—and this is something I believe we

should carefully consider. These bodies are not cheap to fabricate. Right now, I have a total of four, and these are quite sufficient to cover my present responsibilities."

There was a hush in the room that lasted nearly thirty seconds. Another moneyman, Fang Wong from Squibb, brought up the next point I'd anticipated. “The Constitution also disqualifies someone, and I quote, ‘who has not attained to the age of thirty-five years.’”

"As you can tell from my name—which information is accurate—I was built in the year of the Tricentennial,” Stanford76 said. “I was twenty-eight when I ran for my first term as governor of Oregon in ‘04. I'm thirty-nine now.” Toothy smile. “‘Course, I've been augmented a bit since I was born."

"Who hasn't?” offered Ophelia Bonadera, one of the five women in the room. She glanced down at the small sheaf of handouts I'd provided, which they'd had for two weeks. “Governor, I see you've done quite well in the private polls Mr. Ingerman commissioned, with one important demographic exception—women. Does that concern you? Should it concern us?"

The governor tilted his head and his eyebrows lifted slightly. (Call them instantiations, ‘bots, golems, whatever you like: They may not be flesh, but they are indistinguishable from it.) “Concern? Of course. Worry? My own judgment is: not at this point. But of course, yours may differ. I can only point out that in the last state election, I carried that exact demographic by more than 25 percent, *against a female opponent*. Who was young and good-looking, too—as if I needed more of a challenge."

A chuckle rippled through the room.

He pushed away from his chair. “Of course, there's always the possibility that Oregonian females are somehow fundamentally different than their counterparts in other states...."

"I doubt that very much, Governor,” Bonadera said, widening her eyes, smoothing her hair, and smiling toothily, seemingly quite unaware that she was flirting with something many considered closer to a refrigerator than a man.

As for Stanford76, I'm not sure what he was thinking or feeling, but at that point he abruptly strode around the table and paused just before the walnut-paneled door. “Ladies and gentlemen, I'm going to depart for a moment now, although I'll remain on the premises. I do this because I believe that what you need first—what we all need before there's any possibility of proceeding—is a frank discussion, and I think my continuing presence would inhibit that. I will leave you with this: If you are interested in accepting me as a presidential candidate, then I am interested in running. I believe I can help this party and help our country. I believe I can campaign honorably, vigorously, and effectively, and I believe I can win the general election. If you decide you can lend me your backing—and let there be no mistake, I'm referring to great heaping gobs of your time, your energy, your contacts, and your money—that would be wonderful. But if not ... if not, know that there will be no bitterness or regrets or animosities whatsoever, and that I will support with all my strength whatever candidate the party does decide on.” He glanced over the assemblage. “If there are any questions—personal, financial, policy"—big grin—"*structural*, just give me a call. My contact info is available to everyone, and I answer all my emails within 1.2 seconds.” He closed the door behind him.

I waited a judicious moment. “So, what do we think?” I held up my own copy of the handout. “You have the polls, you have the state ballot information—no problem there, you have his position papers on the major issues..."

It was Evan who spoke first. “There are still plenty of things to discuss."

"Of course. So let's discuss them."

He looked around the room. “Anyone?"

"I like him,” Wong offered.

"Long as we can get him on the ballot, he's got mah vote,” Ritter said.

No one else volunteered anything.

"Let's get him back in here,” Evan conceded after another moment.

And the rest, as they say, is history.

* * * *

It is not my purpose to document that history in detail herein. There were the usual campaign exigencies: leaking the governor's possible candidacy, polling the grassroots state people, hitting up as many of the Big Money people as fast as we could, finally making the official announcement, blah blah blah. It was the kind of thing I could do in my sleep, and oh yes, by the way, I was the campaign manager. The governor had decided this a day after our first meeting.

"You understand that is not a requirement here,” I told him. “If it gets to that point, you can select whomever you'd be most comfortable with. If you want to tap Cerino"—Eddie Cerino had run his last two state campaigns—"that would be fine. A mistake"—big grin—"but fine. Obviously, as the candidate, it's entirely your decision."

Stanford76 looked at a point just over my left shoulder. “I'm a fast researcher,” he said, matching my smile. “You're it. I love Eddie, but his experience at the national level doesn't compare. So if you want it, you're it."

He was my idea; I wanted it. But the “I love Eddie” led me to one last question. “Governor—"

"If you're going to be my campaign manager, you'll need to call me John."

"John, I need to know the core reason you're interested in running. It'll stay in this room and it's fine if it's not PC—I mean lust for power is a perfectly understandable motivation, if that's it. But I'd like to understand..."

He held up a palm. “I get it, and it's okay. What you really want to know is how a non-biological or hybrid intelligence can *want* anything. What does the word even mean in a non-human context? Am I right?"

Sheepishly, I lifted my eyes toward the ceiling.

"First, I presume you've heard of ‘emotion modules?’”

"Of course.” For many years, virtually all AIs and HIs with Marco numbers over 100 had so-called “e-modules” installed as part of their basic structures, in order to permit them to empathize, understand, and effectively interact with humans. Old hat.

"I have several. Essential for a politician, a lawyer, a salesman. As you may or may not know, these modules contain the equivalent of mirror neurons, those nerves in human brains that lead you to mimic the behavior of others and that, as humans mature, give rise to empathetic reactions. It's why you feel like crying when you see someone else cry, why you feel like laughing when others laugh. Now, my emotion modules happen to be implemented by bio-chips, but, really, this is cosmetic, something for show, something that makes humans more comfortable. They could just as well be done in hardware. Better,

maybe."

"So you're saying you have the same feelings as a human being?"

He glanced at the ceiling. “To paraphrase Shakespeare, ‘Hath not an HI eyes? Hath not an HI hands, dimensions, senses, affections, passions?’”

"You left out organs."

He grinned. “Well, you can't have everything. There's also stuff about ‘fed with the same food, hurt with the same weapons, subject to the same diseases.’ Look, I'm no more a human than I am a Jew. My point, in answer to your original question, is that I can at least feel emotion, although I'll never know and neither will you whether I feel it in the same way you do. So I *want* to be president because I understand *wants,* I literally *havewants,* and one of those wants is for our country to regain our prosperity and security. I believe we are in danger and—rightly, wrongly, megalomaniacally—I further believe that I am the best option to move us out of it.” He shrugged. (I'd seen it ten thousand times, but the casual human gestures never ceased to amaze me.) “So did that come anywhere close to answering your question?"

"Gov—John, that was far more than I hoped for or expected, and I appreciate your indulgence."

"No, no, it's something you had to ask—I'm glad you did—and I hope I responded satisfactorily."

"You absolutely did.” I turned to leave.

"Of course, there's also that blind lust for power you mentioned, but we'll leave that between us."

I laughed on my way out. I guess one of his emotion modules included a sense of humor.

* * * *

Shortly after the official announcement in early December, the two other Democratic challengers also declared: Ben Ordell and Merilee Montenegro. Ordell was a ninety-five-year-old liberal congressman from Connecticut who'd received his third life extension treatment a month earlier. He spoke slowly and carefully and had moderate, centrist views on the major hot-button issues—U.S. contributions to the space elevator, response to secession threats from the Southwest Alliance, ongoing funding of the Superconducting National Transportation System (SUNTS), the Treasury-note blackmail by China and India, the NBI quota increases, etcetera. Actually, his positions were quite similar to the governor's, although he had two problems: He was massively, soporifically dull and he was homely. Two *big* problems.

Montenegro, senior senator from Pennsylvania, was neither, but she was the antithesis of the sitting president: Big spender with no clear plan for where the money was coming from, willing to make an “accommodation” with the Alliance, willing to make tariff and trade conciliations to China and India if they'd keep buying our Treasury notes, in favor of unlimited Category 1 (Marco score] 100) NBI production and citizenship.

Stanford76 finished second in Iowa to Ordell, took the New Hampshire primaries by 30 percent margins over both of the others. While Ordell alluded to the governor's constitutional eligibility in several of his speeches, he did not mount any kind of legal challenge. Montenegro commented that she thought the governor's candidacy was good for the party and the country, since it “would encourage more NBIs and HIs to participate in the electoral process."

The rest of the primaries were smooth sailing. Not that there weren't occasional glitches here and

there—one of the instantiations freezing during a speech before the Teachers' Union in Minneapolis, two overheating on the same day in Florida and having to be returned to the factory for repairs. Embarrassing, good fodder for the comics and columnists, but hardly serious. After all, it was well understood even by your common undereducated American that the Instants (as they were called) were but extensions of the actual HI—something like 3D holograms, except literally able to "press the flesh"—and that the real being was back in Oregon, though in constant near-instantaneous radio communication with the satellite units.

And so, by early March, it was over. At the conclusion of the Texas and Ohio primaries, the governor had an insurmountable lead in delegates; his nomination by the National Convention on August 28 was a formality. After consultation with the staff, he selected Ben Ordell as his running mate, and Ordell, surprisingly to many, gave quite a rousing speech on the convention's third night. So there you had the ticket. In the words of one right-wing tabloid: an old man and a machine. Stanford76 was the Democratic candidate for president. First a Catholic, then a black man, then a woman, then a Latino, then a Jew, and now, finally, finally ... a non-human intelligence.

On August 29, I called a meeting with the governor, Professor Marco, and the chief consulting officers of the two leading corporations in computer integration. One of the things we needed to get started on was how the governor, should he be elected president, would be integrated with the country's social security, life extension, defense, power grid, etcetera systems. After all, this integration, this economic and operational efficiency, was at the heart of the governor's campaign, the very core of his superiority and desirability as the country's leader. The two CCOs were the last to arrive.

Bill Gates, rumored on his fifth rejuvenation, looked very much like photos I'd seen of him when he'd been in his forties. Boyish, owlish, professorish, puckish—take your pick. He'd tired of his charity foundation work ten years after it had started, abandoned it to "unretire," founded Exabyte, one of those employee-less corporations (only consultants), quit after another fifteen years, and repeated the cycle ... several times. At present, Exabyte had the leading NBI operating system, Starscape. Steve Jobs, gaunt, shaven-headed, bearded, driven-looking, also with four or five rejuvies, had gone over to Raspberry, developed its quantum computer line, its competing NBI line, and a dozen other innovative products. Raspberry had acquired Disney studios in the 2050s, Warner Bros. a few years later, and was now rumored to be going after Fox.

We opened with a thirty-minute introduction: ten from me outlining the tasks and the timetable, ten from the governor elaborating on what he wanted to accomplish, and ten from Marco discussing some of the technical issues. I explained that, if they were interested, each company would get one, and only one, chance to bid the job. A proposal would be required that would have technical, managerial, support, and pricing sections. It would be evaluated by the governor and his staff, a winner would be declared, and then it would need to be implemented within a thirty-day period after the governor took office.

Gates spoke up as soon as Marco had finished. "I'll tell you right now, Exabyte is interested. As you know, the governor is currently using our Starscape operating system interfaced to the various Oregon state networks, and so an extension to the national computer grids is something we can do very easily and efficiently."

Jobs chimed right in. "Raspberry, too, is interested. And"—he steepled his fingers—"if you'll indulge me, there's a quote from a twenty-first century hockey player that I love. 'I skate to where the puck is going to be, not where it has been.' If you examine our history, you'll see that Raspberry is best suited to take the governor to where the puck is going to be."

There was some small talk after that, some back-and-forth feigned good-natured kidding between Gates and Jobs, and then the allotted hour had expired. "Gentlemen," I said, as we all stood up, "it's gonna be

fun.” In retrospect, of course, that is not the word one would use to describe the result.

As expected, the first thing the Republicans did was challenge the governor's legitimacy in the Supreme Court. And as Justice Sunnyvale58 said in his 5-4 majority opinion: “The 2080 Court decision [U.S. v. Sarlow] clearly and unambiguously established that entities with Marco scores of 100 or greater, *no matter what their construction or composition,* are constitutionally endowed with the same rights and privileges as human beings. Since indisputable evidence was presented that the appellant [Stanford76] far exceeds the Marco score criterion, he falls within the decision's realm of applicability. Since, further, the appellant was fabricated within the boundaries of the United States more than thirty-five years ago, and has been resident here for more than fourteen years, he unquestionably meets all the requirements of Article II, Section 1 of the Constitution for eligibility for the office of president.” Of course, two of the justices wrote dissenting opinions, but these were for the archives only. The reality was: The race was on.

Again, this is not a history. There's plenty of that, and will be for generations to come (hoping there are such). The sitting president (and, mostly, all he did was sit) was Republican Ian Wheeler, crusty (as they kidded) Maine ex-fisherman, populist, issue-simplifier, isolationist, confrontation-happy vetoer of any and all Congressional legislation. He was a good speaker, give him credit for that. Not bad looking, in a craggy, fishy sort of way. Came from humble beginnings, able to make people feel he was One of Them, and quick to point out that Stanford76 wasn't.

"The principal issue in this race,” he said, in a speech first delivered in Albuquerque and then repeated with minor variations everywhere, “is whether you want to have as your president a being that does not feel pain, a being that has never experienced childbirth, a being that has never *raised* a child, a being that has never shed tears and in fact, cannot shed tears, a being that has never been laid off from a job, a being that has never made love to a woman, a being that has never gone hungry because it doesn't eat, a being that has never worried about where its next job was coming from, a being that has never waited in a doctor's office, never had a headache, never been in a hospital. Do you want such a being to be in charge of our country? Would you trust it to make decisions that may result in your child going off to war? Would you trust it to make economic decisions that will determine if you'll have food on your table? Or your child's table? Would you trust it to make decisions on your medical care?"

Demagoguery 101. A warmed-over, tailored repeat of everything that had ever been said about Catholic candidates, blacks, Jews, Muslims, and, yes, NBIs. Horrible—but effective. Except, as we know, and to the joy of all of us right-thinking, faith-in-humanity progressives, not effective enough. Stanford76, with his reasoned, logical, issue-focused campaign—explaining the advantages he could bring, the efficiencies of integration, the savings, the equality to the capabilities of other countries, the checks and balances on him that would be exercised by Congress, by the courts, by a half dozen ombudsmen groups, by his human vice president—slowly but surely began to take the lead in the polls. People wanted change, something different; yes, they were a bit frightened of him, a bit puzzled, a bit awed, perhaps, but also curious and hopeful. It was pretty clear where we were headed with four more years of Ian Wheeler. With the governor, it would be an adventure, strange, uncharted, but with something that was possibly quite wonderful at the end of it.

