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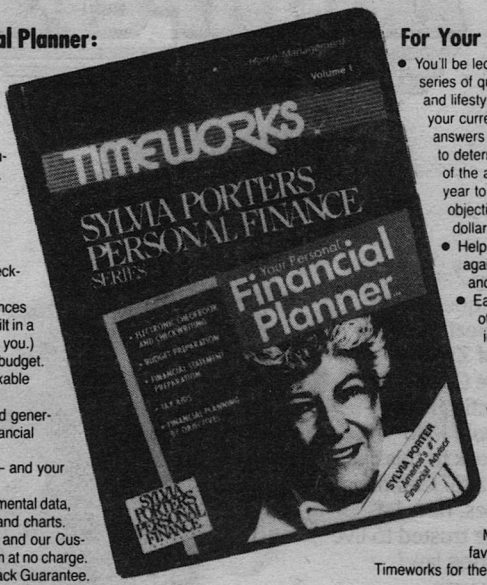

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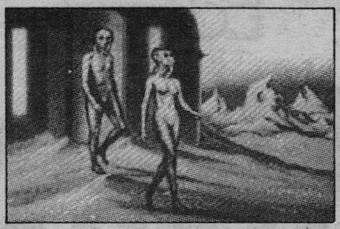

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Editorial

BRAIN LANGUAGE

Stanley Schmidt

Almost 19 years ago (May 1967) *Analog* published an article called "Target: Language," by Lawrence A. Perkins, which came dangerously close to inspiring me to write a letter to the editor. I recently took another look at both Perkins's article and my notes for the letter I almost wrote, and discovered that not only do I still want to say what I wanted to say then, but the passing years have even added a point or two. And since I *am* the editor now, I don't even have to worry about whether he'll print it!

You might still find Perkins's article interesting, if you haven't already read it and you can get your hands on a copy. As the title suggests, it's about the nature of human language. Part of it is descriptive, and if you've had no more exposure to foreign languages than schools commonly provide, this article will give you a good inkling of the extent of variation in how existing human cultures codify and organize thoughts. Perhaps the more important part of it, though, is speculative. Perkins pointed out that linguistic evolution to date is a process which has already happened; it happened in a definite way, but in the absence of a time machine we can't directly observe *how* it happened. So linguists are constantly formulating theories, which often contradict each other and are seldom subject to direct testing. Perkins threw a speculation of his own into the fray, based on several personal experiences with language learning. I found his idea intriguing because it seemed to fit in very well with a series of experiences I had had. Since my experiences were not quite the same as his, they seemed complementary, on one

hand suggesting that he was basically on the right track and on the other suggesting a slightly different perspective.

At the heart of Perkins's speculation is the question of how an individual learns one or more languages. His tentative answer was that an individual first, very early, develops his own personal language, and then learns to translate between that and the language or languages he hears others speaking around him. The experiences and observations from which he induced this hypothesis included the memory of discovering as a child that he had binocular vision but no words to communicate the idea, the later discovery as a multilingual adult that he sometimes had a concept clearly in mind but didn't know a word to express it in one or more of the languages he spoke, and the observation of both waking toddlers and sleeptalking adults using "nonsense" words in what seemed to be consistent and methodical patterns. "The inference which I draw from these data," he wrote, "is that every normal human being evolves his own private language as a natural part of his development, just as he develops teeth and hair. Shortly after he begins using his private language, he realizes that everyone else speaks something else and sets himself to the lifelong task of translating his own interior speech into the vernacular."

Now, there is a sense in which no two individuals speak exactly the same language. No two of us use exactly the same words, or with the same frequencies, and we all avoid and favor certain modes of expression. But Perkins was talking about much more than that. His idea was that the internal language is different for each individual and is quite distinct from any generally spoken language, though as it evolves it may incorporate sounds, words, and constructions from external languages it's exposed to. Evidently he was picturing the internal language as fairly similar in general structure to external languages, with words and sentences, though the internal language was "not directly accessible to examination." He took as given, as many linguists and psychologists did (and still do), that abstract thought could not be done without words. Therefore, if a person could form a concept for which he knew no spoken words, some part of his brain not consciously perceived must be forming it in *un*spoken words.

I am less sure than some that internal thought is necessarily carried on in words that resemble spoken words enough to be called by the same name. But I can pretty easily accept that any information being processed by the brain, like information being processed by any other computer, must be expressed internally in *some* sort of code. Is that code more like the "natural" languages spoken with other people, or like the "machine language" of computers? My current hunch is that ultimately at least some thought is carried out in a "brain language" that *is* more like machine language, functionally if not structurally, and that people beyond infancy have also developed at least one "high-level programming language" which they use for translating between

brain language and people language. That, I suspect, is closest to the internal language Perkins postulated; but I suspect that the lower-level brain language is also there. Most of us are aware of thinking consciously, in English or whatever "common-currency" language we're immersed in—but is that really what we're doing? Probably most of us are also aware of having the solution to a problem "pop into our heads" without being preceded by a conscious train of thought. Maybe this is really the result of extensive processing carried out entirely in brain language, without conscious monitoring. It may even be that *no* real thought is carried out in English, any more than calculations are actually done in FORTRAN (which is best thought of as a device to make it easier for a people-language speaker to tell a machine-language speaker what calculations to do). Maybe "conscious" thought is really

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done in brain language, and the "conscious" aspect merely means that the results are being periodically sampled and translated into spoken language.

If so, such interruption and translation may interfere with the underlying processing—which could help explain why creative breakthroughs often seem to be of the "aha!" rather than the "conscious thought" variety. One of the weirdest experiences I've had as a writer (and I've had it often enough to regard it as fairly routine) is the feeling of certainty that my subconscious mind is working, right now, on a particular problem, but I have no idea what it's doing—and I don't dare try to find out. It will tell me when it's finished, and any attempt to find out prematurely will disrupt the process. This would fit rather nicely with the notion that such processing is most efficiently done in a cerebral analog of machine language, while conscious access means diverting some of the available machinery to the extra work of translating through one or more levels of processing languages.

Some of my experiences that more or less parallel Perkins's seem consistent with both his idea that there are internal languages and my idea that they may exist at more than one level, with work involved in every step of translation. I have always been intrigued by languages and have been lucky enough to find them relatively easy to learn, so I've studied several, covering a rather broad spectrum, just for the fun of it. Like Perkins, I have often been delighted to find in a new language a word or construction neatly expressing a concept I had long had but could verbalize only awkwardly in languages I already knew. Are these concepts which my internal language had already wrapped up neatly, so I felt frustration with external languages that had no good translations for them—and relief at finding one that did?

Despite the translation-oriented approach of many language courses, I have generally found translation among external languages tedious (as well as unsatisfying, since if you know what you're talking about in both languages you'll often find it impossible to make them say exactly the same thing). As early as possible in learning a new language, I start cultivating a section of my mind which works "directly" in that language—or, if Perkins is right, by translating into my internal language without going through English. If I'm right about multiple levels of internal language, this may mean that I have to develop a new "compiler" for each external language I acquire. Translation from German to English is harder than simply reading in German, then, because it requires at least one or two extra steps. *Reading* either German or English requires translating through an appropriate programming language to my own lowest-level brain language. *Translating* either into the other then requires translating back out through another high-level intermediary to the second external language, and I won't do that much extra work unless somebody makes me (or pays me).

I have also long had a penchant for analyzing languages I came in contact

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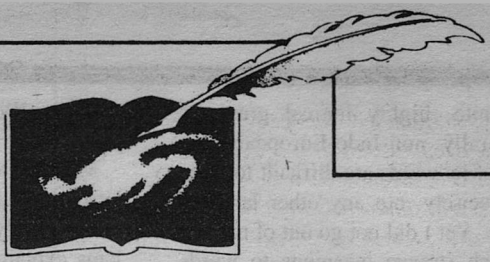
with, and that led eventually to the peculiar habit (useful to a science fiction writer!) of inventing new ones. I started dissecting English on my own long before my teachers started making me do it in school. I noticed that there were different kinds of words, serving particular kinds of functions and sometimes showing structural similarities like the "-ing" of present participles or the "-ly" of many adverbs. I identified and gave my own names to quite a few of these classes, and later, when I had to, learned to translate my names into the conventional parts of speech. (That wasn't always easy: my classifications weren't always the same as the conventional ones, and sometimes they were better. Like Perkins under different circumstances, I was baffled by the gross inconsistency of my teachers' calling "my" a pronoun when it obviously wasn't even by their own definitions.) The first foreign languages I learned to any appreciable extent were Italian and French—not by the conventional textbook method, but by listening to opera recordings and following the original and translation columns in the libretti. That got me far enough to spot a lot of translators' abuses of poetic license and to get a fair idea of grammatical structure, though my formulations of grammatical rules remained on the crude side until I studied them more conventionally years later.

It may have been the experience of seeing two languages side by side, trying to do the same thing, that first led me to think of languages as tools, with strengths and weaknesses, and to think about trying to design better ones. The first languages I invented were pretty obviously influenced by my experience with existing languages. One came about when I was making one of my first attempts at creating a future history and concurrently studying Spanish in junior high school. I gave my fictitious empire a language clearly descended from English, but incorporating some ideas from Spanish orthography and grammar that seemed to me to improve on the English ways. A few years later, after an encounter with Swahili and a lot of reading had given me a much-expanded idea of how much structural variation was possible, I wrote a story (my first that John Campbell showed any real interest in) showing in considerable detail a human's efforts to learn an extraterrestrial language that was as different as I could make it from any human language I knew about.

It's not at all clear how much any of these inventions had to do with my internal language *à la* Perkins, but there was one that seemed uncannily pertinent. All of my other invented languages were rather scholarly exercises, starting with the methodical construction of phonetic and grammatical rules and vocabularies. This one was utterly different. I have never written a single rule or word translation in it. I just started writing in it one day, letting grammar and vocabulary evolve as the need arose. The process proved surprisingly rapid and easy; the language just seemed to "flow out of my pen," and it took no particular effort to remember what the words meant. It has



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by Algis Budrys

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—Algis Budrys

a definite, highly logical grammar, structurally non-Indo-European, and many of its words are difficult to translate precisely into any other language I know. Yet I did not go out of my way to attach strange meanings to words. Rather, I coined words to express concepts which seemed clear and natural to me—often, like those foreign words I had been relieved to discover, more natural than English ones. I haven't used this language much recently, but I can still read existing samples of it effortlessly years after writing them. I can't help wondering: is this language, which seemed to "invent itself," by any chance a version of my "inner language" about which both Perkins and I have speculated?

Perkins suspected that the inner language is not available for conscious examination. I suspect that belief may be too pessimistic. This one invented language of mine which, unlike several others, flowed forth so easily that it almost seems to have been already there "just waiting to be unwrapped," just may be a case where an internal language managed to get close enough to the surface that some of it spilled out where it could be looked at. If so, what released it? I'm not *sure* that's what happened at all, but the possibility is intriguing. If the process could be induced deliberately, that might provide a way to start learning about internal languages; and future research may discover much more direct ways. If somebody can find a way to get a look at exactly how information is encoded in the brain—on several levels, I suspect—the result may be a new and exceptionally instructive branch of psychology.

Meanwhile, one of Perkins's most intriguing ideas was one he passed over rather lightly. "Could structural problems explain," he wrote, "why some American children fall naturally into correct English grammar and usage while their siblings sometimes fight a lifelong and losing battle with the problem of expressing themselves literately in the vernacular? Human languages vary astonishingly; could it be that the advantage is to the child born into a culture whose language is most like his own?"

Well, languages do vary astonishingly, people who learn several often find some easier than others (and not always the same ones), and that one "invented" language of mine seemed *extraordinarily* easy. I find it quite plausible that that was because it was unusually compatible with something that I was already programmed for—and that *any* external language will seem easier or harder depending on how compatible it is with an individual's "operating system." How much of that is "hardwired" and how much is subject to change, and how much "brain language" and "programming languages" vary among individuals, are wide open fields for that new branch of psychology (which we might dub "endolinguistics"). But if that ever gets off the ground, and if there do turn out to be large individual variations, many cases of "low intelligence" may turn out to be curable by transplanting the victim at an early age to a more congenial linguistic environment! ■

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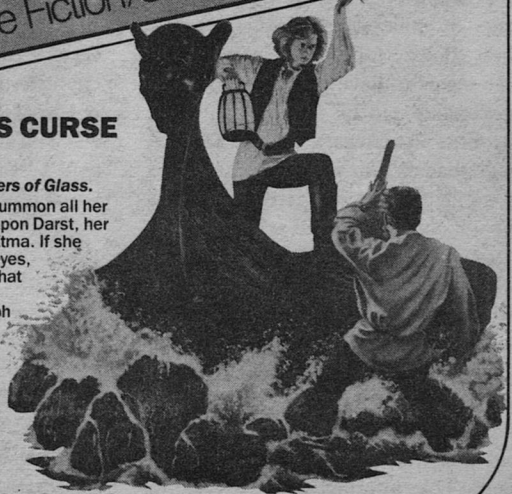

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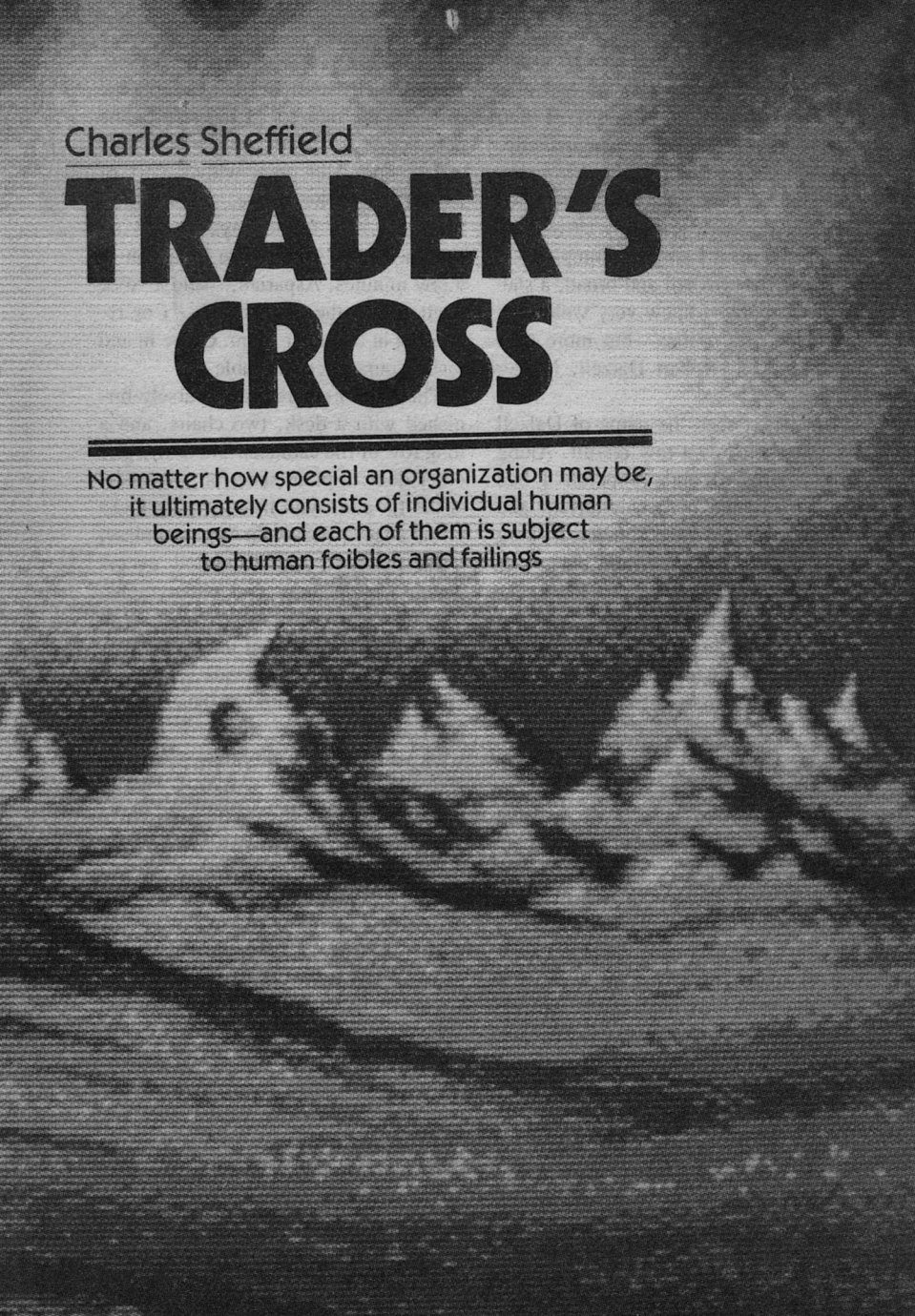

The door. It was visible now as a dull black rectangle, down at the end of a semi-circular tiled corridor. I had marched along that curve at a good clip, conscious of the ringing echoes from my own studded boots. But as I approached the door my pace gradually slowed. A few feet from it I stopped completely.

The portal was tall and broad, a slab of thick ebony. I knew very well what lay behind it. A man—but more than that: Maxwell Robert Dalzell, Master Trader.

I had first seen the name of Dalzell six years ago, as a raw recruit. Along with a hundred other hopefuls I had walked into the main auditorium and wandered around the perimeter, looking at the names, pictures, and dates embossed on the paneled walls. My attention had been taken by the devil's grin and bright blue eyes on one of the pictures. I stopped to read the name and look at the full description.

Maxwell Robert Dalzell: graduate of the Traders's Training Course thirty years before me, at the age of seventeen. Master Trader seven years later, at the unheard of age of twenty-four. One more year, and Dalzell had engineered single-handed the signing of the first power treaty between the Yankees and the Chills. He had made the first Trader trip to space, for discussions and negotiation with the Chips; and he was the absolute expert on the Greasers, with more than fifty successful trips to his credit to every major center from Mexity to F'waygo.

Since that first day, Dalzell and his exploits had never been far from my thoughts. They were flags that waved me on to greater personal efforts. That knowledge ran through my head now, when I finally summoned up the courage to touch the monitor at the side of the entrance.

The door slid open with a purr of motors at the base. I stepped forward—and found myself looking into an empty room. "Be with you in a few minutes, Asparian," said a voice from inside the door itself. "I'm recording in the inner room. Come in and make yourself comfortable."

The room I entered was sparsely furnished with a desk, two chairs, and a long row of file cabinets. There was one other door: a plain sheet of solid steel at the far end, with heavy cipher locks on its edges. The walls were seamless, white-painted, and decorated everywhere with plaques and photographs. The desk top was also covered with mementos, statues, and images.

I stood for a few seconds gazing expectantly at the inner door, then realized I could be gawping there for quite a while. Might as well follow Maxwell Dalzell's suggestion. I took a careful look at each wall, then went to sit in the visitor's chair by the desk and stare at the desk-top array. Quite a display of Trader memorabilia—I had never seen or heard of anything like it outside the Trader Museum. There was a signed copy (or was it the original?) of the first Greaser/Chill joint venture. Maxwell Dalzell had arranged that one himself. It was standing on part of a holmium Chipponese trading token, the sort they had used before the Traders brought them in line with the currencies of the other major groups. Dalzell again! Next to the platelike token was a facsimile of an early Yankee/Trader treaty, and

behind it stood a picture of a smiling Strine bigmomma, displaying one of the first biolab products allowed to emerge from Interior Strine.