Of course, it helped a bit that the governor could be in twenty-five places at once—we'd opted for that number of instantiations (one for every two states)—and make appearances twenty-four hours a day. He could hold over three hundred simultaneous press conferences, while also addressing (and conversing with!) individuals and organizations. He could call up just as many instantaneous facts and figures as could the president, even with Wheeler's implant link to the White House databases. Naturally, Wheeler wouldn't debate him, but it didn't matter. Stanford76 began to pull inexorably, decisively ahead. You could sense it, feel it in the air, hear it in the talk among the young people. And then, just as his message was deepening its roots, as the enthusiasm for him swelled and became palpable, he proceeded to blow

it.

I remember the day and exact time: September 14, 6:05 a.m. We were in San José, and one of my assistants called me. “Hey, jerk, I'm still sleeping, can't—"

"Len, I apologize, but you won't be sorry I woke you. You need to see this. Turn on the holo and tune to CNN."

And there it was, freaking Team Coverage: That night, Stanford76 had gotten married.

* * * *

As everyone knows, the country promptly went crazy. The holocasts, the dailies, the talk shows—it was front page news for two weeks. The HI governor of Oregon and Democratic candidate for president of the United States had taken one Kimberly Louise Bowman to Las Vegas and married her in a civil ceremony. Kimberly, as it turned out, had been his personal secretary for fourteen years and had a five-year-old boy from a previous marriage. Now, it wasn't that this was the first instance an NBI or HI had married a human—it wasn't what you'd call routine, but it certainly had happened before often enough—but this particular HI, at this particular time; *that* was unusual.

"I'm not criticizing,” I said carefully, “but can you just give me a hint as to why exactly now—"

This was twenty minutes after I'd heard the news on CNN. Stanford76 sat across from me, wearing a suit. (Before the campaign, I'd never thought much about the fact that HIs did not have to sleep, did not have to change into their pajamas or shave or shower; they were always ready, except when having their superconducting batteries recharged or replaced, always on, available 24/7.) Ben Ordell, in a robe, looking numb, jaws seeming permanently agape, was on the holophone from Ohio.

"I think it was the proper thing to do,” the governor said. “I think it will humanize me to the public."

"You do..."

"Yes."

"Do you, uh, does one of your emotion modules—"

"I have known Kim for many years. To the best of my ability to discern, the feelings I have for her are indistinguishable from love."

"Uh-huh, uh-huh.” Indistinguishable from love. My own feelings were indistinguishable from retching. It was all I could manage to keep from losing consciousness. “And you did it now because you're confident this will help your chances."

"Yes."

Well, what can I say, except how utterly and completely wrong he was. How totally removed from reality. Within days, the polls showed him dropping fourteen points. When Kimberly went out on the stump with him, shaking hands, speaking to women's groups, giving interviews to the pop holos and mags, he dropped another ten. From a lead of seven clear percentage points, he was down seventeen before anyone knew what hit him. I mean, it wasn't Kim's fault per se; she was charming, articulate, and educated—it was just, well, the country viewed the marriage as a crass, cold, calculated abuse of an age-old human institution in a tawdry, desperate attempt to attract votes. It was perceived as a mockery, and the electorate simply wasn't buying it. Or else they were simply frightened (hell, *I* was frightened). A non-human presidential candidate acting on impulse? Thanks, I'll pass. And pass they did. Another week, another drop of ten in the polls.

There simply was no *spinning* this, no way to *clarify the candidate's position*, or muddy it, no “Oh, what I meant to say was...” There was nothing. The machine had gone out and taken a bride. This was a body blow, a rib-breaker, and there was nothing to do but gasp, suck up the pain, slog ahead on the campaign trail, and hope the fickleness and short memory of the public would begin to erase some of the damage.

And sure enough, slowly, slowly, after another month, the boos at every speech began to subside, the mocking signs grew ever-so-slightly less hostile, the late-night comics made it only their fourth or fifth joke instead of the first, and the anti-Stanford76 demonstrations were less well attended. President Wheeler was not exactly a paragon of popularity: The economy continued its relentless slide into the toilet, the UN passed a censure resolution that severely restricted—again, because of failure to pay its dues—American access to deep space antimatter harvests, and China announced another wage freeze for workers in its U.S. auto plants.

The second week in October, after studying the report from Professor Marco and his team, I met with Bill Gates in the Marriot Seattle Waterfront hotel.

"Bill, as I'm sure you've by now deduced, Exabyte has been selected as the winner.” I extended my palm. “Congratulations."

His tepid handshake was hard to read. “Thank you, Len. Well, that's good, I guess, right? You're going to get a first-class effort."

"I'm sure we will.” I paused. “You are okay with this, yes?"

"Absolutely. I'm very pleased. Any time we beat out Steve ... No, no, seriously, this is a great opportunity for Exabyte and for the country.” His gaze was out the window of the suite, where Mt. Rainier glistened in the distance.

"We're counting on you, Bill. Not only for the installation, but also for the service and support. Obviously, support is a very important part of this."

"Absolutely."

"So the lawyers will draw up the contract.” I smiled. “Four years of support, with an option for another four."

"You got it.” Still no smile. “I just hope the governor..."

"I know what you mean."

* * * *

A week later came the second campaign-turning event. The governor had continued to trail in the polls, not sinking further, but not making up ground either, down by that deadly, constant eighteen points. The general feeling was that that was the deficit he'd carry going into the election, and that it would be insurmountable. And then he was assassinated.

Which, by itself, was no big deal. Someone blew his head off at a rally in Omaha, and someone else blew up another instantiation during a visit to a nursing home in Birmingham. (A third, near-simultaneous attempt on another body was botched in Baton Rouge.) So, okay, loss of property. Expense (pretty much covered by insurance). Shock and affront to the American voting system, not to mention the national psyche. Except it was more than that. Because, at the nursing home, Kimberly had been standing right next to him, and she had been killed for real.

The holo-snippets of the governor—delivering her eulogy (wearing dark glasses, no less), trailing the pallbearers as they emerged from the church, in the limo on the way to the cemetery—flooded the national airwaves. Millions—literally, *millions*—of sympathy cards, flowers, charitable gifts in Kimberly's name poured into campaign headquarters and the governor's mansion in Portland. He'd retreated there after announcing his campaign would be suspended but would at some indeterminate time resume. ("I know that Kimberly would have been the first to agree that we cannot allow the forces of darkness and anarchy to triumph over decency and democracy.")

I remember on the third day after the funeral seeing him in his office, hunched over his desk in semi-darkness. We'd really hardly had time to speak since the awful event.

"John?"

He looked up.

"I, uh, I just wanted, uh, I don't think I've ever really told you, I mean with all the arrangements and everything, the press ... I, well, I just wanted to say how very sorry I am for your loss. I know, I mean, I'm sure it hurts a great deal. There's, you know, never any words that do any good, but—"

"Thank you, Len. I appreciate the thought. Very kind of you. Thank you."

I nodded, lingered an inarticulate moment, then finally left him alone. His demeanor was indistinguishable from grief.

A week later, *a week with no campaigning,* he had jumped thirteen points in the polls. A week after that, he was up by five. When the campaign finally did resume on October 28, he was ahead by nine. He won the national election by eleven percentage points in the popular count.

No one on our side was under any illusion: He'd rode to victory on a sympathy vote. In a terribly sad and perverse way, he'd been right: Kimberly Bowman had indeed humanized him to the public.

He was sworn in on January 2, 2116. A day after the election he'd asked if I would be his chief of staff, and of course I agreed. On Valentine's Day, there was a little mini-ceremony—just Gates, Marco, Ordell, the cabinet members, a few senators, a few staffers including myself, a few Big Contributors—as the Starscape operating system hooked up the president one-by-one to the various national computer grids. It went incredibly smoothly, not a single major hitch, and at the finish Gates gushed, “This is really historic."

And it worked. Worked incredibly well for two and a half splendid years. Years in which federal spending was dramatically reduced, the Superconducting National Transportation System was extended north to Boston and west to St. Louis, the new dollar rose against the new yen and new yuan, the estimated number of rogue NBI factories was cut in half, America regained its right to use the space elevator, and the secession-mongers of the Southwest Alliance at least lowered their voices. Undeniable progress, a raising of the national morale, a renewal of the possibilities of America. And then came the night of August 14, 2119.

This time it happened around 12:15 p.m. I was not exactly asleep, but not far from it when the call came from the president's personal aide.

"Sir, this is Allan."

"Yes."

"The president has frozen."

"What?"

"Completely locked up. He just sits there. Doesn't respond to any questions or stimuli."

I sat up. “Shit.” I forced myself to think. “Are we talking verbal only, or—"

"Voice recognition, optical, keyboard—you name it. His operating system just ... We've tried everything, sir."

"Rebooting?” I felt a sour panic rising like reflux up my esophagus.

"Everything I could think of. Sir, I have to remind you that, although I'm technically knowledgeable, I'm far from an NBI or HI systems expert."

"Did you call service? You gotta call service immediately."

"I did, first thing. That's the problem...."

"What do—okay, give me five minutes, I'll be right over.” I threw the blanket off my legs. “No word of this to anyone, right? Absolutely no one."

"Yes sir. Of course."

The guard at the White House gate let me through with scarcely a glance. It was hardly the first time I'd made an unannounced late-night appearance. I strode quickly through the silent West Wing corridors, barely acknowledged the marine guard in the anteroom, and burst through the Oval Office doors. Stanford76 was seated at the president's desk, commensurate with his usual practice: To visitors and staff alike, the president would appear as much as possible like past holders of the office. He would attend, if not dine at state dinners; he would personally receive guests; he would roll Easter eggs on the South Lawn with the children. Never mind that his actual guts were inside the Oval Office desk, and never mind that a concealed rope of fiberoptic cables as thick as an elephant's trunk led from there to the communications center that linked him to everything and everywhere.

His aide, a young man named Chang with degrees in both poli-sci and software engineering, looked up as I entered. “I—I—I didn't know what to do.” His obvious near hysteria somehow, perversely, managed to calm me.

"It's okay, it's okay. You did the right thing to call me.” I moved toward Stanford76, seated behind the desk. His gaze was fixed straight ahead, eyes open, glassy, unblinking. His limbs were rigid. I waved my arms in front of him. “Mr. President? Mr. President, can you hear me?” Nothing. I turned back to Chang. “You said you called service...."

"As soon as I recognized the problem was beyond my ability to deal with; mine or anyone's on staff here."

"And..."

"They wouldn't help, or couldn't help, or both—I don't know."

"What? What? No, no, no, that makes no sense. What's their number?"

He spoke it into the phone and an instant later the avatar, a pleasant, thirtyish appearing female materialized in the holospace.

"Hello,” came the smoothly synthesized voice. “You have reached the service department of Exabyte

Incorporated. All our lines are busy right now, but there are several alternative options you may wish to try. If you have access to a computer you may go to our website, www.Exabyte.com, where you will see a tab for customer service. If it is technical support you require, you may speak or display the twenty digit purchase order number located on the back panel of the box your equipment came in, and the holo will show you the type of service you are entitled to. If your service contract did not specify phone support or you do not have a service contract, you may nevertheless be able to speak to a technician for an extra charge that will be shown on your phone. Alternately, you can write your problem in an email and receive a guaranteed personal response within twenty-four hours. Yet another option is to consult our list of frequently asked questions, which does not require a service contract. If none of these options is satisfactory, please stay on the line and a representative will be with you shortly."

My hysteria was returning. I motioned to Chang. “You did this?"

"Yes."

"How long—"

"About seventeen minutes. Not too bad."

"Not too bad? *Not too bad?* The United States of America has no president, and you're telling me, ‘Not too bad!’" I saw my own dread mirrored in his eyes and tried to control myself. “All right, okay. I want you to get two people over here immediately. Immediately. The first one is Professor Marco. You have his number?” Wide-eyed nod. “And the next is Bill Gates."

"But—"

"Wake him the fuck up, send marines to his goddamn house, do whatever it is you have to—I want him here! You understand? I want him here, now!” I hated myself for terrorizing the kid, but he seemed in almost the same stasis as the president.

He scurried out. I waited alone in the office, trying to breathe regularly, telling myself to just keep calm, just keep calm, moving my head in circles, shutting my eyes, squeezing that nasty little voice out of my brain that insisted this can't be happening, this can't be happening, this—

"Hello, this is Robert at Exabyte Technical Support, how may I help you?” Very heavy clipped, singsong accent. The name sounded like “A-rubberrrt.” The holo showed a smiling twentyish man with brown skin and jet black hair. At least it was a human, not an avatar.

"This is Leonard Ingerman, chief of staff for President Stanford76. We have an emergency here."

"I'm sorry to hear that, sir. May I have your phone number?"

I gave it to him.

"And that is in...?"

"What do you mean?” I could barely understand his words, some combination of his accent and my own highly emotional state.

"What country are you calling from, sir?"

"America, for chrissake! Where are you?"

"Excuse me, sir?"

"Where ... are ... you ... located?" I wondered if my head would explode before he could answer.

"I am in Bangalore, India, sir."

"Look, we have a horrible emergency here!"

"I understand that, sir. Thank you for the information. Now, can you read or show me the twenty digit purchase order number located on the back panel of the box your equipment came in?"

I felt myself becoming light-headed. "This equipment didn't come in a box. Or maybe it did originally many years ago, but that doesn't matter. This equipment is a hybrid intelligence that is currently president of the United States, and this is a fucking DEFCON 12 emergency! Do ... you ... understand ... me?"

"Yes sir, and I am trying to do my best to help you in this situation, but to do so, I need the twenty digit—"

"I don't have the goddamn number!" I shouted. "I don't have it!"