Well, no doubt where Dalzell's heart lay. None of the pictures showed the man himself, but every one was some personal triumph of Trader negotiation. I was still admiring them when the inner door opened and a tall, strongly-built man breezed through.

"Hello." He gave me a casual nod. "Don't need to bother with formal introductions, do we? I'm Max Dalzell, and you're Mikal Asparian. No, don't stand up, Mike," he went on, as I started to spring to attention. "I'm not the Trader Anthem." He flashed me the famous wide grin that went well with the abrupt manner.

Dalzell flopped easily into the chair behind the desk and gave me a quick, appraising glance. That gave me a chance for my own inspection—I had seen pictures of Dalzell, dozens of them, but this was the first face-to-face encounter with my senior idol.

I saw a man almost a head taller than my own medium height, with a loose, athletic swing to the shoulders. The arms were well muscled in the short-sleeved shirt, and his wrists were thick and powerful, with massive, blunt-fingered hands. The surprise came lower on the body. Dalzell had a substantial paunch at his midriff—something never shown on his pictures. And his face was fuller and saggier than I expected, with jowls, a broader nose, and signs of a double chin.

A legend growing old!—inevitable, but it couldn't have happened inside my imagination. Dalzell was enshrined there as the golden-haired Master Trader, the youngest in history. Now the hair was receding from the temples, and it was streaked with gray.

The grin was still there, though, and the gleam in the blue eyes was unchanged. It was clear that Maxwell Dalzell enjoyed big natural advantages as a Trader. There was something in that look and smile that reached out and demanded instant respect and sympathy. For the first time in my life, I felt dissatisfied with my own unimpressive appearance.

Another grin from across the desk, and a little nod of the graying head. "Fine. Mutual inspection complete? Then let's talk. We've got a lot of ground to cover. We're going to be worrying today about the Chill territories. How much do you know about 'em?"

I thought for a moment and decided on the most honest answer. "If I weren't talking to Max Dalzell, I'd say I know a lot. But everyone says you're the expert. They say you've forgotten more about the Chills than most people have ever learned."

"Do they?" Dalzell frowned, but did not look either surprised or displeased. "I ought to be used to what 'they' say about me, but I never am. But I can tell you, I know the Greasers a whole lot better than I'll ever know the Chills—and I've got lots to learn about both of 'em. Might I ask just what name the Trainees are calling me these days?"

I hesitated for a second, but Dalzell simply sat and waited. When he wanted to he gave an impression of infinite patience and unlimited time.

"Three names, sir," I said at last.

"Sometimes they call you Bobby Dazzler. But usually it's Big Max, or Maximum Maxwell."

"Ah. Pity, I've heard those before." A shrug of the wide shoulders. "I was hoping for something new. Well, let's get back to business. Know why you're here?—and while you're at it you can stop calling me sir."

"No." I found Dalzell's brevity infectious. "I got just a short message from Daddy-O, telling me to report to you."

"Good. Nice to know we've got some security left." Dalzell leaned back in his chair and folded his arms across his belly. "Daddy-O's outputs tell me you're still a bit green, but you're pretty damned good. How do you feel about that?"

"I hope I'm good, sir." I winced, but the last word had popped out involuntarily. I shrugged. "I won't try to teach you our business, but it's a Trader's Rule, isn't it?: *'If you don't have confidence in your ability, no one else will.'* "

"Damn right." Dalzell's gruff voice sounded delighted with my reply. "And that's the answer I was hoping for. So let's get down to it. Mike Asparian, I can tell you now: you'll *need* to be good. We're talking of an official mission down onto the ice cap, to the middle of Chill territory. You'll need to be one hot-shot negotiator. The Unified Empire wants us to act on its behalf for a ten-year deal on gaming-table robot controllers. The Greasers are finally admitting what I've been telling 'em for fifteen years—the Chills are so far ahead of everybody else in micro-electronics that nobody else has a hope of competing. Apparently it's finally sunk into their thick Greaser skulls, and they called me ten days ago. I set out terms they can live with, and I'm fairly sure the Chills will go along with them."

There was a lot hidden behind those words. Dalzell was telling me that a Trader would negotiate the deal—so what else was new? The Traders provided the negotiation interface between all the other major power groups. But Dalzell was also pointing out implicitly the difference between a Trader and a Master Trader: You don't just *negotiate* a deal, Asparian, if you want to go to the top—you sell the idea of the deal *in the first place*. And you set up terms of agreement, before you ever get near the negotiation table, that both sides will be able to live with.

Dalzell was staring at me closely. "Well? Ready to try it? You don't look too keen."

Perceptive as hell—another key trait of the best Traders. I nodded reluctant agreement. "I'm ready to take the assignment, naturally. But it sounds as though you've already done all the hard work."

"Dead right." The grin again. "By design. We want you to have lots of energy left over when you're down on the ice cap. You see, there's another item for you to worry—and it's a dilly."

I sat up straighter. (Trader's Rule: *anyone who isn't working at least two agendas at once should give up being a Trader.*)

The smile had left Dalzell's face. "Ever hear of Seth Paramine?"

"No."

"Good. You shouldn't have. Ever hear of an *idiot savant?*"

"A . . . knowing idiot, isn't that what the words mean?"

"They do. But I think you'll admit that doesn't make much sense. Don't feel too bad, I was in the same position a week ago. *Idiot savant* is a phrase used to describe a special sort of person, normal or often very subnormal in most areas, but with special talents in a particular field. We're all like that in some ways—you could train me forever, and I'd never be able to carry a tune—but the idiot savants take it to extremes. Take a look at something."

Dalzell leaned across to the control settings on the desk. A portion of the wall in front of me turned, to reveal a holographic projection field. As the room lights dimmed, I found myself looking into a large bare room. The only furnishings were a thick carpet, with small spheres and oblongs of bright plastic scattered randomly across it, and a pile of white cardboard sheets next to them. Seated in the middle of the mass, head hunched forward on his shoulders, was an overweight youth in his late teens. His lower legs were bare, and he wore only a plain white smock that covered him from neck to knees. He was holding half a dozen of the colored plastic spheres, and idly sliding them over each other.

"Seth Paramine," said Dalzell's voice. "Nineteen years old. Born in northern Yankeeland, in the wheat belt. Parents both normal, but he didn't learn to stand until he was five, or walk until he was six and a half. He said his first word at ten. He cannot read or write, or speak a complete sentence. He is sexually mature, but has no interest in sex. Until two years ago, the Institute where

he stayed thought he had no interest in *anything*, except food and toys. But they were wrong. Watch closely now. This is a top-secret Yankee recording that no other Traders have seen."

The fat youth had stopped playing with the plastic balls, and was staring around him. The face was dull and doughy, with deep-set eyes under a beetling brow. After a few seconds he reached out his left hand and took one of the big cardboard sheets off the pile. He peered at it for a long time, rubbing the side of his nose with his fingers.

("Patience," said Maxwell Dalzell softly. "We're nearly there now.")

The youth bent his head down, to an inch or two from the sheet. Then he grunted and took a fat pencil from the pocket of his white smock. He began to mark the surface of the cardboard. The field of view zoomed in, to show that the original white board was covered with a complicated network of crossing and intersecting lines. The pencil was being used to mark in changes to the pattern. I could hear the grunts and mutters of satisfaction as the work went on. Finally, the field of view moved back, and after another few seconds the image blinked out of existence.

"Mysterious enough, I imagine," said Dalzell, as the lights of the room came back to full strength. "It was to me, until I was given the explanation. Seth Paramine is one of that rare group of people, the idiot savants. And he is a *spectacular* example. Those cardboard sheets are electronic schematics —circuit diagrams, blown up thousands of times over their original dimensions. They came from Chill micro-circuits, and they're the most advanced gadgets on the market. What you saw there was Seth Paramine studying the designs—and *improving* them. He can't write his name. He wears diapers. In every area of the world except one, he's a complete idiot. But he has an intuitive grasp of micro-circuit functional design that no one else can understand or equal. In circuit design, he's a genius."

I remembered the squat figure and the inert, lifeless face. "That's ridiculous!"

"It is—but it's true." Max Dalzell slid a thin wafer across the top of the desk. "Take a look at some of the data on that when you get home tonight. People like Paramine are rare, but they crop up now and again in a lot of different fields. Daddy-O pulled together a whole batch of information about other cases scattered over the past few centuries, just to give us background. Some of them are damned near unbelievable, but they're all authentic. The most common cases seem to be in mathematics and music. Play through the data and I guarantee you'll be surprised. So far as Daddy-O knows, Paramine is the first in his particular field. But the field didn't *exist* a century ago, so that's not too surprising."

I picked up the wafer, and slipped it into the pocket that held my Trader Recording Sphere. "I'll listen to it. But I'm getting more and more confused. Paramine lives up in northern Yankeeland, and I'm going down to Chill country at the South Pole. What's it have to do with my Trade mission? What's the connection?"

"A strong one." Dalzell looked as though he was really enjoying himself. "You see, Mike, Seth Paramine isn't up in Yankeeland any more. He's down

on the ice cap. The Chills are the world experts on microcircuit design, and somehow they heard about him. They wanted him. They took him. Four days ago, Seth Paramine disappeared from the Institution. He hasn't been heard from since—but all the evidence suggests a Chill smash operation. They're damn near as good at a rapid, quiet pick-up as we are."

"What do they want him for? They have genius designers of their own."

"But none with such strange design logic. According to the Yankees, the Chills don't want Paramine to *design* for them—they just want to poke around inside his head, to know *how he does it.*"

"Do the Yankees have proof that the Chills are holding Paramine?"

"Not *proof*—and the Chills aren't going to admit a thing—but there's some pretty good indirect evidence. The Yankees suspected the Chills as soon as Paramine was kidnapped and disappeared. They acted fast, and signed with the Chips to buy high-resolution surveillance from polar orbit. A couple of the frames that came back show somebody a lot like Paramine, in transit from Chill Central to an isolated station. He's seen climbing into an aircar, and then getting out at Mundsen Labs. That would be the logical place for him, along with the rest of their hot-shot hardware architects."

"Are the Yankees likely to try a rescue?"

"No way. They'd fail for sure. You know the Chill defense system. The Yankees are angry as hell, but they're still not ready to break off dealing with the Chills. They need 'em too much.

Trader's Cross

And Paramine really isn't much use to the Yankees—they don't have the right technology base. I think they'd have sold him to the Chills for any decent offer. But they'd like to have absolute proof that Paramine was kidnapped; then they'll really stick that in the Chills's ear on the next big negotiation. Which is where we—or rather you—come in. Still interested in the assignment?"

I started to give an upward wriggling shrug of my shoulders, but stopped when I realized it was a gesture I had carefully learned as a Trainee, from pictures of Maxwell Dalzell. Instead I nodded. "It means I have to find a way to get myself inside Mundsen Labs, and make recordings of Paramine."

"That's the bottom line. We'll help. But there are lots of details to worry about. I'm going to bring Daddy-O into the loop—that's the sort of thing a computer does better than we'd ever do it. But let me mention one other thing before we open the circuit. You'll be absolutely on your own once you reach the ice cap. We've heard a rumor that the Chills can crack our comm-codes. So we won't be able to give you a Mentor, and you'll be traveling without a Trader Recording Sphere. Throw in those factors, and Daddy-O doesn't put your chances very high—in fact, all the outputs set the probability level of your success between one and two percent. I'm willing to back you, even with those odds—if you are game."

I took a deep breath. "I want it. I want the job."

"Great." Dalzell leaned forward to grasp my hands in his. It felt as though an electric discharge crackled across to me. "I was sure you would. It's going to be a mission in a million. Damn it, I just wish I could go with you."

"So do I." There was real feeling in my voice.

"But it's impossible. They tell me I've got too many Trader secrets inside my head." Dalzell scowled. "And if the Chills have our codes I can't even help you as a Mentor for this one."

I nodded slowly. I'd have given a lot to have Big Max there to prompt me. I licked my lips (something I could not imagine Max Dalzell doing, ever) and felt a tremble of nervous anticipation. "Thanks for the chance. When do I leave?"

Idiot savant. Daddy-O had given me all I could handle about that subject on the Trader flight down to F'waygo. Waiting for the Chill connection that would take me to Chill Central, I now thought again about Seth Paramine. The Yankee was merely the most recent in a long and curious line.

Blind Tom. Back a couple of hundred years ago there was Blind Tom, the sightless half-witted Negro slave. Born in 1850, he was scarcely able to speak, and he had to be coaxed into playing the piano by gifts of cakes and candy from his owner. But he had absolute pitch, and a phenomenal memory. He could imitate any sound he heard, and he rattled off any piece of piano music, no matter how complicated, after one hearing.

Tom Fuller. Another Negro slave, from a century earlier. He was illiterate, but he had tremendous calculating powers. He shared those characteristics with Jed Buxton, an Englishman. They could

multiply ten digit numbers, extract square and cube roots, and factorize large numbers: in their heads, rapidly, without error—and without being able to tell in any way how they did it.

The twentieth-century mathematician, Srinivasa Ramanujan, was in some ways the most remarkable of all. He was a quiet, superstitious Indian clerk, with no obvious abilities—until an uninvited letter to Hardy at Cambridge University revealed that Ramanujan had made important mathematical discoveries, without help from colleagues, training, or books. He had an amazing memory and an uncanny familiarity with the properties of numbers, but he was unable to explain the mental processes that led to his results.

And now there was Seth Paramine. The films made at the Yankee institution showed his physical appearance and actions, but they gave no clue as to the mental processes inside that deformed skull. Paramine spent most of his days sitting on the floor, playing with children's toys. But now and again, according to a schedule that no one had been able to fathom, there was a burst of activity. He would feverishly work on circuit analysis and design, rearranging whole blocks of elements. The Yankee tests suggested that his approach was not analytical. He seemed to grasp the whole circuit at once, in one swoop, and sometimes he would begin to make his changes only a few seconds after the enlarged board diagram was given to him.

Only two other things aroused any animation in him at all. He dreaded pins, needles and scissors, and he had an absolute terror of fire and flames. Attempts to track down a cause for his phobias had all failed.

And what are my own phobias? I wondered. *I'd be crazy to think I don't have them.*

I watched the Chill transfer craft feather to a landing on the F'waygo field, and worried again about my mission. Had I been thinking too much about Paramine, and not enough about the primary negotation for gaming-table robots? Could I handle *that*, even without the other agenda?

Negotiation was different with every one of the major power groups. And it would be my first experience with the Chills. I had known they were hard to work with, even before Max Dalzell's final warning.

"Most Trainees believe the Chips are the most alien of the groups," Dalzell had said, just before I boarded my plane, "simply because they live off-Earth. But for my money the Chills make 'em look like our brothers and sisters. Don't forget how the Chills got their start. Talk about evolution the hard way! Four thousand scientists, invaded by a million refugees fleeing south to avoid the fallout clouds. They started out with no food supplies and no energy—in a place where plants don't grow and solar power is useless. That's something to remember, in all your discussions with them. When the people you'll be negotiating with were children they were half-starved, every one of 'em. They had vitamin deficiencies, and they were dirty—no spare energy for luxuries like hot water. Never forget the Chills are *different*." He rolled one of his sleeves all the way up to the shoulder, to reveal a long, deep scar. "Here's

an example of what can happen when a Chill negotiation goes wrong. It took me totally by surprise. Until one of the Chills put a dart through my arm, I thought I had everything under perfect control. But I made a joke about a penguin not being sure if it was a bird or a fish. And I got this. The others took her away after she did it, and I never saw her again. I'll give you a Trader's Rule that you'll not see in the rule book: *Never make a joke to a Chill.*'' He laughed with real humor and squeezed my shoulder. ''Well, now I've got you nice and relaxed, I'll say so long—and good luck.''

And I'm going to need it, I thought, watching the Chill crew file into the transfer lobby. There were two men and four women, all deeply suntanned and dressed in skin-tight light garments that left their arms and legs bare. Their style of dress confirmed the skimpy outfit that Daddy-O had provided for me. I had been ready for warm, swaddling clothes, all the way up to the eyes. Instead I had been given sunsuits that looked just right for a vacation in Ree-o-dee.

Most of the Chill crew continued through to the port clearance area, but one of the women peeled off from the others and walked directly across to where I was sitting. She came to stand in front of me and stared for a few seconds without speaking.

''I'm Trader Asparian.'' I did not stand, or reach out a hand, but I made my expression friendly.

She was a tall brunette, with a spare, angular figure and a thin-nosed, handsome face. She nodded, unsmiling. ''I am Kristen Waldemar, assigned to this negotiation. We wondered about your name.'' Her voice was soft and puzzled. ''Sweet Scott. It is true, then—you are a man.''

What did you expect—an elephant? I nodded, and tucked her name away into my memory (Trader Rule: *Get everything else wrong if you have to, but get their names right.*) ''I look forward to working with you.''

She averted her eyes as I stood up to look at her. ''Follow me. We will be on our way in a few minutes.''

She turned, and walked off towards port clearance, not looking back to see if I was following. I trailed along five paces behind. Without the comforting presence of a Mentor to drop information into my ear, I felt very much alone. Kristen Waldemar had looked annoyed and said little, just enough to make me feel unwelcome. *Chill negotiation technique?* Too soon to tell.

The whole Chill group was standing, ready to leave. Whether or not I was welcome, there was one formality of greeting that would not be neglected. I was prepared for it.

''To fruitful discussions!'' said Kristen Waldemar curtly. She handed everyone a small metal cup, and lifted it in salutation. I drained mine along with the rest of them, and managed to smack my lips in the required gesture of appreciation. It was liquid seal fat, warmed to a few degrees short of blood heat. That would give my gall bladder a work out. I handed back the cup and prayed there would be no more toasts.

Three minutes later we were airborne. The Chill aircraft never rose above three thousand meters in its slow flight from F'waygo to Chill Central. The southern continent ahead of us was a long time

appearing. The first signs came far out to sea. I saw beneath us the wandering icebergs, like glittering castles in the pale afternoon light of an Antarctic April. Soon after that we reached the island chain, and finally began to cruise south along the curving spine of the long Antarctic Peninsula. The gigantic krill farms were off-shore to our left in the Weddell Sea. Their retaining barriers lay like patterns of golden lacework on the black surface of the water.

The plane flew steadily on, overland into cold and darkness, threading its way between tall mountain peaks in its progress to the deep southern spur of the Ross ice shelf.

Following the formal introductions the Chill party showed no interest at all in me. When my own polite shot at conversation was rebuffed I did not persist. I watched the stark scenery drifting past below us, until by four o'clock in the afternoon it was too dark for any sight but the flashing white light on the tip of the wing. Then I stared at that, thought about my mission, wondered how I'd handle what came next. . . . Finally, lulled by the soft whine of the engines, I fell asleep. (Trader's Rule: *Food, drink, sleep—take them whenever you have a chance.*)

It was a change in the engine sound that woke me. I looked sleepily out of the cabin window on my left, then came instantly to full attention. The pulsing wing-light had become a fuzzy bright point in a dancing cloud of white. We were flying through a snow storm, a blizzard so intense that visibility did not go beyond the wing-tips.