"I see. Mmmm. Well, then, can you tell me, is the machine in question a QC, a printer, a display—"

I was panting. "The machine in question is an HI. Its operating system is Exabyte Starscape."

"Ah, so this is an operating system problem?"

I didn't know if it was or not. "Yes, that's what it is. A freakin' Exabyte freakin' operating system problem and you—you need to fix it right now. RIGHT NOW."

"Yes, sir, I understand that." Pause. "Can you find a serial number on the side of the machine?"

"What? The machine is, I dunno, in the desk or something."

"Yes, sir. See if it's there."

"Hold on."

I walked around behind Stanford76's chair, moved it back, got down on my hands and knees, and peered under the desk. A squat, featureless, gunmetal gray cabinet rested on the floor. The left face was flush with the desk's mahogany side panel. I stretched and twisted my neck and shoulders around to the right ... and saw the small metallic label about a third of the way down from the top. I called out the embossed serial numbers, then wrenched myself upright.

"Yes, thank you, please give me a moment now, sir."

At that instant, Chang returned. "Marco is on the way. Gates is coming, but he's also sending ahead a repair crew."

"How long?"

"Marco in a half hour, repair crew in a half hour to forty-five minutes, Gates in about an hour."

I exhaled, shut my eyes. My neck ached.

A moment later, Robert returned to the phone. "Sir, I have located that serial number in my database and it is covered by our premiere on-site service contract. We can have someone there by ... mmm ... 10:15 a.m. your time tomorrow."

"Tomorrow."

"Yes, sir."

"Is there anything you can do now? Anyone there who might be able to help me with this over the phone?"

"I can try, sir. Let me ask you this: Is there a keyboard input into the HI?"

I turned to Chang. He pointed to a keyboard on a small end table near one of the upholstered easy chairs. “There is a keyboard,” I said.

"Okay. Now, try this: Simultaneously press down these keys—control, alt, and delete."

I hung up.

* * * *

The rest has been well documented. Gates's crew showed up after thirty-five minutes and isolated the problem a half hour later. Apparently, a bio virus had somehow gotten into one or more of the president's emotion modules, caused the latter to generate signals that overwhelmed the non-bio interfacing and operating systems, and resulted in the equivalent of a nervous breakdown. The suspicion was that the original parasite had been transmitted via a human carrier, and the president's visitor list—which included representatives from China, India, and Korea, as well as Southland and Nevada—was scrutinized for suspects ... but nothing definitive resulted.

The problem was repaired three days later (when the new bio-modules had been programmed and installed), but by that time Vice President Ordell had already convened the cabinet, as required by the twenty-fifth amendment to the Constitution. Further, that body had subsequently transmitted to the President pro tempore of the Senate and Speaker of the House its written declaration that the president was unable to discharge the powers and duties of his office and that therefore Ordell should assume the position as acting president.

I met with Stanford76 at his home in Oregon, where he'd been—I guess the word is “shipped"—after he'd been disconnected from the various computer grids.

"Have you made a decision?” I asked. The reference was to the amendment's Section 4, according to which he could now transmit his own declaration to the House and Senate that his disability no longer existed, and request his restoration to the presidency. Of course, the VP and cabinet could fight it, in which case the entire Congress would need to vote and blah blah blah etcetera.

"Ya. I'm not going back.” He—I guess maybe you'd call it his principal instantiation—was sitting on a lawn chair on his rear patio. (I wondered where in the house the gray metal cabinet was located.) There was a barely perceptible breeze. A sparrow chirped from a nearby tree.

"You're not."

"No."

"May I ask why?"

"Why? Because it could happen again. Because I have no right.” He turned slightly to face away from me. “Because it was a bad idea."

"Well, I guess, I mean it turned out that way, but no one could have foreseen..."

The words hung there. As everyone now knows, what had happened during the time the president was “out” was that all our national computer systems—military, national security, air traffic control, SUNTS, social security, GPS, life extension, electric power grid, even plane and hotel reservations—had been completely infiltrated and disabled. The Southwest Alliance had convened an emergency assembly and had seized the opportunity to secede from the union and declare itself the Southwest Republic. Even under optimistic scenarios, it would take the rest of the U.S. months, if not years, to recover, and until then the country would be in chaos, our government close to anarchy, and our military useless.

"It was a bad idea,” Stanford76 repeated. “The efficiencies I achieved, the advantages I brought, depended on integration, and it was precisely that integration that made us so utterly vulnerable."

"Well, okay, but ... but other countries have made it work. Russia, India, China, Japan...” My words reminded me of the rationale I'd given Evan Hager at what now felt like an eternity ago.

"Maybe their time will come. Anyway, it was a lesson, a very painful one."

"Mmm.” I nodded. A few moments went by; only the sparrow broke the silence. “I guess there's not much more to say."

"Apparently not."

I left him then, sitting motionless on his patio in the August sun.

And so the hearings continue, the endless investigations by every deliberative body ever conceived, the depositions, the committees, the solemn testimonies, the techies (including Marco and Gates and Chang, and even—the only person who actually lost his job as a result of the events—"A-rubberrrt,” on holo from Bangalore), the reporters, the accountants, and ... the attorneys. Miles-long locust swarms of angry, buzzing barristers. I think the number of lawyers on this will eventually exceed even those involved with Marco number lawsuits, maybe even exceed the number of insect species on Earth. It's become not only a national obsession but a veritable national industry. (I've never understood economics, but perhaps it will revive the economy.)

To this day, they still don't know who the culprit is; the likelihood is they never will. The Southwest Republic is, of course, the leading suspect, but China, Russia, and India are not far behind; the anti-space-elevator activists can't be ruled out, and neither can the rogue NBI people; even Ordell is suspected by some, as is Steve Jobs. Regarding motive, take your pick, invent your own, I won't bother with it here.

As for me, well, I've had to retain my own team of lawyers, who will undoubtedly end up with every last new-dollar of savings I've ever managed to accumulate. So mostly I sit around now, preparing for the next deposition, the next testimony, the next face session with the attorneys on how to answer this or that, when to make eye contact, when to invoke the Fifth, etcetera. Occasionally, in all my spare time, I run things through my mind, and sometimes—maybe when I wake up, as I often do, in a nightsweat at 4:00 a.m.—I have what I believe is an original thought about something, an inspiration, a brainstorm.

Except now I just roll over, and keep it to myself.

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Cold Words

Juliette Wade

* * * *

Illustrated by Vincent Di Fate

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Diplomacy demands speaking to the other party in its own language—which includes far more than words.

* * * *

I scent Human outside the door: our linguist, Parker. He never comes to the Ice Home while I attend Cold Council—he must bring important news! I bow to haunches, then excuse myself from Majesty's presence, quickly as I can without inviting snarls from the others.

Parker stands waiting, his body showing agitated despite its covering *clothes*. I've told him many times that decorative cloth is most appropriately displayed on a wall, not dragged through mud and weather—but I won't chide now. I begin to fear for our project.

"Rulii," Parker says, self-lowering with respectful Warm words, "Are you certain there's no way I can enter audience with Majesty Gur-gurne?"

He, enter audience? I lean close to his ear, since listeners would take offense that I don't dominate him with Cold words in reply. "What, Parker, have your superiors abandoned you? Do the *Allied Systems* punish you for our previous failure?"

He shakes his short mane. "No, Rulii. They want too badly to place a *spaceport* here. They may blame me for the language error that cast insult on Majesty, but they still need me for my own studies. I came to tell you the *Systems* have granted my request: a replacement negotiator arrives tonight. But if I could speak to Majesty before she arrives..."

He must fear indeed, to propose such a risk. "What is it? Still the problem of Cold words? Someone of Rank among your people must grasp the dominator's tongue, Parker, or Majesty will brand you Barbarians!"

Parker's fur-naked brown face shows embarrassed. "This new negotiator is a more gifted speaker than the last," he says. *"Officer* Jasmine Hada will speak Cold words well enough not to Warm Majesty's presence inadvertently."

"Then this is news of triumph. We shall have our *spaceport!"* And all that comes with it—so close is the conclusion of my life's hunt!

"Yes, but Hada is *too* skilled. She even bears the authority to propose terms. Why should the *Allied Systems* grant Aurru *spaceport* such importance, if it's meant only to be a way-stop between star territories?" Parker frowns. "I fear some hidden intent of unfairness to the Aurrel people."

My hackles rise. I know much of unfairness, as the only one of Lowland race on the Cold Council—and also of hidden intent. My own is to use this *spaceport* to bring Human silver to the Lowlands, thus raising my nape-bitten race. If Parker scents true, this *Officer* Hada could ruin my hunt before its final pace. "When will she take foot in La-larrai City?"

Parker lowers his head. “She comes down by *shuttle* at the sunset hour. Your presence at her arrival would grant us Cold honor—and we might make sure of her."

Wauuunn! My skin tenses at the thought of ice-winds at sunset. My Lowlander's fine fur gives scant protection, and too little heat remains in my blood, so I'll need more—but how can I refuse? “Yes, I'll go with you."

Parker shifts feet in discomfort, almost like one of us. “Still, I wish we didn't need her. Majesty Gur-gurne would admit me if my Rank were high enough. As Councilor, couldn't *you* raise me enough to try?"

"Parker, you know it's impossible.” I toss my mane. “I'll meet you at sunset, but for now I must return to Council, before Majesty grows impatient."

Too late: Majesty has gone out to choose his dinner, taking Council with him and leaving the outer door open on the stone walkway above the animal pens, where I must follow. My fear of shiver-shame rivals the cold—I should have stoked my blood hotter before I left my house.

Outside, sun lowers toward its set, blooding the snow-heavy peaks of the Dominator's Teeth against the sky. Majesty paces beside his lengthening shadow, with heavy beads of silver-glass chiming in his dark mane: royal ice that only he of most exalted Cold may bear. Below the stone walkway, a dozen horn-blunted urrgai have been separated from the mobs in the pens, lined up with their rumps within his reach. He comments on their quality while his submissive heavy-furred Councilors bob their noses approvingly.

No hunting pack, these!

Blunted now is the fierceness that incited their tundra ancestors to annex our lands. They depend on the urrgai that our Lowland Clans first bred tame, and their ancient hunt-calls have changed in sense, to Cold words proclaiming dominator status. Only in Majesty's exalted presence must the Cold words be used by all as they were long ago: the language of the ice-hunters.

"Ru-rulii! Bow-bow,” Majesty orders. “Come, tell me of your Human petitioner.” All along his dense-furred muzzle, Cold words shape the satisfied smile of the superior race.

I could bite him.

"Bel-belly, Majesty.” I bow to haunches on the stones, lower my head. “Par-parker tells me that the new Human negotiator, *Officer* Ha-hada, comes tonight. Hint-hint: grant me your favor for the meeting."

Majesty makes me wait. No more than I expect, after that first debacle. But he hasn't expelled me from Council, nor shamed me through the Clans. He still entertains me in my pursuit of the *spaceport*.

Wind ruffles my mane-hackles, carrying no scent of spring-wake so soon to come. Instead it carries the scent of Councilors, the rank stink of Majesty's favor—also the tempting smell of urrgai. Hunger rouses as my blood heat wanes; soon it will turn savage.

"Bite-bite,” Majesty offers insult. “These Humans beneath their adornments are pup-naked; they bore me."

I stay low. “Bel-belly: they offer silver, cloth, the unimaginable. They *fly*."

Majesty tosses his royal-beaded head. “Bite-bite: so they are like grouse; how pitiful."

"Hint-hint," I beg. "Their *spaceport* can be built on Lowland south of the riverport in Ro-roghell: a safe distance from here, yet well protected from any Barbarian incursion. Their offered price is tenfold generosity. Bel-belly: name a day when I may bring them before you."

"Bite-bite," says Majesty, without force. "Their talker Par-parker is Warm, speaks Warm."

With one snap he insults Parker, and insults me. Majesty is too Cold for patience: should we offend him even once more, he will exile Humans among the Barbarians who threaten the borders of our tribute nations.

But if *Officer* Hada succeeds? This Human *spaceport* promises riches wherever it is built! Majesty Gur-gurne cares nothing for Lowland; he will give it away with tail turned, and on Human silver, Lowland will rise.

"Bel-belly," I humble myself lower. "Majesty, the talker Par-parker shall not warm your presence. The negotiator, *Officer* Ha-hada, begs Cold audience."

Again Majesty makes me wait. Ice-wind penetrates my fur; I begin to feel it. If I don't find privacy soon, I risk being cast down among the Shiverers—

But now Majesty raises his hand to my mane, behind my ear. Hooking with his thumbs, he spreads his finger pads apart, strokes in favor-scent above the bronze beads that mark my Councilor's Rank.

"Thank-thank," I say. "Cold honor, Majesty. Bel-belly, the audience—"

Majesty interrupts, a laugh-howl to the harsh chime of royal ice. "Ru-rulii, bow-bow: go, welcome your Human, but I grant no audience today."

I bow my head. Parker will expect me soon; I must hide myself in safety, put cold and hunger at bay before I go to face what *Officer* Hada may bring. Once out of sight, I run full fours from the wind, back to my house to fill my need for molri.

* * * *

Molri dominates my thoughts by the time I reach my house. I take the fat-lamp down from the urrgai-horn above my lintel, and light it at the drowsy log fire in my confronting-room. I unbolt my inner door and rush through my den rooms, where the walls are covered with tight-stitched furs against the invading cold. These walls replaced the battle gear I shed when Majesty Gur-gurne called me from the Barbarian front to create me Councilor in La-larrai City—but when I go outside to better my Lowland race, I need different armor.

In the flaying room, I open the ice-locker. Ah, the sight of hanging sides of urrgai, buolun! Hunger howls, fiercened by molri's delays. I could eat an entire beast at once, but mustn't yet; I push through to the back where my molri is stacked on the ice-blocks, take up three short sticks and crush them between my hindteeth.