Kristen Waldemar had noticed that I was awake from her seat on the other side of the cabin. She nodded coldly. "In the middle of the descent. Landing in a couple of minutes."

"It's an absolute ice-storm out there. How can the pilot see?"

"She can see as much as she is allowed to." Kristen Waldemar gave me another chilly stare. "Don't worry. Even without snow, no one has been permitted to land at Chill Central on visual flight rules for more than twenty years. Our descent is all on instruments. There will be nothing to see, and it is time you were ready to go outside. Let me show you how it is done."

As the engines were throttled back further, she handed me a compact parcel. I hefted it on my palm; less than a kilogram. She picked up a second package by one corner and cracked it like a whip. The whole fabric unfolded to become a glittering quicksilver mantle.

Chillsuit!

I'd heard of them but never seen one. They were not exported from the Cap territories. According to Trader rumor the suit was the most precious possession any Chill could ever own. I looked at it curiously. It seemed little more than a piece of shiny plastic.

Kristen Waldemar lifted her suit in both hands, the head of the unit downwards, and held it up above her. "Watch now. It looks hard, but it is very easy." She lowered the head unit of the suit to touch the top of her dark curls. As soon as the unit made contact, it *rippled*. Turning inside out, the unfolding suit flowed down over her body to her ankles. She lifted her feet, one after the other. As she did so the chillsuit made closure there. Kristen Waldemar had

vanished, replaced by a shimmering figure of distorting mirror surfaces.

The transformation shocked me. As a Chill Negotiator she had been no more than a rather unfriendly-looking woman, a little taller and thinner than most. Now she was a spectral, menacing figure, with bulging face and spidery limbs.

The main chillsuit covering was less than a millimeter thick. It covered the body completely, head to toe, including mouth, nose and eyes. The chillsuit contoured Kristen Waldemar's slim body to skintight perfection, vacuum-tight everywhere except at the face. There the suit bulged grotesquely outwards. Over the eyes, optic fiber bundles protruded as silver-green disks. Two inches across, they allowed perfect vision in all directions and protected the wearer totally from wind and cold. Below the green protruding disks the suit's mouth and nose formed a swollen muzzle. A network of tubes curved out and down under the chin, allowing the chillsuit wearer to breathe air warmed by circulation near the body.

The glittering shape in front of me raised a fragile-looking arm and nodded. "You now. Get a move on. We'll be landing in another minute."

I hesitated. What Kristen Waldemar had done looked like an impossible trick—a chillsuit donned and in full working order in less than ten seconds. I lifted the parcel and shook it loose. Then I held it high, and gingerly began to lower it towards my head. Even before it made contact I felt the movement. It pulled out of my hands and writhed down to enfold me. There was one unbearable moment when my nose and mouth were covered, then I realized that breathing was unimpaired. And I could see perfectly—better with the suit than without it! There must be some enhancement hardware in the optic bundle image reconstruction. I lifted one gloved hand and stared at the dazzling surface of the back of my forearm. I could see tiny sensors there, no more than a few micrometers across.

"You're not finished yet," said Kristen Waldemar (I could hear her perfectly, too, even though my ears were covered). "If you went out on the ice cap like that you'd freeze in two minutes. Lift your feet."

I did so, and felt the closure around each leg as the chillsuit completed its seals. Just as that happened I also felt a slight shake of the aircar.

The dazzling silver figure in front of me nodded. "Just in time. We're down. Follow me. For your information, it's thirty below zero outside. But see how you feel when you get there. Stay close behind me."

She turned the handle. The cabin door opened as though someone had jerked it violently outwards. There was a great scream of wind past its edges and a flurry of snow flakes.

I was supposed to go out into *that*—without any more protection against the cold than this skimpy suit? Kristen left without another word. I paused for a moment on the step down. Finally I said a prayer and followed her out into the howling winter storm.

I could see a faint pattern of lights ahead, flickering and variable through the whirl of driving snow. Closer to me was the bright reflection from Kristen's chillsuit. She was gliding along fast—faster than I could travel over the

powdery snowpack. I floundered along after her through half a foot of new fall. I was so busy doing it that half a minute passed before I realized that I felt no cold at all. I was warm, and comfortable. And somehow the raging winds that blew snowflakes horizontally across my field of view exerted little force on my body.

I looked down at the miraculous chillsuit, and then stared again around me. The aircar was already invisible behind, though it could be no more than forty meters away. Curious to know if the other crew members were following, I continued my turn through a full revolution.

Mistake—*big* mistake. When I had made what I was sure was a complete turn I looked again in front of me. *Nothing*. Kristen Waldemar had vanished. The lights ahead were gone. There was only grey skygloom and blinding snow. I felt my heart beating faster. I was all alone, out on the Antarctic ice cap in an evening winter blizzard.

Trader training took over. *Remember the rules,* said a voice inside my head: *Anything* can be a piece of negotiation tactics. Suppose this is Kristen Waldemar's way of softening you up before the real business begins?

I forced myself to stoop down and mark four lines with one chillsuit finger in the deepening snow; one in front, one behind, and one on each side. I could still see them, even when fully standing. I began to turn slowly around, surveying to the limit of vision, then looking back to the ground reference points and turning a little farther. After a three-quarter turn my eyes at last picked out a faint and flickering light.

Surely my sense of direction had not been so far off?—I would have sworn this was not the heading for the first lights I'd seen. But there could be no debating of options. I kept my eyes glued on those lights, and headed steadfastly toward them.

Distances were just as deceptive as directions. One moment the lights were far off and faint, a few yards more and I had reached them. They were two narrow bars of illumination, one on each side of a low building with a wide door of translucent blue material. When I was within a few feet of the entrance the door swung open. I went through, and found myself on a platform in front of a curved descending staircase. At the foot stood Kristen Waldemar. She had already removed her chillsuit, and was standing looking up with a strange expression on her face.

I hurried down the stairs and stopped in front of her. "Get this damned thing off me. What sort of hosts are the Chills anyway, leaving a guest to freeze out there on the ice cap?" (It was sure one hell of a way to begin a negotiation—but remember the Trader's Rule: *Don't accept precedents you can't live with.*)

"Like this." She reached out and pressed under my chin. At once the chillsuit rippled upward, folding into a neat package on top of my head. It would have fallen to the floor, but Kristen Waldemar reached out and caught it. "You were in no danger. The chillsuit is completely windproof and nonconducting. It allows no more heat to radiate away than the human body itself produces, and its surface minimizes wind forces. We often stay on the surface all day or all night, in complete

safety." Her words were casual, but the tone sounded oddly conciliatory. She was even offering a tentative smile. "Do not worry. Nothing like that will happen again."

It sounded like a half-hearted apology. But why let the incident happen in the first place? She must have known that I would be struggling along behind her.

"Food and drink?" she said hesitantly. "And then, if you are not too tired, we can begin our official discussions."

She placed my chillsuit on a stand by the entrance. Her own went, carefully folded and packed, into a satchel at her side. As we walked into the interior I had my first chance to examine the unique architecture of the underground caverns of Chill Central.

Wood and metal were in short supply here. The builders had been obliged to use their only plentiful construction material. The walls were thick sheets of ice, covered by a thin layer of chillsuit material. Highly reflecting and nonconducting, it permitted a comfortable living temperature in each room without melting the walls. A system of vents to the surface allowed any heat passing through to the ice to be removed. Over the years, the Chills had gradually extended the underground structure, burrowing deeper and deeper into the ice cap. No outsider knew the extent of that development.

We went through a long communal dining-hall, to a private room at the end. Kristen Waldemar called up a menu on the table-top screen and ordered a meal without consulting me. I put on a worried look that said: *How many ways are there to cook seal and penguin?* I pretended to be pleasantly surprised by the number of dishes offered on the menu.

She must have caught my look, because the earlier half-smile warmed suddenly to a real grin. Since leaving me out there in the snowstorm her whole attitude seemed to have changed.

"Wait and see," she said. "Traders must be familiar with all the foods of the world. But I feel sure that ours will amaze you. It is the best that can be found *anywhere*."

The dishes began to appear from the mid-table hatches. Little of the food looked familiar, and Kristen showed no signs of tasting anything. She was waiting for me. I finally picked up my fork and took a first tentative bite. Trader training told me the protocol: regardless of taste I would offer compliments. In this case, I expected to be on safe ground.

Sure enough. It was delicious.

"What *is* this?" I took another and bigger forkful.

Kristen laughed in delight, and I revised my estimate of her age downwards by five years. "That is seaweed, fried in fish oil. But the special flavor comes from the morel and lactarius garnish. When we have some spare time, I will show you the mushroom caves. Five hundred feet below us, the best fungal growth environment in the world—temperature and humidity exactly controlled, radiation budget precisely right. But there are better courses to come." She finally dug into her own heaped plate and began to eat heartily. "You see," she said between mouthfuls, "we have heard how the rest of the world regards our food. All they know is our

seal-oil toast for a safe journey, and that is an old ritual I would be happy to do without. Now, at one time our reputation *was* justified. We had nothing, and we ate what we could find. But today we are the world's gourmets. We have the pick of the sea-farms, we harvest the waters beyond the ice shelf, and we grow the world's best vegetables and fungi in our underground tanks."

All very plausible—but Kristen must *know* that I would have been thoroughly briefed on Chill ways before I was ever allowed to leave Trader Headquarters. The food might surprise a casual visitor, but not a Trader. *Therefore,* Kristen's delight at surprising me was not genuine. This was all part of the game of negotiation, and she knew just how it was played. (Trader's Rule: *Tell them what they know—it gives them a feeling of confidence.*) My respect for her went up. From now on, it would be unwise to assume that *any* of Kristen Waldemar's responses were spontaneous. And yet I was still convinced that the change in her general attitude to me was genuine.

Wishful thinking?

I let my thoughts run free, and concentrated on enjoyment of the best meal I'd eaten in years. There was a generous array of drink and drugs set out at the end of the table, everything a human might want to snort, smoke, pop, or mainline. I ignored them all. So did Kristen. If there were anything added to the food, we were both getting it. And as an added precaution I'd quietly downed a detox pill.

It was Kristen who broke the spell of genteel dining pleasure. After a course of candied kelp (don't knock it if you haven't tried it) she sat up a little straighter in her chair, glared at me and said: "Mikal Asparian, how old are you?"

I cleared my throat—twice. "I'm twenty-five," I said at last.

"You look twenty. And how many Trader missions have you been on?"

"This is my—er, my third. Not counting final trials."

"Sweet Scott. What are your people *doing?* First, they send in a man. You know, don't you, that we prefer and expect women as Trader negotiators?"

"I didn't know that." (*Daddy-O, what are you doing to me? I'm supposed to be* briefed *when I come here.*)

"Plus, you're ten years too young. And you've got hardly any experience. When I took my first look at you I was ready to tell you to get on the plane and go back home. You're right about me leaving you out in the snow. I was so mad, I wanted to give you a real scare."

"I can see why you'd want to. So why are you being nice to me now?"

"You *didn't* scare. You really were in no danger, I wasn't lying about that. As soon as I got in here I had you under radar observation all the time. There was no way you could get lost or get hurt. But you didn't know any of that. And you surprised me. You did everything right, as well as any native Chill could have done. And that's when I thought, dammit, he's a man, and he's wet behind the ears, but there's good stuff in him. Maybe I'd better give him a chance." She smiled. "You know, I expect to be negotiating deals here for another thirty years. You'll be around longer than that. If there's a chance

we'll be working together that long, we'd better be nice to each other."

"Thank you." I meant it, too (assuming that Kristen did).

"But don't get the wrong idea," she said. "I'm not going to kid-glove you when we get to the deals. You pay for your own mistakes there. Are you willing to have a first session on that tonight, or are you too tired?"

I pulled out the contract I had prepared from Max Dalzell's rough draft, and put it on the table. The Chill serving robots—how did they know we had finished?—came scuttling out of the table hatches and cleared off all the dishes.

"That's a first cut?" said Kristen. "Well, at least you've done some homework. Let's take a look, and we'll see how far apart we are."

She took the five sheets from me and spread them out in front of her. There was a ten minute silence, while she frowned and I fidgeted. I couldn't read a thing from her expression, and when she finally looked up and shook her head I felt more and more nervous.

"This is amazing," she said. "Where did you learn to spell out negotiable options?"

I shrugged. There was one honest answer—all the terms and alternatives had come straight from Max Dalzell—but I didn't want to mention that.

"I thought this would take us a week, minimum," she went on. "But with this as a starting point, we'll be through in an hour or two." She shook her head again. "You know, I could sign this damned thing *now*, and everybody here would be happy. Look, are you *sure* that these terms will be acceptable to the Greasers?"

"I know they will."

"Then they—" She drew in a deep breath, stared through me, and sat like a statue for a couple of minutes. Finally she squared off the sheets I had given her into a neat pile, and leaned back in her seat. "I think we've done enough on this for tonight. But we have to talk some more."

"Carry on."

"Not here." She stood up. "Come on."

We retraced our path, all the way to the entrance chamber. Chillsuits on, and back to the blue door. I wondered what I was getting myself into now. Nothing in Daddy-O's warnings and advice had covered this situation.

Out again, back onto the frozen surface. Three paces beyond the exit I stopped, entranced.

The snowstorm was over. The southern sky had turned to flame. Yellow-green stripes trailed streamers of red and salmon-pink across the starlit heavens.

Aurora australis—the southern lights.

"Bright tonight," said Kristen in a matter-of-fact tone. "Must be one hell of a solar flare. Pity the poor Chips up there on a night like this, eh? But it's good for us—we won't need lights."

"It's gorgeous."

"Ah. First time for you, is it? Don't worry, you'll soon get used to it."

I slowly turned all around for my first real exposure to the terrain of Chill Central. There was nothing—nothing living, nothing familiar. We were standing in a flat area of undisturbed snow, maybe half a mile across. Beyond it lay a landscape crumpled and shattered into spiky ice hills. Sharp ridges and spires

glowed pink and ghostly blue under the flickering sky.

I felt as cold as the outside air and broken as the ice-hill surface. The scenery was beautiful, but everything else was going wrong. The negotiation for the robots had turned into a farce, over before it began. Max Dalzell had done the ground work so well that there was nothing left to do. I was no more than a messenger boy. And now that I was here, I could see why Daddy-O had set the odds so high against my other mission. Mundsen Labs and Seth Paramine were only forty kilometers to the south—but that might as well be four thousand. Perhaps a Chill could find a way across that frozen chaos. For me it would be impossible.

"Walk," said Kristen. "Follow me."

She set off south at a steady pace. This time she was not trying to lose me. I followed her footsteps through the snow. Shades of Good King Wenceslas.

Where the smooth snow gave way to crevasses and ridges she halted. Then she was off again, winding her way easily into the ruined wilderness. In the shadow of an overhanging ice cliff she halted and turned again to face me. The green eye discs glowed.

"This is the *real* Chill homeland. What do you think of it?"

"It's like the frozen circle of Hell. 'Great God, this is an awful place.' "

She laughed in delight. "Marvelous. I guess you did get some briefing before you came here—I was beginning to wonder. But a real Chill would be at the Pole before he'd quote Scott, and we're still four hundred and fifty kilometers north of it. Stand still now, and keep quiet."

She raised one arm to the throat of my suit and pressed hard. The world went dark and silent.

The cheerful tone of her last remark saved me from panic. But I was on the way to it when I felt another pressure against the side of my head. "Right," said Kristen's voice. "I've turned off both our suits. We're head to head and nobody can overhear us. We can't stay like this for very long—no heat control. We'd broil or freeze. But we're safe for half an hour. You all right?"

"I've just learned a good way to kill somebody," I said. "Take them out onto the ice cap. Destroy the chillsuit control—and leave them. If they pull off the suit they freeze. If they don't, they're blind and deaf and never find their way back."

"It's been done. But it's easier to knock you on the head and stick you down a crevasse. Anyway, more people come onto the Cap for sex than death—chillsuits have adaptabilities most outsiders don't dream of. But we're not here for games. I want privacy. We couldn't get that inside. *Trader Oath*?"

I was on the spot. It was the first time those words had been said to me in negotiation. If I accepted information under Trader Oath, it could not be told. Not to *anyone*. Daddy-O would lock it away in the files, but no human would ever know it.

I began to sweat inside my chillsuit. What the devil could Kristen want to tell me that would need Trader Oath? But if I refused it, I might be passing up something big.

I used up three precious minutes while I thought it over. Would the situation become even more out of my

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control? *Could* it? I wished Max Dalzell were hooked in on a Monitor link, whispering advice into my ear.

"I accept," I said at last. "Anything you tell me here will be under Trader Oath."

"Good. Let's start with history. You know we began as a mixture of scientists and refugees?"

"Yep. Even I got that much briefing."

"And you know that when we got organized those two groups became the basis for Chill politics? Well, there are still two political groups, but now we are separated by philosophy more than ancestry. The Purists want Chills to keep to ourselves, and have no dealings with Traders or the other four power groups. They're a minority. The Rimmers—I'm one of them, and so are all our negotiators and most of the Chills—want more trade and cooperation."

"You're wasting Trader Oath time. Everything you've told me is common Trader knowledge."

"So far. But this isn't: the Purists have just been taken over by a group of extremists. They've started a program to *guarantee* Chill isolation. And last week they took the first extreme step. They organized a smash to northern Yankeeland, and captured a group of Yankee scientists. They took them to a research facility that they control completely."

I could feel an icicle crawling up my spine, and it wasn't chillsuit failure. "Seth Paramine," I said.

"What?"

"Nothing. You're sure it was a *group* of Yankee scientists? Keep going."

Kristen gripped my shoulder. "The Purists deny everything—naturally. The information we have, and there's not much of it, came from stringing together bits and pieces of data. But do you see our position? We can't stand up and tell the rest of the world what the Purists have done, because it would look bad for *all* the Chills. We have to stop the Purists, and we have to get the word out to the Yankees that this was an isolated incident that didn't involve most of us."

"I can see that. But I don't know what it has to do with me or the Traders—unless you want me to act as your go-between with the Yankees."

"We do, but that's the easy part. We want you to work on our behalf *with the Purist leaders,* to see if you can work out a way to free the Yankees. Unofficial negotiation. Officially you'll still be on Trader business."

"But why don't *you* do that? You're a negotiator, and you've far more experience than I have."

"And I'm a known Rimmer. I don't think they'd let me near the Mundsen Labs. But *you,* you're a Trader, and a good one; they'll let you in."

But you, she said. *You're good.* I was being stroked by Kristen Waldemar. Could I handle her?

Trader's Rule: If you don't have confidence in your ability, no one else will.

I sighed. "Maybe I'll do it. Tell me what terms you're prepared to offer, then let's get back below before we both freeze."

The flight to Mundsen Labs was made in a skimmer, a wide-bodied craft that traveled just a few meters above the jagged surface. We were under automatic

flight control, and after a few dizzying seconds with the ground blurring away underneath me I turned from the window.

I had plenty to think about.

I was heading for the Chills's main research center, the stronghold of the Purist faction. The Chill scientists there were specialists in miniaturization. Would the visual recorder grafted into the tip of my left middle finger pass their surveillance? If not I'd find it hard to take a picture of Paramine, even if they led me to him.

Worse than that, my agendas for the mission were becoming hopelessly confused. So far as the Unified Empire and the Chill government were concerned, I was here to negotiate the Greaser gaming-robots. From the point of view of the Yankees, I was trying to obtain definitive evidence of Paramine's presence at Mundsen Labs.

But Kristen Waldemar and the Chill Rimmer faction wanted me to *pretend* to be working for the Yankees, while I tried to negotiate secretly for the return of the "kidnapped scientists"—who were just Seth Paramine, though Kristen didn't know it. And finally there were the Purists. *They* thought I was coming to Mundsen Labs to look at the latest ag-robot circuitry as part of a possible separate deal with the Yankees—a deal their isolationist leaders would never agree to make!

I sat with that mess of conflicting objectives buzzing around in the back of my head, and studied the skimmer's control panel. If I had to leave Mundsen Labs in a hurry it would be nice to know how. The skimmer had a free-flight mode, with extensible lifting surfaces. I saw that the airspeed indicator went to Mach Three, and the altimeter to forty-five thousand meters. Not bad—if I could get back to the skimmer and off the ground.

We were slowing to a hover. Kristen had planned my arrival time carefully. At this latitude and season, full daylight lasted only a couple of hours. The skimmer touched down on the Mundsen airstrip just before local noon, with a wintry sun peering over the horizon. We were sitting in a shallow depression, well shielded from southern winds and located to catch every ray of light. On a fine summer's day, the noon temperature here might actually rise above freezing-point. The icy surface was polished smooth and glowed a beautiful phosphor-green in the oblique sunlight.

The human side of the scenery was unfortunately a lot less attractive. Even before I could close my suit and step onto the powdery ice, two chillsuited figures had appeared from nowhere and were standing outside the skimmer door. They were armed strangely—with ancient-looking projectile weapons instead of lasers. But age meant nothing; those guns still looked mean enough to blow multiple holes through me.

"I am Mikal Asparian," I said uneasily as I stepped outside. "I am a Trader. I am here to negotiate on behalf of the Yankees for new ag-robot equipment."

One of the figures shook his head (sex was never in doubt when you wore a chillsuit, it fit him like a second skin). "No," he said, and from the tone of voice I was sure he had a nasty smile on his face. "You're Mikal Asparian, true enough. And you're a Trader. But you're not here working for the Yan-

kees. You're here working for the Rimmers. Want to deny it?''

I certainly did, but I doubted if it would be much use. If they already knew that, what else did they know? I said nothing.

They led me past a complex of four metal huts, ancient and scarred. From their exteriors, the buildings dated to the earliest days of Antarctic research. They were uninhabited. Memorials, maybe, to the early scientists who had worked on the ice cap? That was just the sort of thing that would appeal to the Purists.

We walked on in silence for almost half a kilometer, to another smooth depression in the ice. This one was circled by a substantial chain fence. There was one break in the barricade, a wide opening spanned only by a thin pipe at ground level. We stepped across it, and walked to a cylindrical structure projecting from the ice. It was the top of an elevator shaft.

With one guard on each side of me we stepped in and descended for thirty seconds, the only sound a faint whine of machinery from the side of the shaft. Before we reached the bottom the man on my right removed his chillsuit. He gestured to me to do the same.

''Two degrees a meter temperature gradient,'' he said. ''You may find you're too hot.''

He was a sallow-skinned man with a lumpy bald head and a thin mouth. He looked pleased with himself, but not unfriendly.

''You'll be staying here until tomorrow morning,'' he went on. ''You came a long way to see someone, and it seems only fair that you should get at least a look at him. Go on, out you get.''

He motioned with his gun as the elevator doors opened. Beyond them lay a long, low-ceilinged corridor with the same reflecting walls of chillsuit material. I was led to a closed door, and made to face the other way while my hairless companion operated a cipher lock.

''In you go,'' he said. ''Hope you enjoy the company.''

The other man, still wearing his chillsuit, gave a high-pitched laugh and prodded me gently with his gun. I walked inside, and looked round as the door slammed solidly behind me.

Success—but it didn't feel like it. I was standing no more than twenty feet from Seth Paramine.

He was hunkered down on the floor of the room, in the same posture as the videos had shown him. This time he was frowning and muttering over a sort of interlocking spiral structure, made from many pieces of thin metal and plastic balls.

The Yankees's electronic genius looked up as the door closed, and stared at me with his lower lip pushed out.

''Where's my dinner?'' he said.

I went to sit next to him. The room had a soft floor, but no chairs. ''It's too early,'' I said. ''It won't be dinnertime for another three hours.''

That earned a frown, and a shake of the heavy head. ''I want dinner *now*,'' he said. Then he ignored me to concentrate on his metal spirals.

It's difficult to summarize the thoughts that ran through my head at that point. I was face-to-face with Seth Paramine . . . he was a genius . . . I would explain the whole problem to him . . . he would think of a way to get both of us

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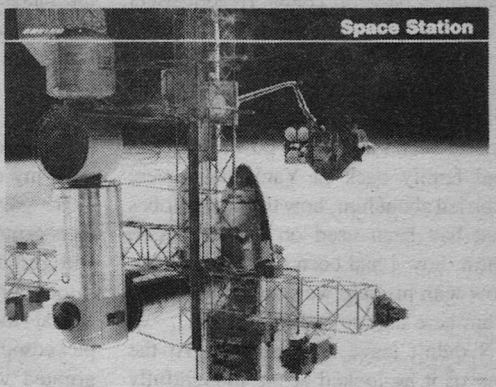

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out of here . . . we'd fly away in the skimmer, back to Trader Headquarters . . . .

I gave it my best shot. I sat beside Seth Paramine, and I explained the whole thing, slowly and in detail: how he had been kidnapped, how his friends and family back in Yankeeland were worried about him, how the brain probes that had been used on him could do harm, how I had been sent to find him, how with his help we could both escape from here and go back home. . . .

I didn't leave anything out. At the end of it he looked at me thoughtfully with those dull, slaty eyes. "You talk too much, and you have funny ears," he said.

And then he delivered the irrefutable counter-argument to all my eloquence: "I get two kinds of pie with dinner here."

For the next three hours he sat happily playing, while I prowled the big room and fantasized about overpowering the man or woman who brought in dinner. I should have known better. This was Chill territory—the land of the people who had invented table-service robots. The whole food supply system, kitchen included, would be automated.

Promptly at five o'clock a wall panel turned, to become a table complete with serving hatch. Plates of hot food slid out onto the flat surface. No knives or forks, but that didn't worry Seth Paramine—he didn't seem to expect them. He picked up his spoon, bent his head low to the plate, and gobbled all his share. Then he sat waiting expectantly for dessert.

It came, but it was not to his satisfaction.

"Only one sort of pie!" he said. He glared at the offending plate, banged on the hatch with his spoon, then looked at me accusingly. "Only one pie. Always get two pies when you're not here."

"Here," I said. I had hardly started my first course. "If you want it you can have my creamcake."

He gave me one slack-jawed gape, then grinned, pulled the plate to him, and grabbed his spoon. I'd guess that it took him twenty seconds, maximum, to eat the creamy dessert. Then he picked up the dish, licked it clean, and grunted with disappointment. He still looked hungry. Apparently two helpings of one dessert did not equal one helping each of two desserts.

"Only one sort of pie!" he said again.

A little of Seth Paramine's company went a long way. It was a relief when he finally stood up and wandered around the room, muttering to himself unhappily about pies. I carried on eating my own food. I didn't even notice that he was near the door until it was already open, and he had gone out through it. Before I could get there it slammed shut again.

"Seth!" I ran across and banged on it with both hands. "Seth, open the door. Let me out, too!"

Nothing. Not a word, not a sound. I groaned, and went back to the table—just in time to see my own food disappear. The serving robots assumed I was finished. It was my turn to bang on the hatch with my spoon, with no more success than Seth Paramine had enjoyed.

I was still doing that when I heard the door behind me opening again. This

time I moved a lot faster. As Seth came back in, triumphantly carrying a plate full of fruit pie, I made sure that the door stayed open behind him.

I held it ajar. "Seth, can you open this anytime?"

He nodded, mouth crammed full.

"*How* do you do it?"

He shrugged. "I open lock."

"Yes, but I mean *how*—"

I stopped. Why bother? Whatever his answer, it wouldn't help me. Seth did electronics at an intuitive level. Opening a mere electronic doorlock would be as natural to him as breathing.

"You're sure you can open it anytime?" I said again. When he nodded, I pulled the door closed and allowed the lock to operate.

I waited a couple of hours, then I began to talk to him again. This time I had found my own key. We talked about food. He was quite willing to do that. He told me all his favorite kinds: sugared figs, roast wild goose, crabcakes, candied morels, corn bread, baked apples, seal-belly pie, stuffed flounder, snapper-turtle soup, treacle tart, fried oysters, persimmon flan—and everything with pineapples and chocolate.

He listed foods in no particular order. When he was done I sat down and developed a menu, drawing on the serving hatch with one of Seth's crayons.

It took me a long time. Twelve courses, not counting the side dishes of breads, salads, and sauces, and every item selected for Seth's tastes.

When I was done I went to sit next to Seth.

"I want to tell you about a dinner I'm going to give for my friends."

I didn't hurry through it. Course by course, I described the whole meal. When I was finished there was a look on Seth's face that can only be described as religious ecstasy.

"When?" he said.

"As soon as I get back to Chill Central. Not far from here—we could fly there tonight. There's a skimmer that would take us."

He stood up and headed for the door.

"We'll have to go outside," I said. "Do you have a chillsuit?"

"Chillsuit?" The eyes were vacant again.

"One of these." I showed him the suit I had arrived in.

"Don't know." A shrug from the heavyset shoulders. "You find one for me?"

"We'll see. You'll have to open the door for us, though, before we can look."

"Mm-mm." He picked up one of the pieces of metal spiral and wandered over to the door. All he seemed to do was wave it a couple of times next to the lock, and push. The door opened and he went through. The savant side of the idiot—but *how did he do it?* No wonder he had driven the Chill designers crazy.

The corridor was deserted. We wandered along until we came to the elevator, and saw nothing like a chillsuit. Well, wouldn't the logical place for a spare suit be up at the surface itself?

Maybe, but it could be fifty below up there. Somewhere down here, in a room of the main building, there *had* to be spare suits. But looking for them might take all night, and if we were seen it was all over.

I knew only one place where I was

sure I would find a spare chillsuit. There was one in the skimmer.

"Wait for me here," I said. "I'll be right back."

Without giving him time to argue I stepped into the elevator and gave the signal to ascend. On the way up I opened my chillsuit. By the time the door opened onto the surface I was completely suited, and near that door—thank God for the logical Chills—was a rack with half a dozen spare chillsuits. I picked one up and looked outside.

Another snow storm was on the way, and the first flakes were already falling. I took a few paces towards the opening in the metal fence, wanting to be sure I knew how to get back to the skimmer with the worsening visibility. As I did so there was a roar and a flash of light in front of me. The gap in the fence vanished, replaced by a wall of burning gas that sprang up from the metal pipe at ground level.

So much for my idea that security at Mundsen Labs was somewhere between casual and non-existent. Anyone who came too close to the gap in the fence triggered the flaming wall. Try to go through it and you'd be fried to a crisp.

Unless . . .

I ran back to the elevator as fast as I could and jabbed at the down button. Somewhere an alarm would be ringing, and every second was important.

Paramine was waiting, leaning idly against the wall. I dragged him into the elevator, hit the button to ascend, and started to work him into the other chillsuit. Halfway through I suddenly felt sick. *The things that terrify Seth Paramine . . . pins, needles and scissors . . . fire and flame . . .*

The suit was on, and the elevator was almost at the surface.

"It's going to be dark and quiet when we get outside," I said urgently to Paramine. "Don't worry, though, I know the way to the skimmer, and I'll be holding your hand. All right?"

"Mm-mm. Getting hungry."

"Just wait, I'll give you the best dinner you've ever had." I lifted my suited hand and pressed at the suit controls under Paramine's chin just as the elevator door opened. The suit sound and vision clicked off.

"Dark," I heard him say. Then I was pulling him toward the fence.

There was a whoosh of igniting gas when we were still five paces away. I kept going, leading him along right through the wall of flame.

Five seconds more and we were clear, heading for the skimmer and freedom.

We almost made it.

I had us off the ground thirty seconds after we reached the skimmer, and I didn't bother to turn Paramine's suit controls back on until we were already airborne.

With the lifting surfaces extended we went up to five thousand meters and I opened the engines all the way. Our speed climbed past Mach Two. I really thought we were clear, on our way home. I took my chillsuit off, and helped Paramine with his. As I was doing so the engine power faded away to zero, and we went into a long, steep glide. Nothing I did at the controls made any difference.

Five hundred meters up the engines came to life again, with enough force to allow a controlled landing. We skid-

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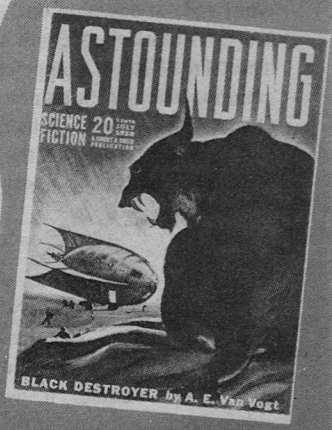

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ded to a halt on a long bank of ice. After that last effort the engines refused to respond at all.

One minute later another skimmer landed at our side. Three armed men came out of it, and moved across to our ship. No sense in fighting any more. I unlocked the door and they came in, removing their suits as they entered.

It was my old bald-headed friend, accompanied by two grim-faced youngsters.

"Well," he said to me. "Well, well, well. I'm glad to see you're being sensible about this. I hope you realize you're making us rethink our whole security system."

I said nothing. Seth Paramine scowled, and said, "We're going to dinner. Are these your friends?"

"Not exactly." Baldy even managed a half-smile (he could afford to—he had won) and sat down on one of the cabin seats. "But maybe we will be, one day. The Chills respect competence and ingenuity, wherever it comes from. How did you know that a chillsuit would let you pass safely through the fire?"

Paramine growled at that word, but did not move.

"Elementary physics." Why was I telling this? Why not, they wouldn't try the same thing again. "I was told that a chillsuit radiates very little heat, and it's made of non-conducting material. If it won't radiate, it won't absorb either—emissivity and absorption *have* to be the same or the second law of thermodynamics is violated. And those—" I pointed at the projectile weapons "—support that idea. With a non-absorbing suit, lasers won't work—but you can still blow holes in people with old-fashioned guns."

"True—but it's rare to find somebody with so much faith in physical laws. I'm not sure I'd take that risk myself." This time it was a real smile. "Oh, well. What now?"

"You tell me. You're in charge."

"That's right, I suppose I am." He sat without moving for a few seconds, looking at me with a curious expression. "Naturally, we'll be taking Paramine back with us. And we'll erase that little gadget you carry in your finger, if you don't mind, so there's no record to show of all this. But after that . . . you know, I'll feel much more relaxed when Mikal Asparian is back in Chill Central—or better still, Trader Headquarters. You make me uncomfortable. I really don't want you at Mundsen Labs again. Let me make a call or two, and work out what's to be done with you."

The trio headed for the door, keeping us well-covered with their weapons. As he left, Baldy turned in the doorway. "Just so you don't set Seth to work picking locks again, let me mention that this is a mechanical closure, not an electronic one. And we'll be keeping an eye on this door all the time. See you shortly."

I went to the window and watched them walk back to their aircar. As he had promised, one of them was always looking back at us, and once they were inside I saw a face peering back at me from their window.

I sat down glumly in the pilot's seat. How long did I have? It didn't make any difference. Even if we ran out of time I still had to make the effort.

I leaned forward to look at the car's

control panel. It was held in place by half a dozen missy-bolts, with their horrible hollow-pentagon heads. A bad start—without the correct missy-bolt screwdriver I'd never be able to turn them. I got down on my hands and knees, crawled forward into the knee-space below the control panel, turned my head around so far I thought my neck would break, and peered upward. The light level was so low under the knee cavity that I couldn't see a thing; and we had no flashlight in the cabin. *And* the panel was only a couple of inches from my face. I couldn't have focused so close, even in perfect light.

Time to think.

I crawled back out, and found Seth staring at me with a bit more interest than usual.

"I'm trying to get the panel off," I explained. "This one. Any ideas?"

He stared at it hard for maybe ten seconds. "No," he said.

So much for help from Genius-boy. If it wasn't food or electronics, forget Seth. I went back to sit in the useless control chair, and stared at the panel for another five minutes. Then I went across to one of the chillsuits, lifted it above my head, and slipped it on. I didn't bother to seal it. As soon as the unit was working I crawled back into the cavity and did the contortionist act again with my head.

The image enhancement equipment in the suit's optical sensors had compensation for low light levels, as well as improved contrast and focus. Now I could see the panel clearly from two inches away, and I could scan across it by turning my head.

It was built in two pieces, meeting at a groove that ran from front to back. I pushed, and it gave a little. Since there was no sign of bolts or screws, it was probably held in position by the pressure of the front panel. Remove that, and the lower panel would slide out in two parts. Unfortunately, I still couldn't get the front panel off.

Stymied again, but not too badly this time. I suspected that the panels butted with a simple tongue-and-groove joint, and there was no reason why they should be glued.

I turned over to lie flat on my back, reached up with my suited hands, and pushed to buckle the right-hand part of the panel. Why the right side? Well, the controls were on the left. I had reached that low level of sophistication in my thinking.

The plate bent a little, then resisted. It was meeting something above it. To hell with it. If I broke their machine they wouldn't do anything worse than they were already planning to do. I braced my back and straightened my arms as hard as I could. There was a creak of strained plastic, then the plate sprang upward. It had separated from its partner, and now I could slide them over each other and reach up into the back side of the front panel.

Now came the really delicate part. Until now I had been trying hard enough, but with no real hope of success. Now that I was making progress I was scared of ruining everything. I felt for the racks, reaching up as gently as I could. It was no good; I'd never do it by feel. I was forced to stick my head up through the panel, squint at the control assemblies sitting right at the end of the suit's

nose, and try at the same time to work with one hand up next to my eyes.

Predictably, the electronic boards I was after couldn't be taken out from the bottom. I would have to remove the front panel, then slide them out that way. And that brought me back to the old problem of the missy-bolts. But now I had one advantage. I could come at them from the *back*, where that hollow pentagonal bolthead did not apply. On the other end of the bolts were, thanks to old-fashioned engineering, nothing more than simple hex-head nuts. I could get a grip on them; and, after a monstrous effort that left my fingertips throbbing and didn't do much for the chillsuit's condition, I was able to undo them.