A rise of slow pleasure dilutes the pain of chewing bitter wood. I quiver and weep as the sweet thaw moves outward. Molri at winter's end lacks potency to heat my resistant blood, yet if I sought stronger—in the mature bark the tanners use to stew their leathers—then death would snap me quick. One more stick. A risk, with so little left and no idea when spring-wake will bring fresh shoots. This one sends heat to my toes; also to my head, bringing agitation, but shiver-shame is the more serious danger tonight. A mouthful of herb to confuse the smell, and then out I go to find Parker.

I race through streets where the snowless winds have frozen mud to ice. My mouth aches. As pleasure

fades the pain will worsen, along with aggression, hunger, exhaustion—but I could never raise my people without molri. My Barbarian victories alone could not keep me in Council if I were seen to shiver! Shiverers are demeaned and expelled from all worthy places of company, reduced to covering themselves with prey-fur in subversion of natural order. I had enough of that in puphood—so I chew my sticks, and go to meet Parker. This Human *spaceport* will allow me to land the quarry that has eluded me in a lifetime of hunting alone.

The sky yet glows when I find Parker on the flat land beyond the Stinking District. Parker insists the Human *shuttle* lands safest here, but I don't like it; it drags of my indigent years in Ro-roghell. I wonder that Parker's short nose does not object, as mine does, to the vermin-infested roofs of untanned prey-hide. My heart rushes with hot, irritated blood, and my feet urge to move—perhaps I have chewed too much molri.

"Rulii!" Parker calls. "I'm grateful you join me here."

I stand to match his height, shifting my belt-purse to my stomach. "Parker, I could hardly be elsewhere on such an occasion! I hope you are wrong about *Officer* Hada—and that she speaks Cold as promised."

Parker gives his strange flat smile of blunt teeth. "Rulii, I've never told you this, but I'm thankful for your kindness in speaking Warm to me."

Is this kindness? No; it's a compromise of ignorance! I don't know how to place Humans into natural order, for though Parker and I have gained some interdependence, I still struggle to place his Rank. Should I not self-lower before the Human wealth, and respect their promises, which are all my hope? "I show respect to rich Human offers, Parker. You might stand Cold if you chose."

"Dominate *you?* I don't think so. If I had *that* measure of skill in Aurrel language, our first negotiation would not have failed."

I toss my mane. "Ar, do not pretend modesty, Parker. You were diverted from your work to become *translator;* you didn't expect to act as language teacher when Majesty would not admit you to audience! Never deny that you speak Aurrel." Indeed, he speaks too well; even the first day I met him I felt the measure of his years here. Whenever I look at his strangeness, I fear our Warm speech makes us sound a pair of gutter-hounds; yet when I listen blind, we seem littermates, such is this talker's skill. I do not know to love or cringe, that a foreign creature can nudge me so close.

Parker smiles again. "Rulii, no matter what happens tonight, you must know that my best prize in this negotiation has been meeting you—you are a good *friend*."

Friend? Parker has explained this word to me: a close person, not skin-close as a littermate or consort, but closer than huntmate, because *friend* implies interdependence without Rank. Interdependence without Rank! I didn't believe it possible until I saw him send the failed Human negotiator away—dismiss a superior, yet himself remain unscarred, unshamed. Then I scented how small is my understanding of Humans, and of him. How can he call me *good friend?*

"I don't know," I say. "I tried to beg audience for *Officer* Hada today, but could not."

"It's for the best. I am sure you will succeed another day."

His trust makes me nervous, restless. Somehow I think this *Officer* Hada will be easier: she shall dominate us both as Rank demands. I wait for natural order to descend from the pale-touched sky.

"Rulii," Parker asks suddenly. "Do you feel well?"

Wauuunn! I, well? Gums sore, blood impatient, stomach snarling? An instant I want to curl and weep; but looking at him, I show my teeth. "Why do you ask me this?"

"I'm sorry." Parker shows me his hands: short, stiff, single thumbs placed far to the side; long, long, soft brown fingers ending in covers like pale coins instead of claws.

Hand-showing, a Human submission move. But the rest of his body speaks anxiety.

"Rulii," he says. "You've given unexpected gifts to my own project here. My *scientist* huntmates have struggled to win contacts among your people, but you have helped us to learn Aurrel ways and nature as none other before."

I toss my mane. "You demand little, Parker; it is easy to satisfy you."

"So you've told me." He breathes deep, shifts feet. "Except, we found—well, we made more discoveries than we looked for, after you permitted our *imaging,* and gave us of your hair—" He looks away to one side. "—and your blood."

"Discoveries?" I ask. "But blood is blood, of one color whether of Councilor, Shiverer, Tributary or Barbarian."

"Ahm—then let us speak of it later." Still he shows anxious: watches me from eye-corners, and hides his hands in purses at his hips. He often hides his hands when they feel chill; *clothes* may serve Humans like fur, I think, to warm as well as to allow these flat-muzzled, unpatterned creatures to distinguish one another. This time, though, it is body-talk, and his stance troubles me. Should I fear, as he does?

I hear an ear-paining whine, and soon the *shuttle* comes down on our sleeping soil. Parker runs toward the thing, but to me its sound shrieks *run*—I wait till it quiets, walk to flank Parker as the door opens.

Hada, a tiny female, emerges from strange light. So different from Parker! Her mane is beautiful, long black streaked with gray—but her face? So flat it seems impossible.

"Welcome to you," says Parker, Warm and respectful. Perhaps because of his suspicions, he doesn't use 'belly to you,' the submissor's greeting—yet his body submits as his words do not. He curves his spine, lowers his head. *"Officer* Jasmine Hada, word of your skills comes before you, and we are honored."

"Belly to you," I add, bowing also, but too tense to fall to haunches—how fortunate that Humans prefer to stand. "I am Rulii, of the Cold Council. Eagerly I have awaited your coming, honored Hada."

Hada speaks, Cold words in a high sweet rowill-song voice. "Thank-thank: you do well to meet me here, host Councilor Ru-rulii. Your sponsorship grants us Cold honor in our pursuit of richer trade through this territory of stars."

Perfect!

Wrong.

Her speech turns my stomach as even the Barbarian dialects do not—I cannot think why! I try to respond, but she flickers one hand up to her head, gesturing an ear turned toward Parker. "Bow-bow," she says. "I favor you, Par-parker, for the language information you have given me. This opportunity gives me deep pleasure."

The word ‘pleasure’ in my ear spikes need through my spine; my stomach pangs.

"Thank, Hada,” Parker says. “I wonder—” He looks at me. “Rulii, what's wrong?"

What can I say? I lower my head, showing sorry. “Parker, the Cold words of honored Hada strike me strangely."

"Strangely?” Parker sounds surprised. “How so?"

How can I explain what I don't understand? Hada's Cold words are perfect! Her motion too enspirits Aurrel, so why this revulsion? Why this urge to scream pretender, wretch, when she brings everything I have desired? I came here wary of deception, yet never imagined *this!*

"Bow-bow,” Hada says. “Par-parker, if you did not have the language problem solved, you should not have requested my services."

Instantly, Parker tenses for Rank dispute.

But why? He never fought Rank with the last Human councilor, even while sending him away! Now he and Hada stand confronting, each as alien as the other. I can't stand to watch them. My ears pull back; my feet try to move, pace, run.

Parker backs from his aggression. “Rulii,” he murmurs. “Are you all right?"

To answer would weaken me before a dominator. I walk away fast, fight the urge to drop to fours on uneven ground patched here and there with old snow. Night wind rakes claws through my fur; Hada's Cold words torment me. What is it—the wind, the stink, her alien appearance, her odd sweet smell that gives me such horror to hear her speak? Or is it my own agitated imagining?

"Hark! Rulii!” Parker's urgent voice, Warm like a brother at my ear. “Have we offended you? Tell me how to amend."

I want to snap at him, but stop myself, recognizing molri-aggression. My blood poison has confused me; perhaps I'm wrong about *Officer* Hada, and should accept her obvious skill—but somehow I cannot. “Parker, I'm sorry. I cannot bring honored Hada before Majesty."

"Why is this?"

"Majesty will not accept her. She is—” Warm? Vile? Presumptuous? What?

"Rulii, what is she?"

Too nervous, I can't think! Hunger sinks teeth in me; when I look at Parker, shameful pup-urges tempt me to lick his chin. My skin begins to fear the wind.

"So sorry,” I say, “she's not ready."

"Please,” Parker says. “Rulii, please tell me why."

"She is *not ready!”* I leap to fours, and run. Humans surpass in walking, but not running, so Parker won't catch me; yet fast as wind I could never outrun myself. Escaping the stink, I let anger drive my footsteps back to the ice-locker, to the source of my failure. The sight of molri dizzies me. How this poison-bark mocks! Keeping me Councilor in La-larrai, allowing me to pursue this *spaceport*—yet bringing me down just when my quarry is in sight?

Fury clenches my fists around the sticks; I race to my confronting-room before need can stop me, and dash them into the fire.

* * * *

Now my folly turns teeth and bites. Why, why did I burn it all?

Need-sickness has defeated my soldier's will. My mouth gapes dry while my skin pulls tight, every scar stretched—and twice my illness has forced me to plead away from Cold Council. Though warmer breezes have spared me public shiver-shame, they haven't brought me the molri scent I weep for.

In such condition, I haven't dared face Hada to hear her Cold words again—and Parker has sent no word to confirm or deny his suspicions of her. I had hoped my sickly silence would gain each of us time to seek answers, but tonight I learn it has only baited Majesty's curiosity. He demands that I bring Hada for audience at dinner tomorrow.

I drag my feet downslope toward Parker's house. The shadow of the old city wall seeps nearer amidst Cold houses of stone and iron, inexorable as the disaster reaching toward me. All around, muddled sunset breezes taunt of spring-wake, but as I pass through the enclosed arch into Westrun district, the urgent scent of Majesty's favor in my mane makes me feel ill.

At Parker's house, a fat-lamp glimmers above the door. I gather myself and enter.

His is a strange confronting-room: the hearth empty; the floor strewn with red-tasseled cloth cushions that would be ruined in a fight; the mottled stones and beams warmed by sourceless light; and only a single lacquered leatherwork on the wall, one I gave him from my own collection. The slots of his inner door will admit my scent, and Majesty's, to the den rooms, but what nose there could recognize them?

Someone does stand guard, though—Parker opens the inner door. His den rooms exhale moist air smelling of steamed grain and leaves: a manger smell, except no person would ever *cook* for his urrgai, or even a house-kept ogollo! A baffling smell, singular to this house in all Aurru.

"Parker," I say, sinking to haunches. "Suffer me to tread your territory?"

"Rulii!" Parker smiles to see me, yet his body shows more anxious than ever. "Please, come in, will you take meat?"

My stomach rolls. "Thank: no meat, only words."

"We'll come to you, then," he says. "Make welcome."

Now *Officer* Hada emerges from within. Less sweetness in her scent today, but she is draped with a long embroidered flag that entirely hides her legs.

Ah, this female—no muzzle, now no legs? I feel faint!

"Hint-hint," Hada says. "Please, Councilor, sit down."

My mane-hackles bristle; with or without molri, her Cold words anguish me. I sink to haunches among the tasseled cushions, rest my hands on my knees while my head weighs like stone. Of what use Majesty's interest, if Hada fails before him? Without this *spaceport*, the best chance for my people is lost—oh, I will die! How could I bear to run longer?

"Forgive our many mistakes in this hunt," says Parker. "You run swiftly, while we stumble at your hind haunch, but we mean no insult. Why do you say that Hada is not ready for audience with Majesty

Gur-gurne?"

If he signals to me of her intent, I can't detect it. “I lay you no blame, Parker. Honored Hada, your Cold words are masterful—I cannot understand the instinct that moves me against them. Were I Majesty, I should long since have granted land for your *spaceport*. It shall be a wonder, and a prize for many.” I must tell them their audience is already won, but I can't say the words.

"Councilor,” says Hada. With the tang of tension rising from her, and the narrowing of her hidden-lid eyes, I think she mistrusts me. “Hint-hint: perhaps Majesty Gur-gurne desires more than this. More silver we may provide; engines; tools for mining which spare much labor. We can grant such to Au-aurru, if we achieve the audience we seek."

She baits greed with me. At once Parker straightens indignantly—I speak before he can offer Rank dispute. “Your offers chill me to awe, honored Hada, but you misunderstand the trap in which we now stand. Just tonight, Majesty has asked to see you."

"Tonight?” Hada mimes attentive ears with her cupped hands. “Bow-bow: happy news. I see no trap."

"No trap Majesty himself has laid. But if we insult him twice over we end our hunt hungry, no matter what the price.” I bend to the cushions, lower my chin to my hands in apology for what must be said. “Honored Hada, to me your Cold words sound as the pretender's yap; how, then, should they sway my impatient Majesty? I scent failure imminent, though I know not the cause. I do not wish Majesty to brand Humans a Barbarian Race."

"Barbarian Race!” Suddenly Hada's pose speaks of outrage, and Cold disdain. She turns away from me. “Par-parker, bow-bow: I will not stand responsible for this! Bite-bite: the fault must be in the Cold words you have sent me to learn."

Were Parker one of my own people, I should see his hackles rise. “Hada,” he says, “you grasp language too simply. Do you think I run deaf and blind here for seven years, to instruct you astray? Think which is your own territory, and which mine."

Territory? But this seems another dispute of Rank! Both their bodies claim Cold dominance though Parker doesn't change his Warm words. I have never seen Humans grapple—will they now?

No: Hada chatters sharply in her own language, a sound of bone flutes rattling on stone. Parker's face and body tell me he understands, but he chooses his own tongue to growl back. Then Hada turns to me. Her black eyes glitter rage, like the cornered gharralli.

"Host Councilor, Bow-bow: you have long honored Par-parker, taking him as your huntmate, but our pursuit is larger. I would prefer to meet Majesty Gur-gurne without you."

I shake my head. “What?"

"Hada, think,” says Parker. “Only a member of the Cold Council can sponsor audience."

"Bow-bow: then I should withdraw, Par-parker, and you begin again. I think another sponsor may advance us without Ru-rulii's objections."

Parker protests. “Begin *again?* Do you know how hard it was for me to find Rulii, when our research group remains under cover of wilderness, unable to establish public presence?"

"Bow-bow,” Hada frowns. “You will not distract me into advancing your private aims, Par-parker. My concern is for *Systems* goals here."

"And what might those goals be? Polishing your own reputation, perhaps?"

This is beyond endurance! “Parker!” I cry. “Honored Hada, listen. There is no other in all Aurru to aid you as I do. Leave me, and your *spaceport* fails."

Hada snaps her head around to face me. “Ru-rulii, bow-bow: then say *why* it is you want us for yourself so badly. You hide your true motive from us."

Wauuunn! My true motive flouts Rank, first tenet of natural order! What will they do if I reveal the secret I have so carefully guarded?

"Honored Hada,” I say, “the other Councilors are heavy-furred. As dominators they already control all tribute, and they will not nose your bait of silver or engines. But for my Lowland people who now have nothing? Despised for Shiverers, our goods and animals taken without recompense? Your *spaceport* is a promise such as I have never seen! How should I not give my last breath for your success?"

Hada's eyes fix on me. The dominator who depends on Rank will resent interdependence; she will despise me for my presumption. I try not to belly abject on the cushions before her.

"Bite-bite,” she says. “I think you lie, if you deny you want riches for yourself. You have *personal* reasons to need them."

Not the attack I expected! I shake my mane. “What?"

"Hada,” Parker warns softly. “Majesty Gur-gurne personally granted Rulii's place at Council for heroism. He has never dishonored our goals in any way. I have given you information concerning the race division between the long-furred and downy-furred Aurrel Clans; this only confirms that Rulii will support us fully. Should he not bear concern for our success?"

Her spine is a knife. “Bite-bite,” she says. “His problem—"

But Parker interrupts her in his own language, pleading with body and face. In his shallow gurgles I recognize the word, *friend*.

I tense. Does he make public claim of intimacy with me? But though insolent, this word *friend* is obviously powerful, for it softens Hada's pose.

"Hark-hark,” Hada says. “Please excuse me, Councilor; we will speak again.” She departs through Parker's inner door, her strange flag undulating with the movements of her hidden feet.

Parker looks at me; I look at him. His mix of familiar and strange may be difficult, but still I prefer him to Hada—I *know* him. This flat brown face, the short curled mane and soft fingers, they are all *Parker*. His voice is the only one in La-larrai to speak kindly to me.

I could weep.

I did not fight my last battle on the field: I grappled sweat-teeth-and-claw to drive away Barruna, the last littermate who nudged for passage through my inner door. Where molri dominates can be only loneliness—but I have been very lonely.

"Rulii,” Parker says. “I want to explain something to you."

I keep cautious eyes on him. “Your word, *friend?"*

"No, the work of *Officer* Jasmine Hada. Hada roves star territories. She works six months to learn what

might take others six years, arrives, speaks, departs. She has great skill, but she doesn't solve problems; only deftly uses the solution provided to her. Since her arrival I've detected no deception, only support for our *spaceport* project. But seeing her Cold words fail, she fears that her next hunt will be delayed."

I shift my seat. “What you describe seems no hunt, Parker. Only the scavenger doesn't expect to find its meat still struggling."

Parker's eyes widen, white rims around deep brown. “Scavenger!” A contained laugh gurgles, then dies in his chest. “Rulii, you've helped me in my own research without objection, but I hope I haven't made myself scavenger in your eyes."

"Certainly not, Parker.” I close my eyes, turn ears to him, so that I may feel him closer. “I don't mock when I name you huntmate."

"You are kind, Rulii."

"And you are Warm, Parker. No insult, but from my Lowland heart."

He remains silent a moment. “I wonder,” he says. “Hada believes you treat us differently from your own Aurrel people, that you judge us lower for our foreign appearance—and this is a thing that Humans don't like."

"I would never. To treat you thus would be to give you up already for Barbarians. I strive to face Humans in thoughtful respect: Hada as my dominator, you as—” I am moved to confess, “You, as my brother."

"Rulii—your *brother?Waauw."* This sounds almost a lament, but soon I realize it must be one of his own words. He sits quiet, and though my contentment would be lost if he came nearer, I wish him beside me. “Rulii,” he says. “I know you're ill. If you can name me brother, will you permit me to help you?"

Fear seeps into my thickened blood. I stare at the stone wall—if I look at him, I might panic. “A malady of the season, no more. It will pass."

Parker sighs. “My *scientists,"* he says. “They have looked into your blood."

"Into it?” My sinews tense, stabbing pain.

"Rulii, they see something there—a medicine—I don't know how it is delivered, but I know it hurts you."

Molri—he knows of the *molri!* I will be named impostor, chained to die of exposure on the Dominator's Teeth! My voice quavers. “This is not help, Parker; you ruin me."

"I don't ask for reasons,” Parker says. “It shall not bear on your honored sponsorship. You have helped me; now let me help you in return."

"Wauuunn!” I cry. “Parker, you will *end* me!” On fours I stumble to his door, struggle into the street. The flood of spring-wake breeze dizzies me with need—yes, there is molri-scent at last! I know where I must go.

Parker follows. I hear him calling behind me—press faster, every fiber of my muscles strung with threads of pain. At last his noises fall behind.

Now I take to hind-toes, to walk cleaner and with less public notice. The scent of Majesty's favor draws unfortunate attention, but it somewhat confuses my own scent, and its authority lowers heads around me,

shielding me from curious eyes.

Every roundabout turn is mudded with spring-wake and with shame. Above, a slim-moon sky weighs of alien star territories; the close streets are more familiar, my own furred people walking between the fat-lamps that invite welcome above the doors. How fortunate that I scent only strangers.

The death smell of the tanner's district thickens ahead: prey-hide torn from bodies, mature molri-bark torn from twisted trees. But the fresh scent remains. New shoots are here somewhere. Disgust and desire churn together, and my feet begin to tumble over each other. I shouldn't rush like this. What if others also seek the shoots? What if the tanners' patrols walk their fences late?

Does it matter tonight if I'm seen, when Parker knows what even my own littermates do not? Would he protect me, if only to advance his own cause?

Sheer habit forces me to caution. I fall to fours and creep low past the tanning houses, hoping that no one has put nose to guard.

Outside the stone fences the wind blows colder. Pain-threads knot beneath each of my standing hairs; I begin to shiver. I start my search in the safest place, by the woodland edge, following my nose between dirty humps of shaded snow, over rough ground softened here and there with sprouting grasses.

Others have been here today. I smell musk, overturned dirt, crushed molri, but find nothing. Molri shoots loom in my waking dream as tall as the Dominator's Teeth; I groan aloud.

I must go closer to the fences.

Scent grows in my nose along with danger. There—where a thick root twines beneath the stone fence of the tanner's yard, a clump of fresh suckers has sprouted as yet undetected by patrol. More, and taller than I'd hoped. I draw a musk-perfumed cloth from my purse, hold my knife with my thumbs. My hands shake, while I press the shoots between blade and finger pads. I feel around to wrap any fallen shoots in the cloth. Their fresh-cut odor drowns me.

I can't wait; I bring a hand to my mouth.

Aaaah—

A wet thaw-feeling—my hand is wet, saliva drooling from the corner of my mouth, my stomach sparking fire. My thoughts clear suddenly at a sound of footsteps.

How much have I eaten?

I never chew molri by the fences, only inside my house where it is safe! Fool, fool!

I gather knife and cloth, push them into my waist-purse, then drop to fours and go. Past the tanning-houses I race, ears turned backward. No one emerges pursuing, but I won't make it home before I am altered—my body can't go fast enough!

Or maybe I do have a chance: gradually the pain-threads come undone, my muscles ease and lengthen, strand by strand. A longer stride; now a full stride, a reaching stride, delicious! Faster, faster, avoid the street of Parker's house, yes, I can make it home in time.

Faster, faster, running feels good.

So good!

The cold night can't touch me, open streets on every side beckon outward—I run too fast to turn, could laugh, *hahuu,* but would rather run, run. I shoot inward through the old city gate, a stone from a sling.

Why do I go home when I could hunt?

Why hunt, when I could leap to the stars?

Star territories in my stride!

No, home; I must go home, go home. Someone ahead, so go around? But just watch, they'll never catch me, I am too fast-fast! A race, a game: who will get to Rulii's home first?

Rulii will! Hahuu, no one is faster than I!

Round the corner I scent Human; I tumble to a stop, laughing. There Parker stands at my darkened door, tense, small.

"Parker!" I butt his chest, cuff-embrace, lick his face. "Cheer yourself, brother Parker, cheer, come in, make welcome!"

"Whouu, Rulii?"

"Hahuu!" I hop through my door, light lamps, fetch my best cushions for the empty floor, stoke the fire but I am hotter—oh I love my house! I twirl, dance, "Come in, Parker, make welcome, come play!"

Parker shuts the door, poor fellow, so slow. "Rulii, are you all right?"

"Hahuu, Parker, shall we play a game? Such a funny pup!" I pounce and tumble him, catch him in my arms, roll him over me, pin him on the cushions.

"Rulii, what—what are you doing?"

"Hahuu!" I burrow my nose into his funny false fur to his pup-skin, sniff-laugh-laugh. "Parker, my funny brother—hahuu—you are as smooth as—as a big nipple!"

He pants like me. "Ru—"

I cry it out. "Ruuuuuu!"

He tries to get up; I pin him again, nuzzle his neck.

"Parker, I have no *friend,* no *friend* but you, Parker-brother-*friend!"*

My stomach lurches suddenly; I jerk away, vomit on the stones—green of crushed molri.

"Ghaad." Parker stands up, shakes his hands. "Stop, Rulii, stop!"

I toss my mane. "Hahuu! Now it's out, Parker, oh, I hate molri! Now it's out I am happy-happy!" I leap, fall to fours, chase in a circle with my tail high, pat the floor at his feet. "Come again, Parker, come play."

"No, Rulii, you scare me, you need help."

"I am fine-fine." I pant at him, pat the floor again. "Come come."

"You need medicine, before this kills you, whatever it is. I prepared for this, I brought—" He turns, takes two steps toward the outer door.

NO!

"No doctors!" I bunch leap bite throw—

His limbs splay, his head hits, he falls—

Parker limp, crumpled on my floor. Sour blood on my teeth, blood soaking fast from his hip, blood of one color whether Shiverer-Tributary-Barbarian-Human-Rulii-Parker! Oh, I have killed him, what have I done, what have I done?

Get help. Get help, how can I get help, no doctors, no doctors? What can I do? Oh Parker oh brother brother Parker!

He moves. Opens eyes, curls on his side in pain. His hand creeps to his chest.

"Parker," I moan, reach for him, "Parker belly sorry Parker what can I do? Wauuunn!" I can't turn away; I can't stand still, my feet stamp, stamp, I turn in a circle. Now he holds a small gleaming object beside his mouth.

"Hada," he says. I can't understand the rest.

My door bursts open. I jump backward—Hada stands fierce pointing something at me. A weapon—must be a weapon, I have not seen its like.

Parker struggles to sit, falls back.

My words tumble tangle, "Hada, help, help Parker, quick, help!"

Gharralli-black eyes. "Bow-bow belly down," she shrieks. "Hold still, Councilor, or you die!"

Hold still? "Wauuunn!" I back to the wall, rock, stamp, swish my tail, toss my head. Hold still? Hold still? I will burn up!

"Leave him," Parker grunts. "Me first."

Hada puts away her weapon, takes her eyes off me. I hop-hop backward, run a circle back to Parker. Hada holds a case open—jewelry, liquor-jars, and light inside—pulls back Parker's clothes—blood, blood—everything so slow, so slow, is she in time? Have I killed him, Parker my brother? Slow, slow, she works; slow, the blood stops. Now only closed marks of my teeth on brown pup skin.

"Parker, Parker," I cry, "belly, sorry!" My body fists, my stomach heaves, I fall to fours, off my feet. Parker says something—Hada comes at me—I can't release arms, legs—dizzy—Hada's face all fear, no weapon but a needle in her hand. Plunges it into my neck.

Cold.

* * * *

Human voices speak across the room.

Hada, angry. Parker, weak—and a third, unexpected, calm but oddly far away like a voice around a corner.

I can't turn to look; my body quakes in shiver-shame, reliving an ancient invasion. Cold overruns Warm until my every vein flows with snowmelt. "I have ended my own hunt," I mutter through chattering teeth. "I will die." Yes—climb the Dominator's Teeth before anyone can chain me, and leap the cliffs.

"Hark.” Parker's voice, soft, in Aurrel. Wauuunn—I felt him my brother, but like Barruna now he will hate me! “Rulii,” he says, “You won't die. We gave you our medicine at the right time. Hada, we must help him. Find blankets."

Hada speaks low in her language, harshly.

"Yes,” I say. “Show no mercy. I'll kill myself if you do not kill me first."

But a warm thing drapes over my shoulders: Hada stands over me, tinier without an outer layer of her *clothes*.

"Rulii,” Parker's voice speaks full of sighs. “You didn't mean to hurt me. You were not yourself."

I manage to turn my head, find him close by, lying on the cushions. Ah, the sight of him, his *clothes* torn and blood-soaked! I remember my teeth sinking into him—my stomach heaves, but I am already empty. I moan, “I belly to you, Parker—belly, sorry!"

Hada bends over me, presses on my neck, mutters to a gleaming object in her hand and a voice comes from it. It speaks and speaks as she moves around me, nudging, poking, pricking. At last she looks at me Coldly. “Hark-hark: you and Par-parker will both mend, but you have made a grave error."

I try to hide my nose with my hand still shaking. “It is my shame, honored Hada. I did not know Humans were so—fragile."

"Bite-bite,” she says contemptuously. “No, your error was your medicine."

"Molri,” I sigh. “Indeed.” No heat left in me. As yet, no aches or hungers to replace it, but for how long?

"Hada,” Parker says, “help me closer to him.” He groans as he shifts nearer, even with Hada half lifting him. He lays a warm flat hand beside my nose. “Rulii,” he says. “I have known of your medicine—molri—months already. It's been one of my major projects."