With the front panel off, I could finally reach the heart of the control panel. It consisted of five boards, each the size and thickness of a playing card.

I looked at my watch. Unbelievable. I had only been at it for twenty-five minutes—not the three or four hours it seemed like. I carried the boards across to where Seth was sitting idly, staring out at the snow.

"Here," I said. "I've got a little game for you to play. It's a puzzle. Somewhere on these control boards is a piece of logic that allows the inputs from the usual controls to be overridden by other inputs that arrive as radio signals. The thing I'd like to know is, where is that logic? And can it be changed?"

Seth sniffed, took the assembly from my hands, and stared at it for a few seconds. He shook his head. "Don't know."

I felt crushed. All my efforts, for a two-second rejection. "Can't you tell anything at all about the circuits?"

"No." He sat staring ahead of him for a while. Then, as though struck by a random afterthought, he added. "Too small."

Too small.

"Damnation. You mean—" I stopped. I should curse myself, not Seth. He was used to working with enlarged schematics. He didn't have eyes like a microscope, any more than I did. To analyze these microcircuits he had to be able to see them!

It took another precious five minutes to get him into the suit, with assurances that we were not going outside again. Finally he was sitting hunched over in the corner, holding each control board in turn half an inch from the chillsuit's nose. Now and again he gave a grunt of surprise, pleasure, or disappointment.

After five minutes he went back to one of the boards, the third in the assembly, and pointed at an area about an inch from the right-hand edge. "Here."

I stifled the urge to ask how he knew. Even the explanation would be beyond me.

"Can you change it?" I said. "Is there any way of making it so that the controls can't be affected from anywhere except the control panel here?"

"Sure." He pointed again. "Four ways to do. Easiest cut these circuits out, cross-connect those four."

He was pointing at things that were completely invisible to me. If it was too small to see, it was probably too small to change.

"What about the other ways? Is there a way with big enough elements for us

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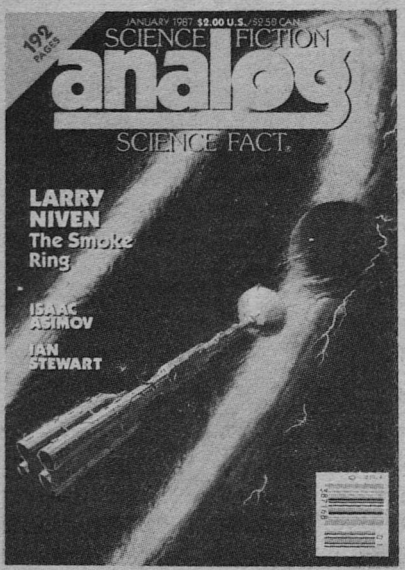

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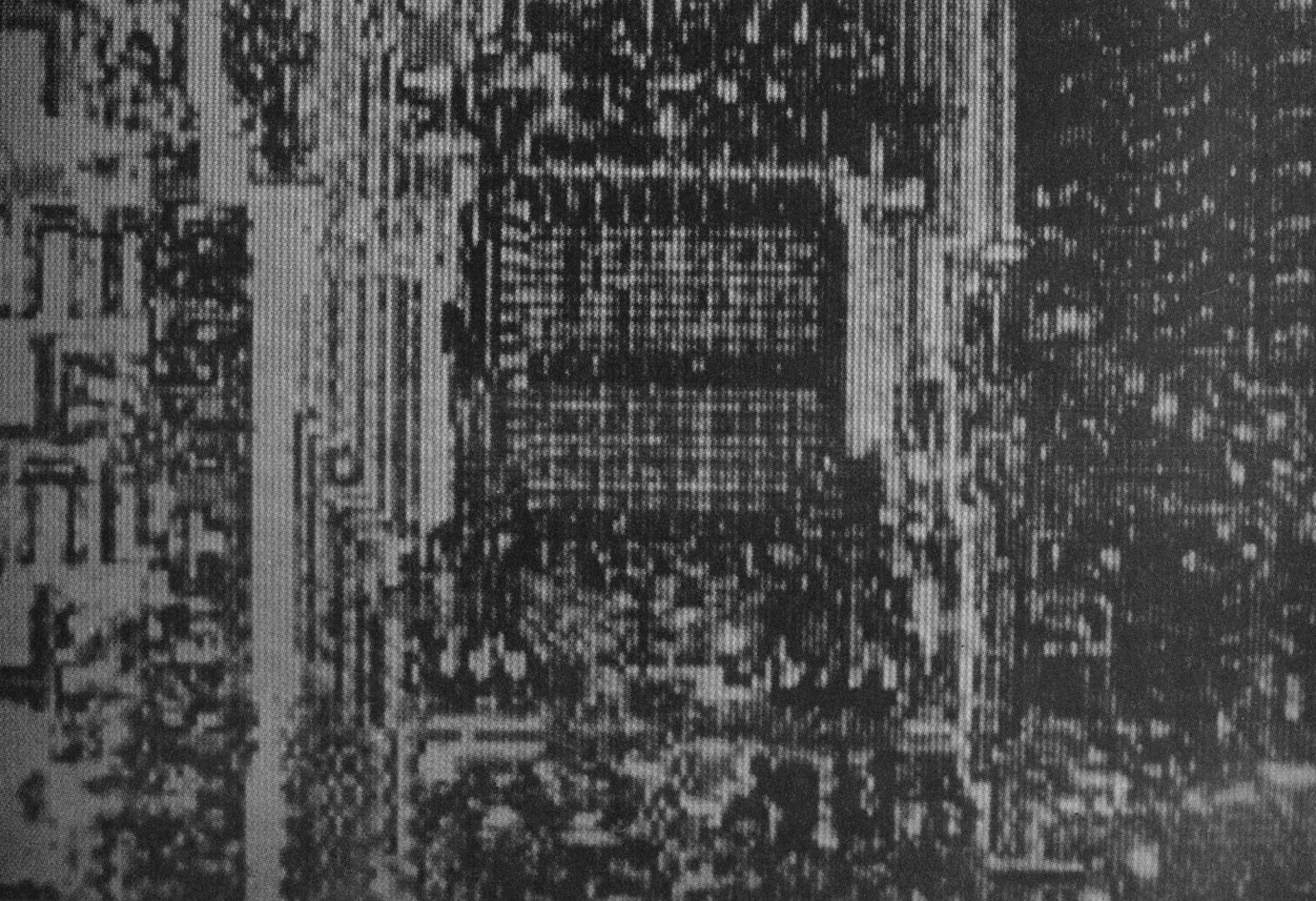


to do the change without special equipment?"

"Sure. Change these." He pointed again. I had the feeling I would get that same answer, sure, if I asked him to change the controls of the aircar so that it could sing and dance.

"Can you do it?" I asked.

"Sure. Do all four ways, if want to." He started to take his chillsuit off.

"Hey. What are you doing?"

"Tools." While I gawped, Seth removed his suit partway and rummaged in one of the front pockets of his blue overall. He took out a dozen tools—including, I was chagrined to note, two sizes of missy-driver—and selected a tiny scriber from a handful of the smallest ones. "OK." He disappeared back into the chillsuit and started work.

Seen from my point of view, he didn't do a thing. Two insignificant nicks on the surface of one of the boards, and a longer scratch parallel to its edge. It took a total of about twenty seconds, then he slipped all the boards back into the chassis and handed me the assembly without another word. I carried them back to the control panel, slid them into locked position, and pushed the panel face back in after them.

Now for the interesting part. If I hadn't ruined something when I buckled the bottom panel upward, or when I fiddled around inside turning the missy-bolts, or when I pulled the control assembly out, or when I put it back; and if Seth hadn't misunderstood the logic of the boards, and hadn't put one of his tiny scratches a little too far to the left or the right; why, then we might have a working aircar. And if the snow wasn't bad enough to cripple us at take-off, or drive us down right out of the air, and if my bald-headed friend didn't have another trick up his sleeve that I couldn't even guess at; why, then we might be able to fly back to Cap City.

No point in thinking about it. I sat in the pilot's seat, not bothering to tighten any of the bolts in the loose panel, and switched on. As we skittered along the ice we passed the other car, and I saw two faces gaping at us out of the window. But there was no shooting. Thirty seconds later we were in the air, heading at maximum speed for success, home, and fame.

Almost.

Ten minutes into the journey, Seth was sitting by my side, breathing heavily through his mouth. His fat face had a brooding look. "We get special dinner?" he said.

"You bet we do." I had been peering into the rearview sensors, and nothing was coming after us. "The dinner that I promised you, at Chill Central. And then we'll be on our way home, back to your family in Yankeeland."

He was silent for another moment. Then he shook his head. "No. You go back. Not me."

"But your home—your family." I gave him five minutes of my best arguments, and at the end of it he shook his head again.

"No. After special dinner, I fly back Mundsen Labs. That the best place I live—best games."

"Best games"—that was Seth's expression of the fact that the Chills in the Mundsen Labs were the world's tops in microcircuits. To him, it was no more than a game, one that he played better

than anyone. Unfortunately, none of that made any difference to my mission.

"Seth, you don't understand." I felt like a swine, but I couldn't give him a choice. "You *have* to go home. The people at the Mundsen Labs did something bad when they took you away from home. We can't let them do what they did, and get away with it."

"Something bad, but not for me. Like it there," he said. Then, "Take me back. After dinner, or right now."

"I can't, Seth." I held us on our course north. Poor guy, he had to learn the hard way what the world was like.

He did not speak, but he looked at me sorrowfully. Then he slouched down in his chair, shook his big head, and stuck his hands in his pockets. I felt like a real villain. He had helped me so much. But I had my job to do.

After another minute or so the controls of the car suddenly became soggy and unresponsive. I no longer had full control. I tried to stay calm, and keep on course. No good. We were holding altitude, but we were banking into a wide arc, turning steadily. In another few seconds we would be heading back the way we had come.

"Damn." I dropped the useless control stick. "It's happened again. They've taken over. Seth, I thought you said you'd made it so—"

I stopped. He was sitting back in his seat, bent over a little square of ceramic. A tiny scriber was in his hand, and he was moving it precisely over the surface. He noticed me looking, and did a little sideways wiggle with the tool. The aircar rolled right, then returned.

"Are you doing that? It's impossible. How, for the sake of Daddy-O, can you control an aircar with a little bit of—?"

He looked at me slyly. "Easy," he said. "Capacitance control. We have special dinner, then I go back. Right? Or we go back now."

Trader's rule: *Try as hard as you can, but know when you've lost.* Why had I ever, for one moment, thought of Seth Paramine as just an idiot? Genius is genius, no matter how it shows itself. And genius could run rings around non-geniuses—like me—whenever it chose to.

"All right," I said reluctantly.

"Trader's Promise?"

Now how the devil had Seth learned about *that?*

I thought for another few moments. He had me. I nodded. "Trader's Promise."

He moved a finger, the car began to turn, and soon we were once more heading for Chill Central.

Then Seth surprised me one more time. He looked at me, with those strange, miles-away eyes, and reached over to pat my hand. "You all right, Mike," he said. "I trust you. Come see me again."

I gripped his hand in return. It was the nearest thing to a true benediction that I ever expected to achieve in life.

The long curved corridor looked the same.

I pressed the monitor as soon as it was in reach, and the massive black door opened. He was in, sitting at his desk. He waved me over to the visitor's chair.

"I heard you were back," he said. Then he took a look at my face and

reached into his desk drawer. "Here. You need a bite from the tortoise."

He handed across a small plastic phial of *testudo* spirit, twisting the top as he did so. There was a long, high-pitched hiss and the bottle cooled twenty degrees in my hand. Joule-Kelvin effect. The Greasers are fond of technology, but they tend to apply it to their own sybaritic ends.

I took my first cautious sip of the icy liquid, and waited for the column of torch-bearers to walk down my throat to my stomach.

"That will help," said Dalzell. "Cheer up. It's not the end of the world."

"I'd like to think you're right."

"You made a successful negotiation for the gaming robots."

"No—*you* did that. They'll accept the agreement you wrote—without any changes."

He grinned. "But you'll get the credit. And you came as close as an eyelash to pulling Paramine out of there. You just had some bad luck."

"I had a lot of luck on the mission—both kinds. And I had something else."

I saw Max Dalzell's expression change. The man was uncannily perceptive.

"What are you getting at?"

"I'm not sure I know. I'm not an experienced Trader, I'll be the first to admit it. But I have a feel for the way a mission is supposed to work. On the plane coming back here, I realized that this one went sour right from the beginning. I started to make a list, and then I linked in to Daddy-O."

"I know. I saw your report as it came into the data bank."

"You saw some of it. I put the rest into a closed file." I drained the bottle of *testudo*, and sighed. "First data point: I didn't realize it until I met them, but the Chills are real stay-at-homes. They love it on the ice cap, and they hardly ever leave it for anything."

"The occasional flight to F'waygo. That's as far as most of them go."

"It's one hell of a long way from there to northern Yankeeland. So that gave me my first question: The Chills heard about Seth Paramine, we know that. *How* did they hear about him? Well, they must have been told. Not too surprising, if you think about it—all the groups try to have agents in the others' territories. And that explained something else that baffled me. That 'wall of fire' defense for the Mundsen Labs isn't a useful idea out on the ice cap. Anybody with a chillsuit on could walk right through it in perfect safety. But if the Chills *knew* about Paramine's fear of flame, it would be the perfect way of making sure he didn't try to leave. Even if he wandered out on his own, he'd have run back terrified. Again, it pointed to somebody feeding secret Yankee information to the Chills."

Max Dalzell puffed out his lips and handed me another bottle of *testudo*. "Plausible. But there could be five other explanations. Maybe the Chills cracked a Yankee communication line—they're hot-shots at electronics."

"That idea occurred to me, too. If they could crack a Yankee comm-code, they'd be just as likely to be able to crack one of ours. And that made me think of something else. One reason I got into trouble with the Chills was that I didn't have a Mentor contact to give

me advice. And the reason for *that* was the rumor that the Chills had cracked our comm-code. On the way back I checked the origin of that idea. Do you know who put the statement into Daddy-O's data files?''

Max Dalzell was like a stone carving. Then his eyes flickered once, down to the desk and back up.

''And I know too,'' I said. ''This trip to the Chills taught me something else. For the first time in my life, I realized that most Trader Rules can be interpreted two ways. Like this one: *If you don't have confidence in yourself, no one else will.* Sounds great, and a Trainee needs it to build up self-image. But it has another consequence. When one of us is chosen for a particular mission, we never ask, *Why me?* We assume it's for our brains and charm and courage. We never dream that we may have been selected for a completely different reason: *that we were picked because we were sure to fail.''*

Dalzell gave a rumbling cough, deep in his chest. ''I told you the odds that Daddy-O gave against success, before you left.''

''You did. You told me the odds against *my* success. I had one chance in a hundred. But you didn't tell me the odds that Daddy-O gave for an *experienced woman Trader* were better than forty percent. The Chills like women negotiators; they expected an experienced woman. They were given a man who just came out of Training. That was almost the end for me, right there. So why was I sent? Normally, the choice of Trader for a mission is made by Daddy-O. There's only one rank of person who can overrule the computer—a Master Trader. Someone who knew the Chills intimately, well enough to have reached a private arrangement with them. Someone who had heard about Seth Paramine through private Yankee channels, and told the Chills about him; someone who could set up a Trader mission to rescue Paramine, but make sure it was going to fail.''

I had finished the second bottle of *testudo*, and it was having its effect. I looked at the iron face of the man in front of me, and thought of all the times that I had longed to meet Big Max in person. Now I wished that I had never come here.

''So you know what I put in the closed file to Daddy-O,'' I said. ''Not proof. I don't have proof. But if I'm right, Daddy-O will get that. Computers never stop looking. And unless I give the counter-instruction, the computer search will begin in an hour. I came here for one reason: so you can tell me that I'm wrong, and then I can cancel the instruction.''

He took another phial of *testudo* from his desk, and tossed it down his throat like water. He sighed. ''I can't do that. Because you're not wrong. And I can't do this, either.'' He raised his other hand from beneath the level of the desk, and showed me the beam weapon he was holding. ''Not on you, Mike. You were just doing your job. Even if I did, it wouldn't stop Daddy-O, would it?''

I shook my head.

''Then can I ask a favor?'' He leaned forward. ''You may find it hard to believe, after what you've just said to me, but I love the Traders. It's been my whole life for thirty years. I don't want another thirty of disgrace, pointed at by

everybody as a traitor." He lifted the weapon. "If I end it here and now—my way—would you cancel that order to the computer? Let my name be a proud one, and not a Trader curse."

My throat was dry. It shouldn't come to this—Max Dalzell, my idol, pleading with me to let him die with honor intact. "Why, Max?" I said. "*Why* did you do it? You had everything, you *were* everything—"

He did not speak, and I could not. I finally nodded, and he stood up.

"I'd like to do this alone," he said. "In my inner office. There's one private file of mine that I want to purge. Five minutes?"

"Of course. As long as you want."

I had stood up when he did, not knowing what to do next. He held out his hand, and I shook it. Then he walked slowly around the big office, looking at the pictures and certificates that filled the walls. Finally he opened the steel door and passed through into the inner office.

I sat down again and buried my face in my hands. It was over. And now that it was over, I realized how desperately I had wanted Max Dalzell to prove that I was wrong, that I had misinterpreted everything. Max Dalzell, the greatest Trader of them all.

The minutes ticked on. I was waiting for that awful sound, the dull explosion made by human flesh when it is suddenly superheated to ten thousand degrees. It did not come. Ten minutes, fifteen minutes, and still no sound from the other office.

I gave in at fifteen. The inner door was ajar, and it swung open to reveal a deserted room. I went over to the corner, to a square opening that led to a steep spiral staircase. I stuck my head inside. At the top I saw daylight filtered through frosted glass.

The data terminal in the corner was still on, with my own code-word already blinking on it. I pressed the sequence for Send mode, and queried Travel Control.

The reply came in a few seconds. Dalzell's private air-shell was in flight, heading south. *Destination: unspecified. Speed: Mach Seven. Interception potential: messages only* (Note to inquirer: the shell of a Master Trader cannot be recalled by outside intervention).

I didn't send a message. I didn't need to. While I was still staring at the screen the receive light came on and the file scrolled in:

TO MIKAL ASPARIAN—FOR WHOM I PREDICT A GREAT TRADER FUTURE:

AS YOU SAID, TRADER RULES CAN BE INTERPRETED IN MORE THAN ONE WAY. REMEMBER THIS ONE? *DON'T TRY TO BE A HERO; THERE'S NO SHAME IN FLIGHT*. I'M APPLYING IT IN A WAY YOU NEVER EXPECTED.

YOU WERE RIGHT ON ALMOST EVERYTHING, BUT YOU MISSED ONE KEY POINT. WHO WOULD SPEND THE REST OF HIS LIFE IN CHILL CENTRAL, BLEAK AND COLD, WHEN HE COULD HAVE THE DELIGHTS OF REE-O-DEE? I DID SOME WORK FOR THE CHILLS, BUT I WAS PERFECTLY HONEST WHEN I TOLD YOU I KNOW THE GREASERS FIFTY TIMES AS WELL. TELL DADDY-O NOT TO WASTE HIS ELECTRONS LOOKING FOR ME. I'VE HAD A LONG TIME TO PREPARE FOR THIS, AND I'LL BE WELL PROTECTED. WHY DID YOU DO IT? YOU ASKED. I SAW THE PAIN AND PUZZLEMENT ON YOUR FACE.