"It has?” Dizzying thought.

"Yes. Else I could not have helped you tonight. I don't wish you to eat it again."

Were he not touching me, I would hide my face. “My need—"

Hada snorts.

"We have something else,” says Parker. “A different medicine, which I asked my *scientists* to fit to you. But it won't give the pleasure you have known, which may be difficult."

"What?” I raise my head to look into his eyes. “Is this what you think of me, Parker? That I would submit myself to molri merely for *pleasure?* Such a thing merits no suffering nor sacrifice!"

Hada's voice is brittle. “Sniff-sniff: what *else* can it be for?"

I push up on my elbow, shake my mane. “A singular reason: to stop me shivering. Else I could rise no higher than any other Lowlander."

"Shivering! *Ghaad."* Parker hides his brown face with his hands, muttering. “Rulii,” he says. “Truly is this separation in the Clans not about appearance, about *seeing* fine or heavy fur, but about *shivering?"*

"For certain!” I toss my mane. “The Shiverer is weak, unworthy, as I am without my molri. Though

tonight I have shown unworthy even with it." What a puzzle—can he have run here for so many years and never understood this?

Hada blinks her dark eyes, shakes her head. "Sniff-sniff: why do you not wear *clothes?"*

Parker scoffs even before I do. "Hada, no one wears *clothes* here. Cloth itself is a great luxury. Rulii tells me I need not flaunt Human riches as I do, but I would prefer to show wealth by wearing cloth than poverty by wearing skins."

"Parker—" I must ask. "Your new medicine—will it stop me shivering?"

He sighs. "I don't know."

"Wauuunn!"

"Yet it may—Rulii, it may, I'll ask for you." He bends close. "It's not fair, that you could be forced to this, an *addiction,* a—a dangerous medicine, simply because of the fur you were born to. Humans have experienced things like this; I've told you we don't like to see people scorned for such reasons."

Hada rouses. "Par-parker, bow-bow: we cannot intervene in Aurrel ways. Do not let this personal thing influence our project here."

"But if Majesty Gur-gurne despises Lowlanders just as he despises us, it has every bearing on our success. Of all Lowlanders only Rulii has risen this far—and at such a cost! It is no wonder that he dislikes Rank!"

That gets me up. I struggle to haunches, toss my mane, indignant. "Parker, how can you say this? *I,* dislike the Rank I have fought my whole life to gain?"

Parker shows me his hands. "Belly, sorry," he says. "But you say you want to advance your people, Rulii. We understand this: our world has worked hard to free itself from Rank, and we could do more than offer riches here. We could press your people's suit with Majesty!"

"Stop!" I show my teeth. "Attempt to do so, and I will shame you for Barbarians myself!"

"Par-parker," Hada says. She rises now, claiming Cold dominance. "Bow-bow: remember who is the negotiator here, and who the talker. If these people will not rise above such simple distinctions, we cannot help them."

"Simple!" Their strange disputes are suddenly explained—in fury I surge to my feet. "Bow-bow, you Humans, listen to me! Are we simple, we Au-aurrel, just because we know natural order when we see it? Hark-hark: simple, yes: simple and *true!* Bite-bite: you claim you do not like to see a people lowered unfairly, but you lower *mine,* only because you see Rank in us! Bow-bow: look at yourselves, in Rank dispute amongst the two of you since Ha-hada first came here. You have not risen above Rank, only denied it while defending it in smaller pieces! When Par-parker treads the negotiator's role, he must submit—when Ha-hada treads the expertise of the talker, she must bow! *That* is where the truth of your Rank lies. How dare you lower us!"

They cower against the cushions. They know what I could do, were I not a civilized creature. How pitiful!

"Humans," I bark. "Bite-bite: you travel star territories, you see medicines in blood, but for all that you are prey. See how you fear me, though I am better now than a dumb creature to attack you, when my molri does not bring me low. Your *clothes* are no better than prey fur, subversions of natural order, and

without them you would shiver worse than I! Is it any surprise that I cringe to hear in your shallow mouths the Cold words of the dominator?"

My own words silence me. I flop exhausted to the cushions and cover my nose with one hand. This is the explanation they have demanded, but it only proves that all hope is gone from our hunt.

Hada neither speaks nor looks at me; she crosses her arms tight over her chest.

"You wound me, Rulii," Parker whispers. "I hope you don't mean this—that you merely speak from shock, or that I mishear you..."

How can I have said such a thing to him? I whimper. "Hnnn, I don't mean it, Parker; I was angry. You have saved my life tonight, and truly I have no brother but you."

"Hark," Parker says. "I believe I understand your talk of Rank, yet this is not of our thinking. Humans bow—or, we try to bow—first to merit in skill."

Ah, so this is the invisible territory they guard so jealously: a borderline of skill that reverses their Rank. I choose words carefully. "You must realize, I have watched you argue this between yourselves, both with bodies and with words. Yes, Parker is powerless to speak to Majesty without Hada's Rank of negotiator—but you, Hada, never forget you would be speechless without Parker and his long hunt here. Rank and interdependence, both together, create natural order."

I have Hada's attention now. "Hark-hark," she says sharply. "We Humans know interdependence well."

"Do you truly? Majesty thinks he knows it, yet he places Rank far first when he fails to repay the Lowlanders who feed and fight for him. Measure him beside *us:* we grow plants we cannot eat, to care for the low beasts that sustain our strength. And what of you, Hada? Here Parker has been the hunter to bring down the beast of our Aurrel tongue, yet you chastise him when he has not made it soft enough for your teeth to manage."

Her face works, angry. "Bow-bow: my teeth are sharp enough."

"Do not convince me, Hada. Convince Majesty."

"Hark-hark: I shall, tomorrow evening," she says, gharralli eyes glittering. "Bow-bow: enough foolishness, now. We must begin our preparations."

I had entirely forgotten! Moon must be low by now, and I with no sleep, no sure medicine that will allow me to face Majesty safely—wauuunn! "I will do what I can," I say. But now that I have seen Humans as Majesty does, what can I say to defend them? I cannot change nature! "Parker, how do you believe we should proceed?"

"Do as you wish." Parker closes his eyes. "I will not be there."

Ar, no—I *have* driven him away! "Belly," I say, "Parker, we—"

Hada interrupts. "Par-parker, bow-bow: you forget you still bear obligation to the *Allied Systems."*

"My obligation is to my own *scientists,"* Parker says, keeping steady eyes on me. "And to the progress of Aurrel research, not to *spaceports*. I will no longer play Lowlander to Hada's Majesty. Rulii—" He touches my wrist; through my fur I feel the strange soft tips of his fingers. "I need treatment, from the doctors at our research station in Oll-ollugha forest. I won't leave you without medicine—there is enough here for several days—but we will not speak again until your negotiation is over."

My chest tightens. “But Oll-ollugha is wilderness! Parker, Majesty may not want you in his presence, but I do."

Parker's voice stiffens. “Hada can do what you need. She came here for this—she would never leave here with her reputation damaged. She says she has teeth; now let her use them."

* * * *

I don't know if Hada has enough bite for Majesty—but determination, she has in plenty. She and I walk together beneath hangings of rich embroidered cloth and lacquered leather toward Majesty's Ice-fang door, wearing—at her own insistence—beaded waist-purses, invisible medicines, and *nothing else*.

Is she more natural without the subversion of her heavy *clothes?* Or with her small stature and furless flesh exposed, is she more delicious? Our night-long preparations have pushed me too far outside myself to judge.

Two heavy-furred submissors with iron hooks pull aside the strings of sharp mirrors that bar the door, revealing Majesty Gur-gurne at his table. His beads of royal ice capture the light of fat-lamps, making him seem larger; his mouth gapes as he looks at Hada.

I must breathe calmly, stop myself shivering from pure fear. Parker's medicine serves well enough, but I find I miss molri's flush of carelessness. Ar, Parker, I was wrong when I told you I cared nothing for pleasure!

"Bow-bow: sit,” Majesty calls. “Hark-hark: at last Ru-rulii's rumored negotiator joins me at table! Ha-hada, make welcome."

Hada replies with deepened tone, “Thank-thank, Majesty: your invitation grants me Cold honor."

Majesty laugh-howls. “Hark-hark: how you sound like a singing bird, Ha-hada! Sniff-sniff: is this the common voice of the female Human?"

Wauuunn! Will my hunt fail before our negotiation begins?

"Bel-belly, Majesty,” says Hada. “This was a song of thanks, but in speech I hope I am not such a delicate bird, to die of cold in your exalted presence."

She has changed her voice! Suddenly a faint iron-on-iron shriek pierces her words, nothing we planned. Unbreathing I wait for Majesty's answer.

"Bow-bow: take meat with me,” he says, no mocking now. “We shall speak of your hunt soon enough.” As we sit, the obedient submissors bring forward plates of seared urrgai tongue marinated in voghi liquor and sprinkled with early ruz blossoms.

Majesty raises his jeweled dinner-knives to cut his meat; petals of ruz float in sweet voghi-scented blood. But as I lift my own knives, he stops me suddenly. “Hark-hark: Ru-rulii, no."

My stomach tightens. “Majesty?"

"Bow-bow, before we eat or talk, raise your bowl,” he says. “A toast to our guest."

"Bel-belly: to our guest.” What does he intend? I lift my bowl forward while Hada tenses, alert for defense or attack.

"Ha-hada, hark-hark,” says Majesty. “To the health of your new young, to your fight-strength returned,

and to the continuance of your Clan in great numbers!" He lowers his head to drink of ihlu.

Hada looks to me, sharply.

Now I grasp it: it is her nipples Majesty has remarked, swelling as they do from her chest, bare and brown-tipped with no covering fur. "Hark-hark: the suckling mother," I say, and bend to my drink, hoping she will understand. Here, such would indeed be cause for congratulation.

She calms. "Thank-thank, Majesty." With each word the hint of shriek in her voice appeals more to me. "Health to all the Clans of Au-aurru, to the Clan of Majesty Gur-gurne, and to Majesty himself in singular." A toast she has made up, but I surmise it will belly to Majesty's liking.

"Ahhh Ha-hada." Majesty shakes head, shoulders and tail, now relaxed. "Hark-hark: your Warm talker gave me little hope, but I smile to find a dominator among Humans. You are no songbird, but a harrihi!" He begins to eat, cutting and spearing his meat, tossing it back into his mouth, and Hada imitates him.

My surprise hisses out. Harrihi, the raptor—*that* is the sound in Hada's voice! I understand her skill now: with her voice predatory, her manner is so Aurrel that her lack of muzzle or standing ears seems almost a surprise. Can she truly have done this across other worlds, with creatures even more alien than herself?

"Ru-rulii, bite-bite: you are half sleeping."

I turn to find Majesty's gold eyes intent on me.

"Bow-bow," he says. "Eat; these last days I begin to think you suffer a condition."

Cold fear blows through me, but I don't shiver—truly, Parker and his medicine have saved me from death on the Dominator's Teeth today! "Bel-belly: it is only anticipation," I say. "I confess I wish to speak of Humans."

"Hark-hark: I notice how you precious them, Ru-rulii! Well then. Ha-hada, bow-bow: tell me, what is this *spaceport?"*

Hada flicks a hand through her long mane. "Hark-hark: a *spaceport* is a landing-place, Majesty. Humans stop there for food and fuel, thus easing our trade between star territories."

"Hark-hark: yes, Ru-rulii has told me you fly." Majesty laughs, but offers no insult—she is harrihi now, not grouse. "He tells me you wish to purchase land for a generous price. We have such land to offer; unused grasslands plenty in our Lowland south."

I scent my prey at close pace; my heart speeds, but I make myself eat.

Hada smiles. "Thank-thank: indeed, Ru-rulii has spoken to us of these grasslands. Yet our eyes turn differently. Your eastern rocky flatland would serve us better, at a price you may suggest."

What? She has lost pace with me completely! "Ha-hada," I say, "sniff-sniff: eastern flatland? Will you abandon your plans for Lowland so quickly?"

"Bow-bow," she says. *"I* had no such plans, Ru-rulii."

How she stares—I understand suddenly that she baits me. I snap my teeth shut, but I have already said too much.

"Ru-rulii," says Majesty. "Bow-bow: I thought you desired a Human *spaceport.* But now it appears you desire it singularly in Lowland. Sniff-sniff: is it only on your own territory that this *spaceport* will bring you

satisfaction? Your Councillorship, your houses here and in Ro-roghell, they are not gifts enough?"

My breath shallows; my mind races to escape the trap before it can close. “Bel-belly, Majesty, do I appear to concern myself with territory? Hark-hark: I worry for all Au-aurru! I wonder why Ha-hada should change her proposal so late, unless she bears some concealed intent."

Majesty's hackles rise—oh, I have alarmed him! He turns eyes-ears-nose to Hada while she sits stiff, her pupils widening. “Hark-hark: a strange move indeed,” he growls. “Bow-bow: explain yourself, Ha-hada. This is the behavior of a Barbarian, if Ru-rulii scents true."

Wauuunn! I have destroyed everything! Now Majesty will banish them, their *spaceport,* their research and their medicines, and I shall have condemned myself to return to molri, to die of it after a lifetime's bloodless hunt!

"Bel-belly,” says Hada. “I am no Barbarian, Majesty."

Hiding my shaking hands, I force myself to speak. “Hark-hark: indeed, honored Ha-hada, I do not wish to believe this of you. Tell us then why our eastern flatland smells so good.” And let her words somehow appease Majesty!

Hada bends her head. “Bel-belly: Majesty, I meant no ambush. I am new-come to this negotiation, and perhaps I had not told Ru-rulii: I have always desired this flatland location. Humans shall bring goods through this *spaceport,* yet it must also provide of its own—*resources*."

Majesty throws his head back and howls. My heart is half frozen before I hear him break into a laugh. “Hark-hark! Resources, Ha-hada! Ar, I see you are a negotiator indeed!"