WHY. WHY, INDEED.

MIKE, I ENVY YOU. YOU'RE YOUNG, YOU'RE ENTHUSIASTIC, AND YOU'RE SEEING IT ALL FOR THE FIRST TIME. YOU'LL BE FINE. BUT WHAT WILL YOU DO WHEN YOU HAVE SEEN IT ALL BEFORE, WHEN THERE IS NOTHING IN THE TRADERS'S WORLD THAT IS NOVEL OR EXCITING, WHEN TRADING IS SO AUTOMATIC IT CAN BE DONE WITHOUT THINKING? CHILLS, CHIPS, YANKEES, GREASERS, STRINES, TRADERS—WHO CARES? I'VE SEEN THEM ALL, WITH EVERYTHING THEY CAN OFFER. I WAS BORED, MIKE. BORED BEYOND DEATH. JUST PRAY THAT IT NEVER HAPPENS TO YOU.

GOOD LUCK, AND LONG LIFE (BUT NOT TOO LONG)—MAX DALZELL.

P.S. THIS RECORD WILL NOT BE STORED ANYWHERE IN DADDY-O'S DATA BANKS.

The file closed, and left me staring at an empty screen. After a couple of minutes I went back to Send mode, and opened the connection to Daddy-O. I had to explain what I had done—I had confirmed my suspicions about Dalzell, then been stupid and naive enough to let him escape.

But I hesitated. If I wanted to, I could purge the file where I suggested that Max Dalzell was a traitor. His disappearance would be a mystery, but there would be nothing to connect it to my return. And no record of my meeting with him.

Dalzell's final P.S. said it all: if I left his reputation intact, I could keep secret my own bungling.

It was a temptation. I could hide my blunders, and start on a path that could lead to success and a position as Master Trader—and maybe, thirty years from now, to another high-speed flight to Ree-o-dee.

I thought about it for a few seconds. Then I sent the message that converted my conjecture about Max Dalzell to an open data file, and asked Daddy-O to go ahead and investigate. The computer accepted my instructions without comment or criticism—those would come later, from others.

I had done it. I would tell everything, and drag the legend of Max Dalzell down into the gutter. Max Dalzell, the greatest of them all, the super-Trader with one fatal flaw.

My idol, infallible Max.

But he was not infallible. He had been wrong on at least one other thing. You'll be fine, he had said. You're young. I stared at the messages on the terminal, and knew I'd never be young again. ■

● Creative minds always have been known to survive any kind of bad training.

Anna Freud

● Well, sometimes, anyway.

The Editor

Tom Pace and Dan DeLong

CHEAP BUT NOT DIRTY: PROPOSAL FOR A SPACEPLANE

The American space effort seems to need a radical new approach, fast—which may mean that what it really needs is a clever new application of *old* approaches.

In this article the authors present preliminary calculations for a simple vehicle which could serve as a supplement to the Shuttle fleet; one that will fill a specific and rather important niche in the spectrum of capabilities needed to support the industrialization of space. We will describe the general characteristics of the vehicle system we envision, give preliminary discussions of the characteristics of such a lift system, and finally will discuss costs of developing, building, and operating such equipment.

A few preliminary words. This article is being written at a time of serious disarray in our space program. Since we discuss an alternative to the Space Shuttle, it seems in order to state that this article was by no means inspired by the *Challenger* disaster and to emphasize that we are discussing a supplement to, not a replacement for, the Shuttle fleet.

The Shuttle design was guided by the desire to produce an all-purpose, heavy lift system capable of a very wide variety of manned missions in orbit. It is a wonderful tool for such activity, as was demonstrated with Spacelab. It has proven to be a splendid means of returning hardware from low earth orbit, as the Palapa and Westar recoveries demonstrated, and it has served well to place satellites into orbit. Satellite failures have been caused by the upper stages and the satellites themselves, not the Space Shuttle or its crews. The Shuttle is also an excellent tool for simple manned improvisation, as was shown by the successful Leasat repair.

Perhaps above all, the Shuttle program has served as a highly visible focus for man's presence in space. The nature of the country's reaction to the *Challenger* explosion, in which pride in the *Challenger* Seven and determination to continue with the space program are as prominent as the national feeling of sadness, is evidence of how well the program has been accepted.

That is not to say that the Luddites are not alive and well. We are only beginning to hear from those in Washington whose budgetary adventurism originally produced the situation in which the shuttle is boosted by solid fuel rockets instead of the flyback liquid fuel booster as planned by NASA. Legislators who considered a sound space policy far less important than a huge force of welfare administrators, or those who furthered the fiction that the space program consumes more than a few percent of the federal budget, are hardly likely to have changed their ways.

We have mentioned the virtues of the Shuttle concept, and we feel that the program will continue to be vital to the future development of space. There are things the Shuttle can do that are best done by it, and these things will remain whether another system or two is fielded or not.

However, one thing the Shuttle is *not* good for is the shipment of commercial quantities of cargo into orbit at commercial prices. We are not attacking the shuttle pricing policy. That is the outcome of many things: the multiple capabilities of the space transportation system, the unforeseen difficulty of advances over the prior state-of-the-art, the previously mentioned financial tinkering from Washington, and a few doses of the management techniques that have brought the Pentagon, and so much else of Washington, the same advantages that the Edsel brought to the Ford Motor Company.

Just prior to the *Challenger* accident, NASA had the goal of reducing STS costs to one hundred million dollars per launch, or $1,500 per pound of payload delivered to orbit assuming a full payload bay. Their recent pricing policy supposedly charged customers about 70% of that figure for a full manifest. That amounts to a hefty subsidy to be paid by a federal agency already suffering from a too-small budget, even assuming that costs could be brought down to the target level.

But a price of a thousand dollars per pound into orbit is a horrid thing to contemplate for anyone interested in industrial activity in space. Certainly, any organization wanting to establish an orbiting factory to manufacture semiconductor devices made of Unobtainium, or to produce anything else not feasible to manufacture in a high gravity field, is going to have to think hard and long about what kind of cost. Further, even if our putative space industrialists could afford it, they'd be faced with a situation wherein, even if they bought *all* the cargo capability of all the shuttle and unmanned launcher flights, they could only get about two million pounds into orbit in a year. Getting materials back from orbit would be even more difficult, as only the shuttle is capable of return-

ing material, and even its maximum return payload is only about half of its launch payload. A thousand tons up and less than half that back. These aren't industrial capabilities.

Several organizations are proposing to build vehicles to carry these loads into space. Most of these proposals suffer from creeping complexity or from too little imagination. For example, the research and development required to develop the large hypersonic ramjets for the Orient Express is not merely creeping complexity, it is the personification of thinking BIG. Lets think small. So small that a program could be undertaken by a private company or consortium.

Briefly, let's describe the basic characteristics of the vehicle system we suggest;

1) It will be basically intended for freight hauling only; general capabilities added only if they don't detract from the "prime directive."
2) It will generally be unmanned, but could be piloted and carry passengers. More on this later.
3) There will be no new technology to be developed for this program.
4) It will be sized to deliver a relatively small amount of freight, but to do so often.
5) It will have low wing loading to lessen reentry temperature buildup and allow good power-off landing performance.
6) It will not have the expenses related to using a rocket for a first stage; an airplane will be used for initial altitude and speed boost.
7) It will minimize costs associated with ground handling and turnaround.
8) Costs should be 15% to 20% of shuttle costs per pound of freight into orbit.
9) Quantity of freight into orbit can exceed 600,000 pounds per year per vehicle, with vehicles costing two to three times as much as a big airliner.

The Booster

Let's discuss the booster first, since it is the key to the operation. We have in mind a small spaceplane piggybacked onto the top of a modified Boeing 747 and launched the same way the Enterprise was launched for its glide tests way back in 1977. What does the booster do for us? It gets us off the ground in the first place, without the necessity of a "launch complex." Then, it provides a useful fraction of orbital speed while burning cheap fuel in a very efficient engine. Finally, it delivers the fully fuelled spaceplane to a point above most of the atmosphere. After separation, the booster throttles down and glides back to the takeoff runway, where it makes a normal airplane landing.

The booster contributes little—but enough—to the ultimate altitude and velocity of the spaceplane, but it certainly gets us through the thickest part of the atmosphere and does so rather cheaply. A Boeing 747-200F has the following characteristics:

Empty weight: 342,000 lb.
Max gross weight: 833,000 lb.
Normal max cargo: 248,000 lb.

Notice the maximum cargo capacity is not the gross minus the net weights, because there is a 243,000 lb. allowance for enough kerosene to cruise several thousand miles. *But*, we don't want to cruise all day long, we only want enough fuel to climb to the separation point, then glide back for a landing. Without going into all the gory detail required, the airplane characteristics now become:

Empty weight: 377,000 lb. including special equipment

Max gross weight: 833,000 lb.

Fuel load: 76,000 lb.

Cargo: 380,000 lb.

Therefore, the 747 can release a 380,000 lb. spaceplane at our design point of 39,000 feet altitude with a velocity of Mach 0.84, or 250 meters per second.

Why, suddenly, the metric units? Well, most orbital calculations are done in metric units and that is where we are headed. Besides, any good technical person uses whatever units are appropriate at the moment with no more problem in switching from English to metric units than is encountered in switching from inches to feet (12.000024 by the way, the inch shortened to equal exactly 2.54 centimeters).

The Spaceplane

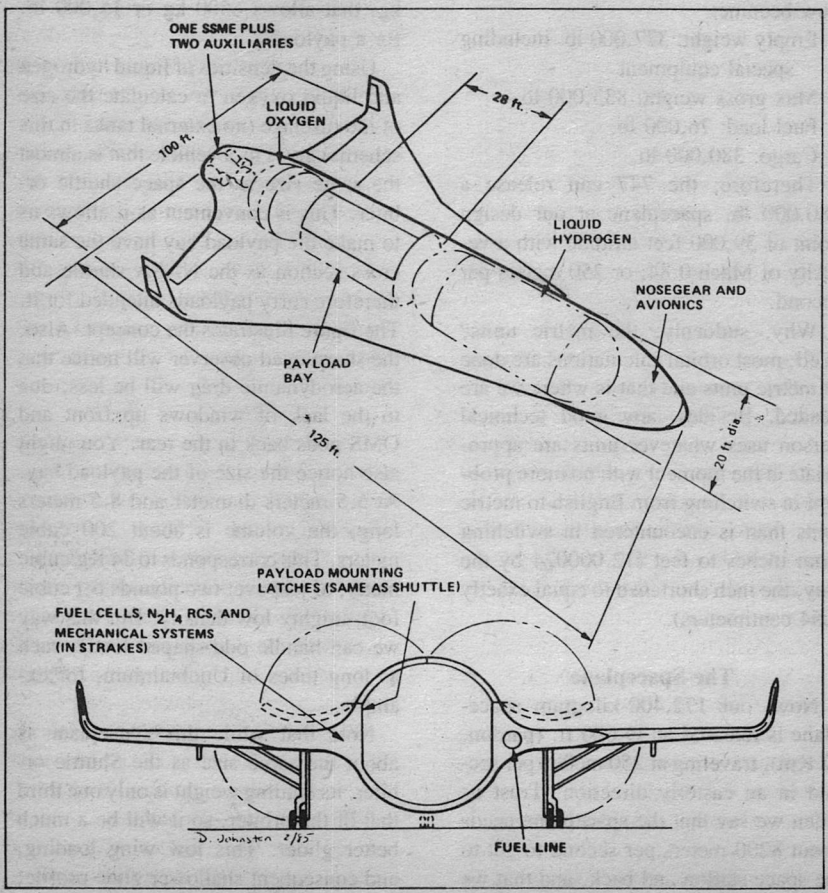
Now, our 172,400-kilogram spaceplane is released at 39,000 ft. (pardon, 12 Km), traveling at 250 meters per second in an easterly direction. Trust us when we say that the spaceplane needs about 8200 meters per second to get to the space station and back, and that we need to add to this to account for air drag and gravity losses, and to subtract the assist from the earth's rotation. Factoring in the performance of a single space shuttle main engine gives the fraction of the total spaceplane mass required to be fuel. That magic number happens to be 86%, which leaves 24,100 kilograms for the vehicle and payload. Finally, if the vehicle weighs 17,500 kg, that allows 6500 kg or 15,000 lb. for a payload.

Using the densities of liquid hydrogen and liquid oxygen to calculate the size of the fuselage (no external tanks in this scheme) gives us a vehicle that is almost the same size as the space shuttle orbiter. This is convenient as it allows us to make the payload bay have the same cross section as the NASA shuttle and therefore carry payloads intended for it. The figure illustrates the concept. Also, the sharp-eyed observer will notice that the aerodynamic drag will be less, due to the lack of windows up front and OMS pods back in the rear. You might also notice the size of the payload bay. At 5.5 meters diameter and 8.5 meters long, the volume is about 200 cubic meters. This corresponds to 34 Kg/cubic meter, or just over two pounds per cubic foot; mighty low density. But this way we can handle odd-shaped loads, such as long tubes of Unobtainium, for example.

Note that while this spaceplane is about the same size as the Shuttle orbiter, its landing weight is only one third that of the orbiter, so it will be a much better glider. This low wing loading, and consequent shallower glide profile,

accounts for our lack of need for thermal protection tiles, just as the "Orient Express" doesn't need tiles. Without the payload, this vehicle has a wing loading of only 22 lb. per square foot. Clearly, these wing loadings add tremendously to the maneuvering capability of the spaceplane, and to the ease of reentry and landing measures. With return payload, the spaceplane has about half the landing weight of a DC-9, and one third more wing area, but the DC-9 has power and a more suitable airfoil shape.

As mentioned, the intent is for the spaceplane to be unmanned. It is true that someone such as John Young would be undoubtedly a better self-programming, adaptive, nonlinear autopilot than any electronic system. But Mr. Young breathes, eats corned-beef sandwiches,



and needs to be kept warm and safe. The additional weight and cost penalties associated with man-rating the vehicle might well be prohibitive, as well as unnecessary for initial capabilities. We expect that at least one vehicle in the fleet will be made capable of carrying a pressurized module containing all the necessary life support equipment. Possibly, that module could be permanently docked to the Space Station to be used as an emergency return to earth capsule. Or suppose there is a production problem in the unmanned orbital factory that produces Nonsuch-dioxide semiconductors. A spaceplane could be outfitted with the pressurized pod to carry troubleshooting technicians to fix the problems in a hurry without waiting for an available shuttle flight. So, if people get to ride the spaceplane, they'll no doubt prefer to have a live pilot: a John Young or equal.

The spaceplane uses, as indicated before, a Space Shuttle Main Engine, that delivers between 305,000 and 470,000 pounds of thrust. We also stipulate two auxiliary engines that push 16,000 to 50,000 pounds each. These currently do not exist, but if the development program for them is deemed undesirable, each of them could be replaced with three of the twenty-five year old Pratt & Whitney RL-10 engines that have an astonishing reliability record. The imaginary auxiliary engine that we used to calculate spaceplane payload assumes the weight of six RL-10s, so the numbers are conservative in this respect.

Reliability is another area in which our proposed spaceplane has advantages. There has been six catastrophic failures of major launch systems in the past two years. Two of them were Titans, two were Arianes, with the Shuttle and Delta programs each having one. If the same failures are stipulated to happen to our spaceplane, not one payload or vehicle would be lost. Two of the accidents were solid rocket failures, and this scheme has no solid rockets. The other four were engine shutdown or start failures, and this system is insensitive to non-explosive engine failures. If the engines fail to start, the fuel is dumped and the 747 returns to land with the spaceplane still attached, and if the engines prematurely shut down, the remaining fuel is dumped so that the spaceplane can make a normal gliding reentry. Because of its good glide properties, it is never out of range of a suitable landing spot.

Ground Facilities

The launch site for the spaceplane/booster 747 can be any runway of sufficient length at or below the latitude of Cape Canaveral, Orlando. Tampa, or Dade County airports in Florida, or any long runway in Hawaii would perform admirably. Grenada airport would be even better as it is closer to the equator, although the logistics of getting freight to it are more complicated.

The handling, transfer, and storage of liquid hydrogen and oxygen have become a "mere technique." In the case of Grenada, the propellants could be barged from the Gulf of Mexico and transferred directly from the barges to

the spaceplane, as the runway extends out onto a breakwater.

Loading and maintenance would take place in hangars. After all, these are airplanes we're talking about. There is always the possibility that a payload customer with special requirements could perform his own "Payload Integration" in his own clean room. As long as he has a 10,000 foot runway at his facility, the spaceplane could be rented to him while it sits in his clean room hangar.

Costs

Let's start with the 747 booster. An air freight company will typically quote $80,000 to ship a 200,000 pound boiler from New Orleans to Houston in a 747. This amounts to 40 cents per pound. This is an all-in cost for the 747; it had better be, and it had better include profit, if the company wants to stay in business.

However, costs for our airplane's first stage might reasonably be 10 times higher, because of small production quantities of the special modifications required, less frequent flights, some flights with no payload, and more labor intensive ground turnaround. This would give us, say, an $800,000 bill for the 15,000 lb. payload, or a first stage cost of $54 per pound delivered to orbit.

Our estimates of the second stage spaceplane costs are of course very preliminary. Let's assume a development cost of $4 billion, including financing. Let's also assume a manufacturing cost of $4 billion for a fleet of 8 spaceplanes. The Japanese intend to spend $800 million developing their H-2 launch vehicle, including launch site, engine development, and first flight; so our $4 billion development number should be conservative. (Hermes spaceplane development costs are quoted to be $1.9 billion.)

We assume that each of the 500 million dollar spaceplanes will make 1000 flights during its lifetime; that is one tenth the number of flights that airliners routinely fly. The cost per pound of payload into orbit is $8 billion divided by 8 planes, each of which lifts 15 million pounds to low earth orbit during its lifetime; or $67 per pound for the hardware, including amortization of the development cost.

Then, the operations cost would be $67 per pound, assuming 350 flights per

The following table is a somewhat gloomy assessment of operational costs:

Salaries for 400 people	$52. million per year
Operations of two small chaseplanes	4.
250% overhead including facilities	140.
Legal, landing fees	15.
Fuel	40.
Insurance	100.
Total operations cost:	351. million per year

year, and a 15,000 lb. payload in each. Total first and second stage costs now total $188 per pound delivered into low earth orbit. This cost will drop to $155 per pound after development costs are amortized. These are *costs;* obviously, a comfortable profit margin would still result in an attractive selling price.

Three hundred fifty flights a year, or approximately 44 per spaceplane, do not seem extraordinary. A turn-around every four days for each plane, and 75% average availability, would work out to 547 flights per year. In that case, costs would drop to $167 per pound, not including profit. After development cost is amortized, costs would be $134 per pound.