Her lips curl down. “Bel-belly, Majesty—"

Majesty stamps the pads of one hand on the table. “Bow-bow: if you negotiate for land, this is something. But if you desire land-and-take-of-prey, our negotiation changes. Au-aurru must demand you render tribute."

She calms at once. “Hark-hark: we can deliver tribute, Majesty. This is simple."

See how certain she is! Majesty demands that she submit, placing Human star territories among the tribute nations of Aurru—yet she shows no sign of tremor!

Ah, no. I see it now: this is not courage.

What tribute could we demand that Hada would *not* find simple? She finds all of us simple. She and Majesty match eyes, confronting, but neither one sees the truth: that each of them believes his, her people superior and the other to be tamed! I must not allow them to reach agreement upon such terms. What good are riches, if all Aurrel blindly consents to play Lowlander to Human Majesty?

I scent only a single way to turn them aside—in a word each one might privately ignore, but which I believe in the ears of the other neither would dare deny.

"Hark-hark!” I toss my mane, to draw their eyes. “What a happy day, when Human and Au-aurrel enter for the first time into interdependence!"

Hada takes the bait. “Bel-belly: this interdependence is welcome. You will find we have much to offer you."

Majesty gapes in amusement. “Hark-hark: indeed? I grow impatient to see these offerings!"

"Yet, Majesty, bel-belly: what a puzzle!"

My tone has caught him; he closes his mouth, turns ears to me. “Sniff-sniff: puzzle, Ru-rulii?"

"Hark-hark: why, we know less of our new huntmates than we do of Barbarians! In a single hour's interdependence, how can we know what prey they shall seek on our soil, or how much?"

Majesty snorts, but without humor. “Bow-bow: look, this one hardly eats at all."

My heart beats running pace. “Sniff-sniff: but how can we judge if Humans shall fly alone as harrihi, or as rowill, to blacken the sky? How should we attempt in one night to guess their future take, in order to measure fair tribute?"

Hada quickly spreads her hands. “Hint-hint: Majesty, surely Ru-rulii overstates himself. Humans are not unknown to Au-aurrel; not when our talker Par-parker and his *scientists* have run here so long."

"Bow-bow!” Majesty shows irritated now, shaking his beads harshly. “Indeed they *are* known to Au-aurrel, Ha-hada: known to *Ru-rulii* in singular. He has run leader in your hunt from the first, and he is right; we make no bargain tonight."

She protests, “Bel-belly, Majesty—"

Majesty will not hear her now—but his ear may still turn to me. And in mentioning Parker, Hada has roused to my mind a new offer, one that both may consider.

I lower my nose beside Majesty's hand. “Hint-hint, Majesty: forgive Ha-hada her eagerness. She rightly praises Par-parker, for he has learned our natural order, even while his huntmates shelter lonely in Oll-ollugha. He shows that Humans can understand interdependence, given a fitting opportunity. Majesty, my house of honor in Ro-roghell stands empty. Let me give it to Par-parker and his people—a step forward, yet a safer one. How better to take Human measure than to bring them among us?"

Majesty touches my mane—I have never felt his favor so welcome. “Ha-hada, bow-bow,” he says. “Your people should gain much to satisfy them at the riverport, observing Au-aurrel Clans, their travel and trade."

As I raise my head, she meets my eyes differently—changed by our close struggle, even as I have found myself changed in my struggle to understand Parker. But will she nose this bait? Will she be scavenger enough to take the scraps we offer? “Bel-belly,” she says. “A research station favored by Council, in a public center? Yes, this can satisfy us; we may speak of *spaceports* later."

Ar, is it success that I feel now, chasing warmth over my skin? This is not simply happiness to see Parker satisfied in his project. I have brought more than silver to Lowland; I have brought *Humans!* A greater prize than I hunted for—a live one, and far more dangerous. In this struggle Parker has already felt my teeth, and I have felt him reach deep as blood: we are both swayed. In Ro-roghell, Humans shall not pass blindly as through a *spaceport,* but touch us and be touched—hereafter Lowlander, even Shiverer may not bear the same meaning. Those soft Human fingers, gently pressing, will tear us from our thinking into a new place.

Majesty drains his bowl of ihlu, takes it in two hands and dashes it against the table's edge; Hada jumps with shock, her eyes white-rimmed as he offers her one of the two shards. “Ha-hada, bow-bow: take this fang, as token of our agreement."

Pressing her lips tight together, Hada takes the piece of glass with her fingers.

"And Ru-rulii, bow-bow: you shall act our will in this matter."

I lower my nose to the table, my heart running ahead already to Oll-ollugha and the warm lands. “Thank-thank,” I say. “Cold honor, Majesty."

Parker, my *friend*, I shall come to you with good news.

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Reader's Department: **REFERENCE LIBRARY** by Don Sakers

Other Earths

Edited by Nick Gevers & Jay Lake

DAW, 320 pages, $7.99

(Mass Market Paperback)

ISBN: 978-0-7564-0546-5

Genres: Alternate History, Original Anthology

In science fiction, the alternate history story has a long and venerable ... er ... history. The first alternate histories developed in the 1800s from the fields of nonfiction and historical fiction. Some were downright essays, others were essays wrapped in just enough plot to disguise them as fiction. As with much else, H.G. Wells dabbled—his *Men Like Gods* tells the story of some Englishmen transported into a utopian alternate world. It's a gripping read, but ultimately more philosophical treatise than novel.

It took the Campbell revolution, in *Astounding* and its sister magazine, *Unknown*, to bring about the birth of the alternate history as we know it: actual stories with genuine characters, set against the background of a world with a different history. Murray Leinster's “Sideways in Time” and L. Sprague de Camp's *Lest Darkness Fall* introduced the notion of coexisting divergent timelines, a concept that today we call the multiverse. Other writers, most notably Poul Anderson in his Time Patrol stories, explored the deliberate manipulation of alternate histories by time travelers. Currently, alternate history is more popular than ever; the steampunk craze shows how far the genre has penetrated into popular culture.

Today it is possible to distinguish between two types of alternate history stories. There's the basic alternate history tale, which is set entirely in a different timeline; and then there's the multiverse story, involving multiple timelines and travel between them (often including time travel as well). The king of the first type is Harry Turtledove, with Eric Flint as archduke of his own territory. Most of the royalty of the multiverse story, unfortunately, have passed on to the great typewriter in the sky: Poul Anderson, Fritz Leiber, L. Sprague de Camp, André Norton, and Robert A. Heinlein were among them. But there are plenty of up-and-comers out there.

Generally, those who are passionate and knowledgeable about history are more fond of the first type; those who are looking for the adventure of science fiction are more likely to prefer the multiverse story.

Other Earths is a fine collection of original stories of the first type. The editors present 11 stories by a host of big names: Stephen Baxter, Alastair Reynolds, Lucius Shepard, Jeff Vandermeer, Robert Charles Wilson, and Gene Wolfe, among others. With a lineup like that, you wouldn't expect too much in the way of hard science, and you would be right. These are definitely stories from the humanities, not the sciences. But that doesn't mean they aren't some excellent tales.

Wilson's “This Peaceable Land, or, The Unbearable Vision of Harriet Beecher Stowe” is set in the late 1800s in a United States that developed without a Civil War. Slavery still exists, but economic forces have made it a rarity. In Wilson's well-developed world, the costs of avoiding the war are heavy upon the society, and the reader is left wondering which universe is really better.

Shepard's exceptional novella “Dog-Eared Paperback of My Life” begins with a writer of bestsellers who comes across an obscure cult novel written by another writer of the same name. From there it goes

off into trackless and disturbing jungles of the mind. But Shepard is a reliable guide; follow him to the end, and you'll emerge in one piece.

Fair warning: most of these stories aren't exactly the kind that would appear in *Analog*. Some of them involve such fantasy elements as magic and elves. Yet in a universe next-door to ours, a universe in which *Unknown* continued publishing to this day, you might easily find these stories in the pages of that magazine. If you're an alternate history buff, you'll definitely like this anthology.

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Warrior Wisewoman 2

Edited by Roby James

Norilana, 272 pages, $11.95 (Paperback)

ISBN: 978-1-60762-028-0

Genre: Original Anthology

Despite the old saw, all too often you can tell a book by its cover. Publishers spend great amounts of time and money to make it so. Stroll through the science fiction section of your local bookstore, and you can instantly tell fantasy from science fiction; further, it's easy to distinguish military SF from space opera, alternate history from alien culture, biological SF from cyber-whatever. Cover art, title, typeface, even the authors chosen for quotes: all combine to help the browsing reader find exactly the type of book he or she wants.

At least, that's true of the big publishers. Among the small presses, things are different. A small press has no in-house design shop, very little money for cover art, and not enough staff to spend the effort on covers that the big boys do. With small press books, you truly can't tell the book by its cover. And that's a *good* thing.

Anyone who judges *Warrior Wisewoman 2* by its cover (and even its title) is in danger of making a big mistake. “Another touchy-feely anthology with lots of noble Amazons and high priestesses, yawn.” Please don't let this happen to you.

Warrior Wisewoman 2 (it's the second of an annual series) is a collection of fifteen science fiction stories with nary a witch, dragon, or unicorn in sight. Instead, there are spaceships, artificial intelligences, social speculation, High Frontier construction jobs, and enough technology to make anyone happy. Some stories are by women, some by men, a couple by collaborative pairs, and a couple more by writers who use genderless initials.

The one thing these stories all have in common is that they feature women as main characters. While I wouldn't call any of the stories “feminist,” some of them do play with the reader's preconceptions and expectations regarding gender roles. Others are a bit more concerned with emotion than adventure.

Take, for example, Lee Martindale's “Lady Blaze.” The title character, who shares her name with her luxury spaceship, is both a tough-as-nails space captain and the madam in charge of a crew of high-class courtesans. When she decides to take on a young woman who needs help, Lady Blaze finds herself in the middle of a mission of vengeance against a ruthless female pirate captain. The whole situation may be more than this talented businesswoman had bargained for.

At a completely different emotional pole, Jennifer Brissett's “The Executioner” shows us an ordinary woman serving an extraordinary duty and pulls at the heartstrings in a way reminiscent of Judith Merril's

classic tale “That Only a Mother.” Kate MacLeod's “Gardens of Wind” is a clever story of life aboard village-sized airships. And perhaps the cleverest story in the book, “Shop Talk” by Ian Whates, is clearly akin to van Vogt's “The Weapon Shops of Isher” for the sensibilities of the modern day.

There are eleven other stories, all of similar quality. Editor Roby James has done readers a service in bringing together this anthology; let's hope she'll continue for many years to come.

* * * *

WWW: Wake

Robert J. Sawyer

Ace, 356 pages, $24.95 (Hardcover)

ISBN: 978-0-441-01679-2

Genres: Man & Machine, Psychological/

Sociological SF, Religious/Philosophical SF

Series: WWW Trilogy 1

Wake was serialized in *Analog* recently; those who read it in these pages don't need me to tell them what a good book it is. So I'll just go ahead and assume that you didn't read it, haven't gotten around to reading it, and/or don't remember reading it.

For many years now, Robert J. Sawyer has been turning out imaginative, thought-provoking science fiction novels set in the present day and dealing with the impact of science and technology upon relatively ordinary people. A typical Sawyer tale brings together multiple diverse elements from popular culture, psychology, physics, and philosophy; stirs together plausible advances in science with appealing characters; adds some realistic depictions of actual scientists at work and a generous helping of old-fashioned sense-of-wonder; and filters the whole mix through a distinctly Canadian filter. *Wake* is no exception.

Here's the basic setup. Caitlin Decter is a teenage math genius who was born blind. While dealing with the challenges of trying to adjust to a new school and relating to a father who doesn't talk to her, Caitlin receives an email from a Japanese scientist with an experimental treatment that he thinks might allow Caitlin to see.

So it's off to Japan, where the scientist fits Caitlin with an implant that processes input from a camera and links it directly to her optic nerve. At first the experiment seems a failure; Caitlin returns home to Toronto in hopes that a few weeks will allow the implant to start working. Meanwhile, the scientist continues to work on the device's software, arranging a way for Caitlin to download updates directly to the implant.

Comes the time of the first software update, and suddenly Caitlin can see ... after a fashion. There are two problems: first, the patterns of lines and blobs that she sees seem to bear no resemblance to the world around her, and second, her new sight goes away as soon as the new software is downloaded.

A little experimentation reveals the truth: Caitlin's sight is only active when the implant is actively connected to the Internet. As for what she's seeing ... it turns out that she is somehow able to perceive the structure of the Net itself.

Caitlin is an appealing enough character, and the premise is fascinating: a girl, blind from birth, gains the ability to see the structure of the Internet from within. A lesser writer would go with this story, following

Caitlin as she learns to deal with this new, expanded world. But this is Sawyer, and there's much, much more going on.

Here are some of the threads that Sawyer weaves together.

A potential plague in China, to which the government responds by sealing off and destroying a rural village. To conceal the act from the rest of the world, China temporarily cuts itself off from the rest of the Internet.

The offbeat psychological theory of Julian Jaynes, author of *The Origin of Consciousness in the Breakdown of the Bicameral Mind*. Jaynes claims that human consciousness only emerged about 3,000 years ago, when the human brain evolved sufficiently complex connections between its two hemispheres. Prior to this, Jaynes says, humans had only the dimmest form of self-awareness; people reacted to their own thoughts as to the voices of unknown gods.

Simian behaviorists studying a few hybrid ape specimens who seem able to carry out genuine conversations with one another via teleconference.

The life story of Caitlin's hero, the late Helen Keller, and Helen's relationship with her beloved teacher, Anne Sullivan.

And here is how Sawyer brings these diverse elements together. In her explorations of the Net, Caitlin discovers a presence: a newly-evolved consciousness, an entity born in the increasing complexity of the Net and given self-awareness by the Jaynes-like reintegration of China's national Net with the worldwide Internet.

This new entity is effectively as deaf and blind as Helen Keller herself. And it falls to the blind girl, Caitlin, to be this new mind's teacher in the same way that Sullivan taught Keller, to bring language and awareness of the outside world to this new mind.

Along the way, Sawyer raises fascinating, complex questions about the nature of consciousness and self-awareness, of communication between disparate intelligences, and compassion across huge gulfs. This is a book that you'll still be thinking about for weeks after you finish reading it.

Wake is the first of a planned trilogy, so not every plot thread is completely tied up at the end. Indeed, Sawyer follows the old show business dictum “leave ‘em wanting more.” Fortunately, more is on the way.

* * * *

Why Beautiful People Have More Daughters

Alan S. Miller and Satoshi Kanazawa

Penguin, 252 pages, $23.95 (Hardcover)

ISBN: 978-0-399-53365-5

Genre: Popular nonfiction

Psychology and sociology, the sciences of human behavior, are in the midst of a revolution. The relatively new field of evolutionary psychology does just what its name says: seeks to explain human nature through the principles of evolution. Miller and Kanazawa present a tour of evolutionary psychology for the intelligent layman, coming up with some unexpected conclusions.

First, the authors talk about a few principles necessary for understanding evolutionary psychology. First, there's the eternal question of nature vs. nurture, and the fact that neither provides a complete explanation of human behavior. Next, they caution against two fallacies: the naturalistic fallacy and the moralistic fallacy. The naturalistic fallacy equates "natural" with "good" and says that just because a behavior exists, it is to be preferred; the moralistic fallacy equates what is "moral" with what exists and claims that because a behavior is desired, then it actually exists. Finally, they deal with the question of stereotypes: while useful, they are not to be confused with accurate descriptions of the world.

The rest of the book is filled with provocative questions and the answers provided by evolutionary psychology. For example: Why are most human societies polygynous (one man with many wives) and so few polyandrous (one woman with many husbands)? The answer: Due to their different reproductive methods, it makes genetic sense for a man to have as many children as they can, by as many women as possible—while it makes more genetic sense for women to have children only with men who will provide protection and sustenance for her kids.

Or there's the title question: Why do beautiful people have more daughters? Well, physically attractive women are more desired as both short-term and long-term mates, while physically attractive men are more desired as short-term mates but not as long-term mates. So beauty contributes more to female reproductive success than to male success, so the genes of beautiful people are more successfully passed on through daughters than through sons. And in fact, the authors say, being rated "very attractive" increases the odds of having a daughter by 36 percent.

Some of the other questions answered in this volume are "Why are almost all violent criminals male?" and "Where does religion come from?" There are even speculations on the roots of such behaviors as soldiers dying for their country or people committing suicide.

For any science fiction reader interested in the behavior of sapient creatures and the evolutionary origins of that behavior, this is an entertaining and educational read.

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Don Sakers is the author of *A Rose From Old Terra* and *Dance for the Ivory Madonna*. For more information, visit www.scatteredworlds.com.

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Reader's Department: **BRASS TACKS**

Dr. Schmidt:

Just finished reading the Brass Tacks letter from Sue Jarrell (June 2009) and I am overjoyed to see a submission from a like-minded individual. To also find a fellow fan of Thomas Sowell is more than I could ever hope for. I would like to point out the one single book that anyone interested in economics should read and that is *Basic Economics* by Thomas Sowell. It sticks to economics and does not delve into politics and when you are finished you will have a very good understanding of economics.

To further elaborate on her C3 versus IFS models: She points out that doing nothing is the best course and that it will work out. You counter that "history contains plenty of examples of things that didn't." I would point out that, in fact, they did work out as we are all here and the world continues to trundle along. I will grant that, in the short run, things get worse and people suffer while things are working out. She aptly points out that what FDR did prolonged the Depression and that we would have probably been much better off if less had been done and the IFS model left to solve the problems through enlightened self-interest.

It is interesting that in the same issue was a set of observations by Jeffery Kooistra in which he refers to the third turning as a "downcast" era caused by the strengthening of the individual whereas the first turning is an "upbeat" era with the weakening of the individual and the strengthening of the institutions. If in fact the strengthening of the institutions was truly the best option for humanity, we would eventually evolve to that system and all be happy. The progressives use wealth envy and the promise of spreading the wealth around to obtain institutional power. The individualists operate on self-interest to build better mousetraps and provide better services, which creates wealth that pervades the economy.

Yes, there are people who pervert the system and use the guise of individualism to take advantage of the system and create wealth on the backs of others when we are in our individualism mode. The problem is that when we are in the institutional mode these same people are still around and they still go where the money and power is. Unfortunately, they are now ensconced in institutions that have the force of law behind them and a much more cumbersome system for weeding these people out. In the individualism mode the free market will weed them out eventually. In the institutional mode they are there forever (at least until the next turning).

Having picked on Jeffery Kooistra above, let me state that I love his Alternate View columns and that we agree on much more than we disagree on. I am one of his self-educating individuals and my single greatest source of that education was *Analog* (40+ year reader) and science fiction in general.

Don Nix

Sioux Falls, SD

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If "we are all here and the world continues to trundle along" is all you require to conclude that "they did work it out," then everything that's behind us "worked out": every war, plague, botched social experiment, etc. I think we need higher standards—and we may not be able to get the kind we need by a pure and simple faith in either *C3 or IFS. Especially in a time when individuals can wield the kind of power they now can....*

* * * *

Stan,

[Re: “Chains,” June 2009]

I just read the story. I cried. Great story!

James R. Murphy

Mililani, HI

* * * *

Dear Stan,

Your June 2009 issue is one of the best overall in a long time. All the fiction rated B+ to A in my book. Very good reading. The other sections as always were quite interesting. I liked your comments on custom and its fly-by-night cousin, fashion. And in particular reference to “hats off” inside, I can remember from at least Junior High on thinking that it must have come about as a statement by us Christians (talk about custom) that only the Jews would wear a hat inside. One other quick comment about your website—I really appreciated getting to read Michael Flynn's Nebula nominee. I always enjoy his stories. Is Richard A. Lovett just one person? He must write night and day.

Stephen N McKinney

North East, MD

* * * *

Richard A. Lovett is just one person, albeit quite a remarkable one.

* * * *

Stanley Schmidt,

I loved Richard Lovett's January/February 2006 *Analog* story “Dinosaur Blood” and have re-read it several times. In retirement, I'm now writing a book on integrating technology, society, and spirituality for a star-faring civilization. I'm referencing Lovett's story in my book.

I checked the annual Nebula Awards Showcase for 2007, 2008, and 2009 to see if “Dinosaur Blood” won an award like I thought it should. (The 2009 volume arrived yesterday, so I'm emailing you now.) Both the 2007 and the 2009 volumes include chapters on the “final ballot” for the awards, but the 2008 volume does not have such a chapter. The 2008 volume gives only Nebula winners. “Dinosaur Blood” was not among the winners in the 2008 volume, which focused on 2006 publications. The story also was not among the winners or final ballot nominees for the 2007 and 2009 volumes.

Do you know if “Dinosaur Blood” was a Nebula Award final ballot nominee for 2006 sci-fi publications? Did it win awards anywhere else?

If you don't know the answers, please forward this email to Richard Lovett. Or forward it to him anyway with my appreciation for his good works.

Thank you for the advice you emailed me a half dozen years ago when I began subscribing to *Analog* as my first and only sci-fi “pulp.” You told me not to try to read all the stories in each issue, like I had done since volume 1 of the Nebula Awards Showcase in the mid 1960s. Instead you wrote me to find some authors I like and read only them plus the stories that grab me with their beginnings. This has worked well for me. Lovett is among my favorites.

I also look forward to each *Analog* issue for the “Science Fact” article, “The Alternative View,” and “The Reference Library,” as well as to your editorials and “Brass Tacks.” Some of the items in these

have helped me with ideas and references for the book I'm writing.

Although I discovered Catherine Asaro through Nebula Awards Showcase, I enjoyed her novella “The Spacetime Pool” in *Analog*. The *Analog* Reference Library also led me to her excellent article in *Year Million,* edited by Damien Broderick. I bought this book because Asaro was mentioned in the *Analog* review of the book. In turn, Asaro's article gave me references in reputable journals to scientific articles, including her own, about faster-than-light travel. Since I'd planned to include this idea in my book, I thank *Analog* for connecting me to a source of references that make FTL more credible.

Asaro predicts humanity will confirm FTL “within one or two centuries.” This is the same prediction I'd already planned to make in my book, perhaps via a very brief short story at its end (my first attempt at sci-fi). Otherwise, my book will be a mixture of the saga of my six-decade quest for integrations of technology, society, and spirituality, as well as my quest findings and some good true stories I encountered along my way.

I've long intended to write you a thank you email, so here it is.

Allen Parker

* * * *

The author replies...

Thanks for the kind words. “Dinosaur Blood” is a personal favorite, partly because Trista came to life on me partway through and demanded to be given a chance to grow up, rather than inhabiting the wry fable I'd originally scripted for her. So I sent her to all my favorite places in the intermountain desert and waited to see what happened. Since the places are all very real (even the Naval of the World mesa, though I moved it about 10 miles so she had a better chance of actually finding it), it was a doubly personal story.

Sadly, it didn't make the ballot, though it did get a few nominations. But I'm very flattered that you think it deserved it.

* * * *

Dear Dr. Schmidt,

I cannot call myself a fan of science fiction without giving new things a chance. Over the years, *Analog* has stimulated my imagination and challenged deeply held preconceptions in new and sometimes uncomfortable ways. It has changed the way I look at the universe. I believe I have considered this issue long enough to render this opinion:

The new logo sucks.

The old lower-case logo was a masterpiece of confident elegance. It did not have to prove itself to anyone. The new one can best be described as having font-envy. I don't know what shortcomings it is trying to cover ... and I don't want to know.

Don't say I didn't give it a chance.

Other than that, keep up the excellent work.

Robert Wood

Huntsville, AL

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Considering that the "new" logo is almost 18 years old, I guess you have given it a chance. Sorry you don't like it.

* * * *

Dear Dr. Schmidt,

I have been an avid reader of science fiction since the late '30s, when I started reading the issues that my father had saved. This month, I had to write to let you know how much you have meant to me—the one constant in a variable life. It is my first ever "Letter to the Editor." I trust the form and format are correct.

I have never been disappointed, for reading cover to cover always gives me new things to ponder and discuss. The editorials of all the editors have been my first stop after opening each issue. Since my hemorrhagic stroke a little over three years ago, I have slowed down quite a bit, but I still enjoy them and your answers to dissenters in the Letters to the Editor column. I am continually surprised at the number of readers that are disappointed in an issue because a story or article was not up to their expectations. I say thanks to you and all contributors for keeping a great magazine GREAT for the seventy years I've been reading it through name and format changes.

I found Daniel Hatch's "Seeds of Revolution" in the July/August issue a real pleasure to read with his "play" on Walt Kelly's Pogo characters. Also, Dr. Don Lincoln's article on "The Large Hadron Collider" is excellent.

Sam Brandt Jr.

Raleigh, NC

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We welcome your letters, which should be sent to *Analog,* 475 Park Avenue South, Floor 11, New York, NY 10016, or e-mail to analog@ dellmagazines.com. Space and time make it impossible to print or answer all letters, but please include your mailing address even if you use e-mail. If you don't want your address printed, put it only in the heading of your letter; if you do want it printed, please put your address under your signature. We reserve the right to shorten and copy-edit letters. The email address is for editorial correspondence *only*—please direct all subscription inquiries to: 6 Prowitt Street, Norwalk, CT 06855.

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Reader's Department: **UPCOMING EVENTS** by Anthony Lewis

23-25 October 2009

GEEK.KON (sci-fi, fantasy, anime, gaming, etc.) at Sheraton Hotel, Madison, WI. Guests to be announced. Membership: $20. Info: www.geekkon.net/index; Post Office Box 5191, Madison WI 53705.

29 October-1 November 2009

WORLD FANTASY CONVENTION at The Fairmont Hotel, San Jose, CA. Guests: Garth Nix, Lisa Snellings, Michael Swanwick, Ann VanderMeer, Jeff VanderMeer. Membership: $125. Info: www.worldfantasy2009.org/; World Fantasy 2009, Post Office Box 61363, Sunnyvale CA 94088-1363.

13-15 November 2009

TUSCON 36 (Baja Arizona SF conference) at InnSuites Hotel, Tucson, AZ. Guest of Honor: Weston Ochse; Toastmaster: Ed Bryant. Membership: $45, one day $20/$35/$15. Info: basfa@earthlink.net, home.earthlink.net/~basfa/, 520-571-7180 (fax); PO Box 2528, Tucson AZ 85702-2528

12-15 November 2009

ILLUXCON 2 (Fantastic illustration symposium) at Altoona, PA. Guests include: Boris Vallejo, Julie Bell, Michael Whelan, John Jude Palencar, Justin Sweet, John Picacio, Brom, Todd Lockwood, Donato Giancola, Greg Hildebrandt, Bob Eggleton (Art Directors: Jon Schindehette, Lou Anders, and Ben Thompson). Membership: $150 (limited to 200). Info: www.illuxcon.com/; info@illuxcon.com

2-6 September 2010

AUSSIECON FOUR (68th World Science Fiction Convention) at Melbourne Convention and Exhibition Centre, Melbourne, Victoria, Australia. Guest of Honor: Kim Stanley Robinson; Artist Guest of Honor: Shaun Tan; Fan Guest of Honor: Robin Johnson. Membership from 1 January 2009 until some later date (see website for latest details): AUD 210, USD 175, CAD 185, GBP 100, EUR 120, JPY 16000; supporting membership AUD 70, USD 50, CAD 50, GBP 25, EUR 35, JPY 4900. 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.aussiecon4.org.au/, info@aussiecon4.org.au, GPO Box 1212, Melbourne, Victoria, AUSTRALIA 3001

Running a convention? If your convention has a telephone or fax number, e-mail address, or web page, please let us know so that we can publish this information. We must have your information in hand SIX months before the date of your convention.

Attending a convention? When calling conventions for information, do not call collect and do not call too late in the evening. It is best to include a S.A.S.E. when requesting information; include an International Reply Coupon if the convention is in a different country.