Note that if the development costs, including financing, were doubled, to $8 billion, the cost for payload delivery at 350 flights per year would only go to $222 per pound. That would still be much more attractive than $1000-1500 per pound, and the cost would *still* reduce to $155 per pound after development payback.

It is granted that the 15,000-lb. payload is significantly smaller than the shuttle's 65,000 lb. maximum; but very large constructions could be built in orbit when one can put up 5.25 and 8.2 million pounds per year. A significant advantage of the small payload capability lies in the freedom to schedule flights without the headaches of multiple payload manifests.

Perhaps it is too much to expect any U.S. corporation, or consortium, to take on such a program (Where is D.D. Harriman, now that we really need him?). But the industrial interest certainly already exists; offer people 350 flights a year, 5.25 million pounds per year delivered to orbit, at even $222 per pound plus profit; and see what happens. The ideal program team would of course be a large builder of commercial aircraft, teamed with an enterprising manufacturer of rocket engines. Perhaps some of the funding would come from one of the communications satellite manufacturers, who now face a several year hiatus in the ability to put their products into orbit.

Funding might also come from as yet untapped sources. How much would a soft drink manufacturer pay to paint the spaceplane fuselage to resemble a giant soda bottle? And how much would his competitor pay to have it painted white? How many individuals are out there who would buy $500,000 worth of non-voting stock if it also meant getting an assigned number on the passenger manifest? Another possible funding method for this project would require NASA to agree to ship a given quantity of cargo at an agreed price. Such an agreement would allow the developers to obtain private funding more easily; but this article assumes a completely commercial effort.

It should be kept in mind that there would be very little new technology development required for this spaceplane, as there would be with a single-stage-to-orbit vehicle; and the development would be nothing like the enormous development program required to incorporate supersonic combustion ramjets. This lowers the cost and risk

to the point where private enterprise, not just government agencies, would be capable of funding the project.

Questions From the Gentle Reader

Q) If all this looks so good, why didn't they build the Shuttle that way?

A) The Shuttle was designed to fill a great many needs, in a great many ways; it can be thought of as a cross between a Winnebago and a Ferrari. We're talking about a small pickup truck. Furthermore, the Shuttle is a prerequisite for this project. Not only are we using technology and hardware developed for the Shuttle, heavy stuff like the Space Station pressurized modules must be lifted by the Shuttle. Only then would we set up our pipeline, taking more equipment, life support consumables, construction raw materials, and the like.

Q) How come you don't make it bigger? Fifteen thousand pounds isn't very much.

A) We'd love to make it bigger, but the 747 just can't stagger off the ground with any more load. Remember, we insist on using available, easily modified hardware, including the airplane. Furthermore, remember the pipeline analogy we used above. Pipelines aren't very large in diameter, and materials don't necessarily move rapidly through them. But once a pipeline starts flowing, it keeps flowing, and in the fullness of time, a lot of stuff goes through. In our case, five and a quarter million pounds a year, or possibly a good deal more. If the demand requires, we can build spaceplanes as fast as we can buy 747s.

Q) This all looks very good, but if it's that good, how come nobody else has done it before?

A) In other words, if we're so smart, how come we ain't rich? Well, until now, it hasn't been *time* for a spaceplane. Serious talk about manufacturing in orbit, and about permanently manned space stations, has only recently begun. Further, to reiterate, the shuttle program is a necessary precursor to this program, especially in hardware development.

Right now, what is necessary is for the STS to cure their problems, whether they be SRB design, management shortcomings, unrealistic scheduling, or all the above. It would be nice to have this spaceplane in the works by the time the Shuttle is flying again.

Q) You really think the Gummint is going to put money into this?

A We sure hope not! We hope *industry* does.

Q) Where might one buy stock in this enterprise?

A) Good man that you are! We'd love to answer that question, but we'd be lying, and anyway, the SEC would ruin our whole day.

But stick around. ■

ABOUT THE AUTHORS

Tom Pace is an electrical engineer and occasional science fiction and mystery writer with a long-standing interest in the exploration and use of space. He has worked for the University of Michigan, for RCA at Cape Canaveral, and on rocket and jet engine control systems and instrumentation for Pratt & Whitney. He is currently a consulting

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Dan DeLong is a Principal Engineer with Teledyne Brown Engineering, working on systems for NASA's STS and other projects. His original training was in materials engineering and he has worked extensively in the ocean engineering and ocean industry fields. He is also a private pilot and president of the Huntsville, Alabama chapter of the Experimental Aircraft Association.

IN TIMES TO COME

David Hardy has the cover again next month, this time for "A Hole in the Sun," a novella by Roger MacBride Allen. The last couple of decades have seen an unprecedented amount of close-up exploration of our Solar System, but there's one part that has so far been off limits: the Sun itself. But the fact that present technology is only capable of distant looks at our friendly neighborhood fusion reactor doesn't mean those limits will *always* apply. Given sufficient time, resources, and determination, it's quite imaginable that someone who follows us will someday get a lot closer, and that what he sees will be well beyond impressive. Of course, the person who undertakes such a venture will be driven by no ordinary motivation—and the Sun will be anything but a passive subject for study.

Richard D. Meisner's fact article, "Universe—the Ultimate Artifact?" is about something else which, in the opinion of some cosmologists, may not be quite as passive as commonly supposed. The title, as you've probably already surmised, hints at the farthest-out speculation in the piece, which may seem, depending on your viewpoint, either very *avant-garde* or very old-fashioned. But whether or not you find that speculation believable or useful, the facts leading up to it *are* rather odd....

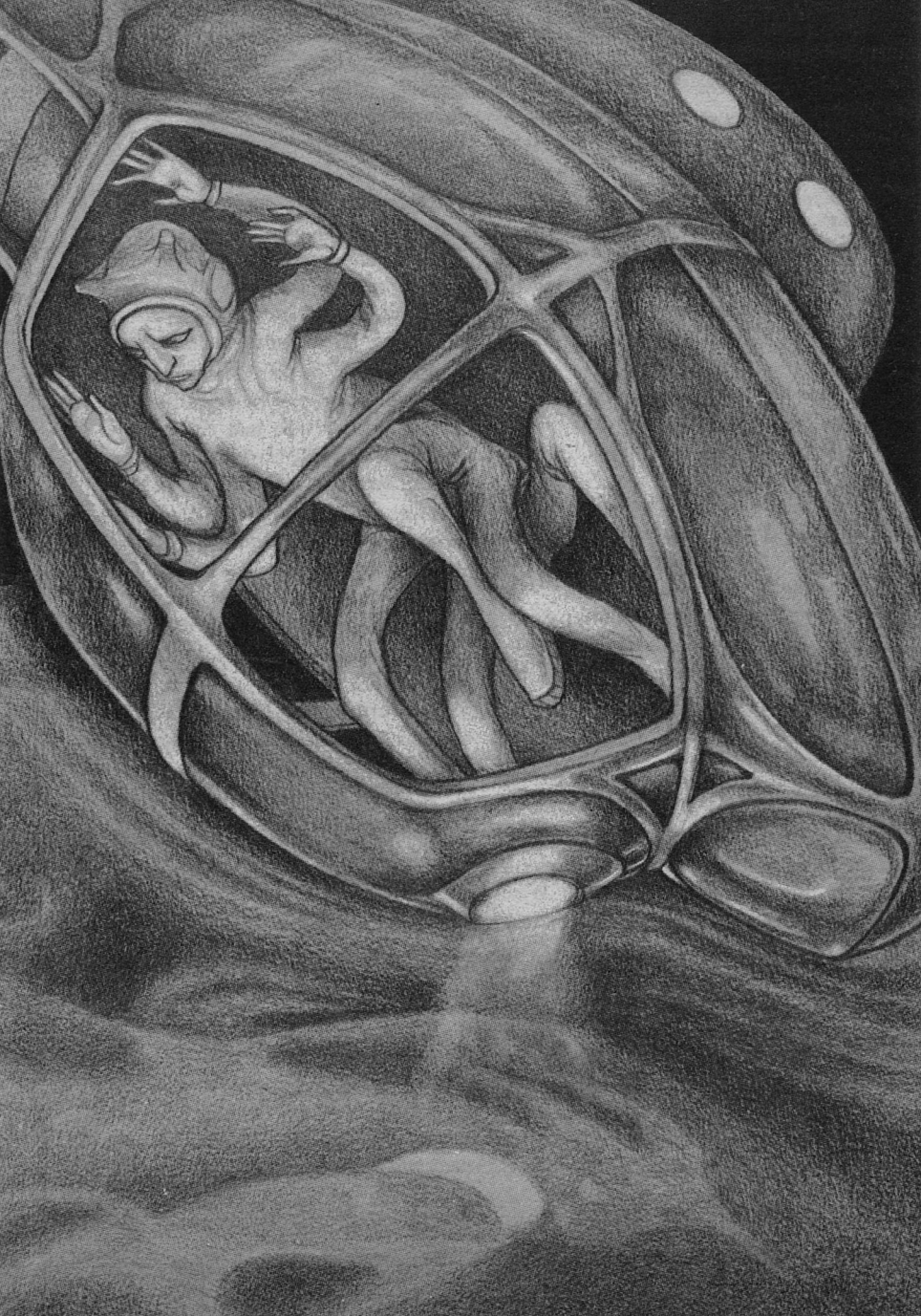
Our April issue also features the fourth and final part of Larry Niven's *The Smoke Ring*, as well as stories by Gregory Kusnick and Eric Vinicoff.

Bill Vaughan

HERE THERE BE DRAGONS

The unknown is quite likely to hold dangers—and the best protection against them is likely to involve looking at them with as few preconceptions as possible!

Judith Mitchell



Ice III: *a dense form of ice, stable at pressures greater than 207 MPa (2040 Earth atmospheres) and temperatures below −22 degrees Celsius. It is roughly 15% denser than water at the same temperature and pressure.*

Europa: *a satellite of Jupiter 3130 kilometers in diameter, covered with ice. Some scientists think that the ice covers a layer of water many kilometers deep, kept liquid by the heat of Europa's core.*

At a depth of 150 kilometers in Europa's gravity, the water pressure is 207 MPa.

Cargo Swimmer 17 was upside down and descending slowly. Tiny bits of dirt, dislodged from hidden places, muddied the usually clear water in its cabin. Walking on the cabin ceiling, Kaasteohn could just reach the viewports. But he could catch no glimpse of the thing that was pulling the swimmer down, though he put his ears right up to the membrane.

The water outside was pure black. He couldn't even see the echoes from drifting plankton—because there isn't any, *he thought*. Nothing can live in this cold. But something's caught us. What the hell is it and where does it come from?

Kaasteohn made his way to the pilot's station. With a powerful thrust of his siphon, he leaped up to the erstwhile floor and coiled two arms around the console stanchions. Turning on the big sonar, he put its tubes in his ears. He swiveled the sender around, trying to illuminate his captor. But nothing could be seen.

It must be directly below, where the buoyancy chamber blocks my view, *he thought. Then,* Aha! *he turned up the buoyancy control all the way*. I'll make it pull harder—maybe it'll get tired and let go.

Another look through the sonar. Raising the frequency for higher magnification, Kaasteohn examined the edges of the buoyancy chamber. Not a trace of the creature could be seen—not an arm, not a finger, not a tentacle.

What's that in the distance? *He reduced the pulse rate*. It looks like bottom. I shouldn't be that close to the bottom. It's awfully smooth. *He couldn't discern the texture of sand or rocks.*

It was getting uncomfortably hot. The buoyancy mechanism, turned up all the way, was venting too much waste heat into the cabin. Kaasteohn cracked a valve, letting some outside water in.

"Ouch! God, that's cold!" He had inadvertently let the stream of cold water brush his arm. That's going to be sore tomorrow, *he thought, coiling and uncoiling his arm to warm it and get some feeling back into it.*

Back to the communicator.

"Swimmer 17 calling Base, calling Base, come in Base—" No good, we've been out of range for too long. *Switching knobs, with some trepidation, Kaasteohn turned to the general distress frequency.*

"Distress, Distress, Swimmer 17 in distress, does anyone see me?"

He repeated the distress call several times, then listened, waiting. It's the new route, there aren't any other swimmers out there.

Back to the sonar. Where is that beast . . . oh shit, the bottom! *The*

glassy-seeming surface was very close and approaching rapidly.

Kaasteohn released the emergency beacon. He heard a muted (pop) as the beacon released from the hull, its "gas" bottle emptying its precious contents into the beacon's float. It would ascend rapidly, beaming its simple on-off signal, until the base came over its expanding horizon and saw the news.

They'll be here in a couple of weeks, *thought Kaasteohn, bracing for the crash,* if the monster doesn't get the beacon; if its signal is strong enough to see; if it doesn't go too high and burst; if the "gas" hasn't seeped out of the bottle—here it COMES.

Washed by the cold water from the sprung viewport, Kaasteohn couldn't feel any of his injuries. Before lapsing into unconsciousness, he thought crazily: I hope they don't dock my account for the price of the "gas"—

Toruun had been waiting in the Tsestokaar's anteroom long enough to read his news-scroll from beginning to end; but if asked, he couldn't have told what he had just read. Fidgeting on his stool, he rewound the scroll and tried again to focus his ears on the words.

His thickened, rugose skin was due more to a case of nerves than to the admittedly cool temperatures the Tsestokaar maintained in his office on the highest level of the Tokaar clan hive.

The news-scroll was more than half unrolled when a clerk emerged from the inner office with the message that the Tsestokaar regretted the delay and would see Toruun now. Sliding aside the varnished copper-bound partitions, the clerk ushered Toruun into the inner office.

The Tsestokaar was old but not flabby. In fact, he was surprisingly fit, his cylindrical body trim and muscular. Seeing him for the first time, Toruun remembered news-scroll accounts that said the Tsestokaar, disdaining the transportation due one of his rank, often swam all the way from his office to his home on one of the higher residential levels of the hive.

Stacking scrolls on his desk with his left arms, the Tsestokaar spoke:

"Toruun of the Kotaakhk family—" Toruun dipped his upper arms slightly in assent.

"You have been chosen to perform a mission of some importance to our clan." (Toruun nodded his arms again, like a school child to an instructor.)

"You are familiar with the principles behind our new cargo swimmers—" (Another "nod" by Toruun) "—both engineering and scientific. (Nod.) Your superiors at the swimmer yards (nod) where you are an . . . engineering trainee, is it?"

"Junior engineer, sir," interrupted Toruun.

"Yes, junior engineer . . . they say you are intelligent and quick-witted." The skin between Toruun's lower arms thickened from embarrassment.

"And that you are becoming a good trouble-shooter . . . (nod) . . . that you have recently discovered and corrected production problems in both the sonar and refrigeration systems."

"Minor problems, sir," said Toruun. "You see, the main sonar transducer—"

Waving Toruun into silence, the Tsestokaar continued. "You must know that a number of swimmers have been lost recently. (Nod.) They have all been

lost on the new route crossing the Great Desert, which only our new swimmers can cross. And though these swimmers are expensive and use much power (nod) they cut nearly sixty-four days off the trip to Tsegaan."

"Fifty-eight and a half days, exactly, sir," said Toruun.

"Indeed, nearly sixty-four days, and a significant profit they return for our clan because of it. (Nod.) But if we continue to lose as many as one in four swimmers, people will return to shipping their goods by way of Rift's End, and those magnificent vehicles we both love will be no more . . . and our clan will have to find some other way to raise money." The Tsestokaar paused.

"What can I do to help, sir?"

"Ah, I was coming to that. The pilots talk about monsters or dragons, but we don't believe there are any. The scientists assure us that life as we know it cannot live in waters so cold, and in addition, the Great Desert is sterile —nothing for dragons to eat, you know.

"We've sent one or two heavily insulated small swimmers out as far into the Great Desert as possible, and probed with powerful sonars . . . sonars that can see all the way to Tsegaan, around the curve of the world. Of course, that's not to leave this room, you understand."

Toruun felt quite proud to be trusted with this information, though it was hardly a real secret: for quite a long time, the news-scrolls had been speculating on the existence of such sonars.

"Nothing was found," the Tsestokaar continued. "We could see bits of debris, but no monsters—not even the wreck of one of the swimmers, and that's odd."

Toruun spoke up. "Perhaps they fell down some crevasse."

"We don't think so. It seems that the floor of the Great Desert, though it is quite deep, is flat as a leaf-worm. No boulders, no rocks, no cracks, no crevasses. As though it were scoured down to bedrock. There's no place for anything to hide, monster or wreck.

"We've found out everything we can find from a distance. We're going to have to get up close. And that's where you come in.

"The last swimmer lost—Swimmer 17—we know its course and where it went down. We retrieved the message capsule from the emergency beacon released by its pilot, Kaasteohn of the Tokhaats family, of our own clan.

"You are to pilot a new swimmer on that very course. As an engineer, you will be able to examine the equipment carefully throughout the entire trip. If anything begins to go wrong, return home. If that is impossible, you may be able to repair the fault. And if that in turn is impossible, we will at least have the observations of a knowledgeable engineer on your message capsule.

"You will be trained as a swimmer pilot. Your mission will commence in eight days."

Boring, thought Toruun, pacing the deck of Swimmer 22. *How do they ever get anyone to pilot these things?* He was one week, eight days out from Base, and six days into the Great Desert. Communication with Base was now next to impossible.

Toruun had already worked all the

word puzzles he had brought along, and read all the scrolls. He had kept his logs scrupulously, but since entering the desert they were beginning to look monotonous. Nothing to observe. Nothing to see out the viewport but clear water. No sound but the pulse of the great swimmer's engines and the drone of its refrigeration unit.

And I don't know how they can take this artificial environment. It all smells the same—I can hardly tell day from night!

Away from the great rifts where everyone lived, the natural rhythm of the world was absent. The rifts pumped hot water in great regular throbs. All life regulated itself by this rhythm. Most creatures, from the simplest tubeworms up to and including people, were active by "day"—the warm period—but some, particularly predators, were "nocturnal."

The temperature on the swimmer was regulated to provide an artificial "night" and "day," but it just didn't feel the same. For one thing, the smells were gone. The daytime smell, of water flowing out of the rift full of nutrients and sulfides, was far different from the nighttime smell. You couldn't help missing the smells, but you could get used to it—assuming you could get used to an artificial environment at all—that's why swimmer pilots had to be tested. By now, Toruun was beginning to wish he had failed the test.

I think I'll take a look aloft, thought Toruun. *At least it's something to do.* Opening a locker, he took out his bulky cold suit and began to put it on.

He pulled the suit on over his hind legs, smoothed down the spongy insulation, made sure there were no creases and that his feet were snug in the ends; then drew the suit up over his body and went through the same procedure with his middle legs, forelegs, and lower arms. Upper arms next—Toruun had to curl his hands nearly into cylinders to fit through the tight cuffs—and finally he sealed the collar around his face, making sure the membranes were squarely over his ears and sonar projectors.

Climbing the ladder to the buoyancy chamber, Toruun opened the inner hatch. He entered the transition chamber, closed the inner hatch carefully, then slid open the outer hatch a crack. A trickle of cold water came in—quite a contrast to the uncomfortably warm water near the ceiling of the cabin. Toruun checked his suit integrity at every seam, cuff and collar, before opening the outer hatch further.

Opening the outer hatch revealed the buoyancy chamber. *What a difference,* thought Toruun. *It sure didn't look like that back at the yards.* At the swimmer yards, a buoyancy chamber was a great cavern criss-crossed with pipes. But a buoyancy chamber in use was a cramped and crowded thing. Except for a few access ways, the whole chamber was packed with ice.

Ice: the great secret of the Tokaar clan. Well, the secret wasn't exactly ice itself—ice had been a laboratry curiosity everywhere, since its discovery when Toruun was a child—the secret was its uses. Ice is lighter than water. A lighter-than-water vehicle doesn't need to spend much power on propulsion. So it can carry great quantities of cargo, though slowly, quite cheaply. And it can go

where nothing else can go—across the Great Desert.

The rifts that criss-cross the globe are the only places where things can live. Between the rifts are deserts. At the center of the deserts are strong cold currents descending from above, barriers to any form of life.

Heavily insulated swimmers and power gliders can cross the smaller deserts. They must carry much fuel, for the trip must be made quickly to preserve the life of the pilot. They don't usually carry cargo except the lightest stuff; heavy cargo is shipped along the rifts.

At the back of the world (according to all the maps) is the Great Desert. It is many times the size of any other desert. The water is deeper and colder; it is not crossed by even a dead fragment of a rift. Until recently it had never been traversed. (Toruun suddenly remembered an antique map he had once seen. The Great Desert was a blank, with the note "Here there be dragons," and a crude picture of a monster. It didn't make him feel any better.)

On the other side of the Great Desert is exotic Tsegaan. *I can't believe I'm actually going to Tsegaan,* thought Toruun. *I wish I knew more of the language—well, I did bring that phrase-scroll.*

In Tsegaan, the culture was different, the language was different, even the inhabitants didn't look quite the same, and there were exotic and rare trade goods. Rare, that is, in Toruun's part of the world—in Tsegaan the cargo Toruun carried ("While we're at it, we might as well make a small profit, eh?") was just as exotic, equally in demand.

There was a lot of money to be made in shipping goods to and from Tsegaan, but there was no direct route until Kkhartau, a Tokaar clan engineer, designed the lighter-than-water swimmer.

Her design was simple—a huge buoyancy chamber made in an oval shape with a blunt nose and pointed tail, much like the body of a plankton-eater; vertical and horizontal fins on the tail for steering; large ports on the underside to let the water in and out. Between the ports, a comparatively small cargo compartment, looking like a finless miniature of the buoyancy chamber, with a cabin forward and an engine room aft. *The plankton-eater and her pup*, thought Toruun.

But this plankton-eater was all skin and bones: Kkhartau's swimmers were lightly built, of tough woven fabric stretched over rigid frames, using a minimum of metals. To save power, the cabin was heated by waste heat from the refrigeration system.

Spotting a cavity in the ice, Toruun looked closer. It was nothing abnormal: just a thick spot in one of the heat pipes. That was to be expected, though inspection of the pipes was quite careful. They were not manufactured by Toruun's folk, but harvested from pipeworms that lived in certain parts of the rifts.

Copper compounds are toxic to most life forms; in the parts of the rift system where there is a lot of copper, the creatures have various ways to tolerate it. Some secrete metallic copper. Of these, the most fascinating is the pipeworm. Its body, exceedingly long, contains a pipe made of copper and filled with organic fluid. This pipe conducts heat extremely well; the pipeworm uses it to

make habitations of places that would otherwise be too cold to live in.

Removed from the worms, the pipes still operate. Toruun's folk had long used them to heat their hives, though how the pipes worked was a mystery. Perhaps it was not a mystery to all folk: Toruun had heard rumors that the Kohstats clan, whose scientists had invented (or discovered) the mysterious substance called "gas," understood the workings of heat pipes and knew how to build them artificially. But the cost of production, they said, was far more than the Takuust clan charged for freshly harvested prime heat pipes.

Toruun was starting to get cold. His cold-suit's insulation, though bulky, wasn't really very good. Completing his circuit of the buoyancy chamber, he descended the ladder to the cabin.

Over halfway there and nothing's happened yet.

After twenty days, Toruun wasn't really getting used to the monotony, but he had learned to cope with it. Every morning (but it didn't really *feel* like morning), he ate, cleaned the galley, spent some time at the sonar, wrote his log entry, looked at his instruments, cleaned the pilot's station, ate, inspected the engine room, checked the fuel cells, spent some time at the sonar, wrote his log entry, practiced some phrases in the language of Tsegaan, ate; and in the evening (but it didn't really *smell* like evening) went to sleep.

Time to try the sonar. Toruun put the tubes in his ears and turned on the sender. *Same as ever. Nothing but the bottom. Not even a wreck.* He was having a hard time understanding that. According to the charts and instruments, he had crossed directly above the spot where Swimmer 17 had sunk, but there was no wreck anywhere.

The bottom was smooth. It had the rolling contour of a sandy bottom, but none of the wavy patterns that sand makes when swept by a current. Its texture was smooth, like polished rock. But there were no cracks and fissures as rock might have.

In the center of the desert the bottom had risen quite a bit. Swimmer 17 had not even made it that far, going down in one of the deepest parts of the desert, about three-eighths of the way across. It was *really* deep there. Even in the center where the bottom rose, it was far lower than the normal elevation among the rifts; the cargo swimmers's depth gauges had had to be specially modified for this route.

Toruun was beginning to believe the dragon theory. True, life as it was known couldn't live in the cold, without food, but there *had* been such things as dragons recently, before they were all hunted to death. Toruun's great-grandfather had boasted of being on one of the last dragon hunts. *Suppose a few dragons retreated to the Great Desert? Maybe they can live here. They have a tough, heavy hide. But no. What would they eat? Other than swimmer pilots . . .*

Another sweep with the sonar. *If there* are *any dragons, they aren't around here,* Toruun thought. *Put the sonar tubes away, turn off the sender. Get out the log. Read the instruments, write down the readings. Roll up the log, put it away. What do I do now?*

Toruun got out the "log" of Swimmer 17 again. It wasn't really the log,

just what they could get from the message capsule, but it did contain the key instrument readings.

I wish I knew why I didn't find the wreck, Toruun thought. *I'm sure I passed right over it.* And comparing the readings against his own log yet again, Toruun saw no deviation.

Of course, the depth's not quite the same. . . . Toruun had followed Swimmer 17's course at precisely the prescribed depth for cargo swimmers, calculated to prolong communications with Base. Swimmer 17 had actually been quite a bit deeper at the time it went down.

They told us in pilot school, deeper is better, Toruun remembered. *The deeper you go, the denser the water, the more buoyant your ice is, so you don't need as much ice, so you don't use as much fuel, so you stand a chance of getting an efficiency bonus for the trip. That's why 17 was going so low.*

But depth shouldn't make a difference—it doesn't affect the fuel cells or the engines. . . .

But he could hear the senior engineers at the yards: "It's an art, Toruun. Engineering isn't a science. When you get outside our cookbooks, we don't really know how things behave."

And Staakeuuts, his one-time tutor: "Interpolation's safe. Extrapolation isn't. Look. I take this stick. I bend it. Measure the force, the deflection. Bend it more, bend it less. Plot the points. Now extrapolate. How far does it bend if I apply so much force? Would you like to bet on it? I'll give you good odds. Predict the deflection. If you can come within a factor of two, you win.

"Ah. It broke, didn't it. Extrapolation can't predict that, can it. Pay up, boy. You don't learn lessons like this for free."

. . . I wonder if the depth could *make a difference?*

Toruun put the swimmer through a course change, added a note to his log entry. *I'm going back for another try.*

Cargo Swimmer 22 was upside down and descending slowly. Tiny bits of dirt, dislodged from hidden places, muddied the usually clear water in its cabin. Walking on the cabin ceiling, Toruun could just reach the viewports. But he could catch no glimpse of the thing that was pulling the swimmer down, though he put his ears right up to the membrane.

The water outside was pure black. He couldn't even see the echoes from drifting plankton—*because there isn't any,* he thought. *Nothing can live in this cold. But it feels like something's caught us. I wonder what it could be?*

Toruun made his way to the pilot's station. With a powerful thrust of his siphon, he leaped up to the erstwhile floor and coiled two arms around the console stanchions. Turning on the big sonar, he put its tubes in his ears. He swivelled the sender around, trying to illuminate his captor. But nothing could be seen.

He turned his attention to the depth gauge. It still worked well, despite being upside down. *Dropping steadily but slowly. What if I turn the buoyancy up?* He turned up the buoyancy control all the way. *I'll see if that helps.*

Toruun was oddly pleased with himself. He had returned to the spot where Swimmer 17 had gone down, as closely as he could place it, turned down the

buoyancy control, and begun to descend. About when he had reached 17's reported depth, there had been a loud noise from aloft, and the swimmer had shuddered and slowly capsized.

So it's the depth after all. I've found the problem. Now if I can just get myself out of this scrape . . . Toruun knew intellectually that he was in some danger, but for some reason he still felt in control.

Another look through the sonar. *Let's see if there's anything on the bottom. No, nothing. Hmmm . . . looks like we're pretty close.* He checked the depth gauge. *I seem to be dropping faster than before.*

It was getting uncomfortably hot. The buoyancy mechanism, turned up all the way, was venting too much waste heat into the cabin. The fact that the swimmer was upside-down didn't help: the warm water didn't rise to the ceiling as usual—it now rose to the "floor." *Well, that didn't work anyway*, thought Toruun, and turned the buoyancy control back to normal.

Back to the communicator. "Swimmer 22 calling Base, calling Base, come in Base—" *No good, still out of range.*

Another look at the depth gauge. *Not falling any faster. That settles it. Something's wrong with the buoyancy system. I'm going up—er, down—to check.*

Putting on his cold-suit in record time and ignoring all safety precautions, Toruun entered the buoyancy chamber.

It didn't look right. Much of the ice had broken away from the heat pipes and was lying in what was now the bottom of the buoyancy chamber. New ice was slowly forming as Toruun watched. *It reminds me of back at the yards,* To-

ruun thought. *Why? . . . Oh! I see: there's too much water in here!* Indeed, the chamber was more than a quarter full of water.

A chunk of ice broke away from one of the nearby pipes and drifted down towards the bottom. *What! Ice shouldn't sink. . . .* Incredulous, Toruun watched for a moment, then reached out and, ignoring the pain in his hand, grabbed it. *It's heavy, all right. Now I know what kind of dragon's pulling on me. It's the ice!*

Back through the outer hatch, which he had left open. Toruun hurriedly slid it shut, opened the inner hatch. The piece of heavy ice slid from his numbed grasp as he raced for the buoyancy control and turned it all the way down.

To the sonar. *Where's the bottom?* It looked pretty close. The depth gauge told Toruun he was still descending slowly, but maybe a little faster than before.

No wonder, with all that heavy ice—say, where is it? Looking around, Toruun spotted his piece of ice, still heavy but much smaller.

At least it still melts. I'd like to melt it all. . . . Wait! Maybe I can. The refrigeration system will work nearly as well in reverse. Toruun headed purposefully toward the engine room.

Swimmer 22 was upright again, but still drifting slowly downward. Even through the suit, Toruun was getting very cold. He was beginning to lose confidence that he could figure his way out of this. It wasn't going to be easy.

He had the buoyancy control turned down now, so no more ice would form around the heat pipes in the cabin. Since he had rewired the refrigeration system, that's where it had been forming. He had had to chip it off several times, but meanwhile the ice in the buoyancy chamber had begun to melt. With the change in weight balance, Swimmer 22 had righted itself, and the loose ice had fallen out the ports on the buoyancy chamber's underside.

Though not as heavy as before, the swimmer was still heavier than water. Its descent rate was quite slow, but Toruun knew that the cabin would not likely survive the impact. When swimmers were built at the yards, and when (rarely) their buoyancy chambers were emptied for maintenance, they had to be suspended from cables to keep the weight off the cabin and cargo compartment.

Anyway, before the swimmer hit bottom, Toruun would probably be dead of the cold. He had begun swimming the length of the cabin to generate heat, but he was tiring out. His people were walkers, not swimmers—especially Toruun, who had never been much of an athlete.

He stopped swimming and began to pace. As he did, his brain raced, trying to find a way out of his predicament. He could almost hear Staakeuuts's voice:

"Observe. Observe. How are you different from the animals? They only see. You observe. You know what effects things have. And from that you plan. You know what to do because you observe."

Maybe he had overlooked something . . . *but it's so hard to think. It's so cold.* Not long ago it had been warm—too warm. With the heat from the pipes rising right into the pilot's sta-

tion . . . *Hmmm. Warm water* does *rise, doesn't it. Maybe that's worth a try—at least I'll be warm.*

Toruun was warm all right, but he was still uncomfortable. No wonder. He was crouched in the transition chamber between the cabin and buoyancy chamber, with both hatches jammed open. The uncomfortably hot water above mixed with the icy cold water below, making this small habitable niche.

Toruun wasn't just uncomfortable, he was discouraged. *Warm water rises, all right. Just not quite enough to lift a swimmer . . .*

The swimmer had nearly stopped descending, but not quite. It was a good question whether it would hit the bottom hard enough to break anything. Pessimistically, Toruun guessed it would. *On the other hand, it's no better if I touch down safely. How do I get off? Nobody can come down after me; they'll sink too.*

I'd better get a message capsule ready to go before I hit bottom.

With that thought, Toruun's emotions themselves seemed to hit bottom. For the first time, he really felt afraid. He had tried everything he could think of. It had all helped—but nothing had helped enough.

He had never realized before that you can get yourself into a situation you can't get out of—never realized it in his belly. He did now. It didn't look like he was going to get out of this one.

Damn. Time to go down and break loose the ice again. Is it even worth bothering? It's cold down there. But though he couldn't really see a purpose in going, Toruun wasn't going to give up yet.

I guess I can do it one more time.

He quickly swam down through the frigid cabin, reversed the crude switch he had rigged on the refrigeration unit, waited several breaths, reversed it again, as quickly swam back. He heard a *crack* as the pulse of heat through the cabin end of the pipes broke the ice free.

But the swimmer's descent didn't slow. Cursing, Toruun swam for the pipes, pried at the ice with a wrench he had taken from the engine room. He could feel the swimmer's descent slow as the ice fell through the ragged hole in the cabin floor—the swimmer's belly skin was tough but could be cut—and headed for the bottom.

The ice didn't have far to go. The bottom was so close Toruun didn't need the big sonar to see it. *What's that? Looks like something on the bottom.*

Ignoring the cold, he looked out through the hole. As he had suspected, the bottom was ice, and deeply embedded in it was the wreck of a cargo swimmer—Swimmer 17!

A little pride poked through Toruun's gloomy spirits. *What navigation! I'm right on top of it!* he thought. *It must have melted its way right into the bottom—they'll never retrieve it.* Toruun shuddered at the thought of his own fate and morbidly studied the wreck.

Its buoyancy chamber was crushed, its cabin and cargo compartment cracked open. Though protected from the direct force of the impact, the cargo compartment had split, strewing cargo around. There was no sign of the pilot's body—it was probably still inside the cabin.

There's one cargo that never made

Tsegaan . . . Oh, God, the cargo! I didn't think of the cargo! Toruun dared to feel a little hope as he grabbed a knife and raced for the cargo compartment.

He swam for the stern and plunged the knife into the floor. It took all his strength to keep the knife cutting the fabric as he headed back towards the cabin. The cold-suit made it hard for his feet to get a good purchase on the deck. He wrapped his lower arms around a stanchion and hauled, but the knife started to come out—he needed the strength of his lower arms to hold the knife in the cut.

Hook the stanchion with a hind foot. Haul. The hole's getting bigger. Now a middle foot. Haul. Don't let the knife slip.

The cut's opening—I can see the bottom. It's so close. Haul. Now a foreleg—Damn! I can't reach it yet! Haul. Now I've got it. Haul.

Now another stanchion. Haul. Almost halfway there. Haul. The bottom's so close—less than a body length. Haul. Damn you to the Six Hells, cargo, why won't you move? Haul. Keep the knife in. Haul.

At last the cargo began to shift. A crate slid through the cut, followed by another and another. The cut opened wider. The deck sagged.

Suddenly everything gave way. With a loud RRRIIIPPP, the deck tore open all the way to the cabin bulkhead. Crates, boxes, bolts, bales, barrels slid majestically through the cut and fell the short distance to the ice.

Toruun found himself without footing in the midst of the falling cargo. Dropping his knife, he swam desperately for the cabin companionway. With the last of his strength, he gave a thrust of his siphon and got within grabbing distance of the companionway hatch.

Swimmer 22 began to lift, slowly at first, then faster. Feeling triumphant and relieved, but mostly tired and sore, Toruun hauled himself into the cabin and headed for his cramped little niche below the buoyancy compartment.

"So you've returned with the answer we were looking for. Well done, my boy." The Tsestokaar looked pleased. Toruun began to relax—a little.

"But there's the loss of the cargo—"

"We might be able to retrieve it, sir. It's undamaged, right on top—"

Waving Toruun into silence, the Tsestokaar continued: "And the damage to the swimmer—'

Abashed, Toruun simply said "Yes, sir."

"But I'm sure we don't need to consider such things, since you've decided to give the clan the rights to that little alarm device you invented on your way back."

"Yes, of course, sir." In fact, he had decided no such thing. "The engineering tests of the prototype are nearly—"

"Indeed. Well then, as I said, it's good to see you back, and the clan is proud of your accomplishment. I'm sure we will hear more of you."

The audience was over. Toruun turned to leave. But as he reached the door, he heard the Tsestokaar: "Lucky it wasn't a real dragon, eh?"

Toruun shuddered. *Give me a real dragon any day—I couldn't have been more scared. But I beat it. Goddamn, I beat it.* He felt good.

"Yes, sir," he said, and left. ■

on gaming

Matthew J. Costello

Chances are, people will still be playing chess 500 years from now.

On the other hand, most of the SF and fantasy games reported on in this witty and erudite column will have long since passed into oblivion.

Yes, when people finally emerge from their suspended animation chambers in deep space, hungry for some reconstituted beef stroganoff and a Miller Lite, they'll more likely spend their recreation hours hunkered over a chess board (or a hologram of one) than the celestial Sturm-und-Drang of *Star Fleet Battles*.

Colossus Chess IV (Firebird Licensees Inc., P.O. Box 49, Ramsey, NJ; $34.95, for the Commodore 64-128) is a marvelous chess program that was designed in the United Kingdom and has recently become available here. While much of the British software that I've seen has been humdrum, this program, along with Firebird's *Elite* (reviewed in January *Analog*), an exciting space trade and combat game, are top-notch.

This program offers a variety of options to fine tune the chess program to your ability level and time. Moves can be entered via the keyboard or the joy stick, and commands can be changed even after a move has been entered. (This can be very handy after you've made a terrible blunder that the computer cold-heartedly has capitalized on.) Best of all, an entire sequence can be eliminated and you can backtrack to an earlier position to examine another tactic.

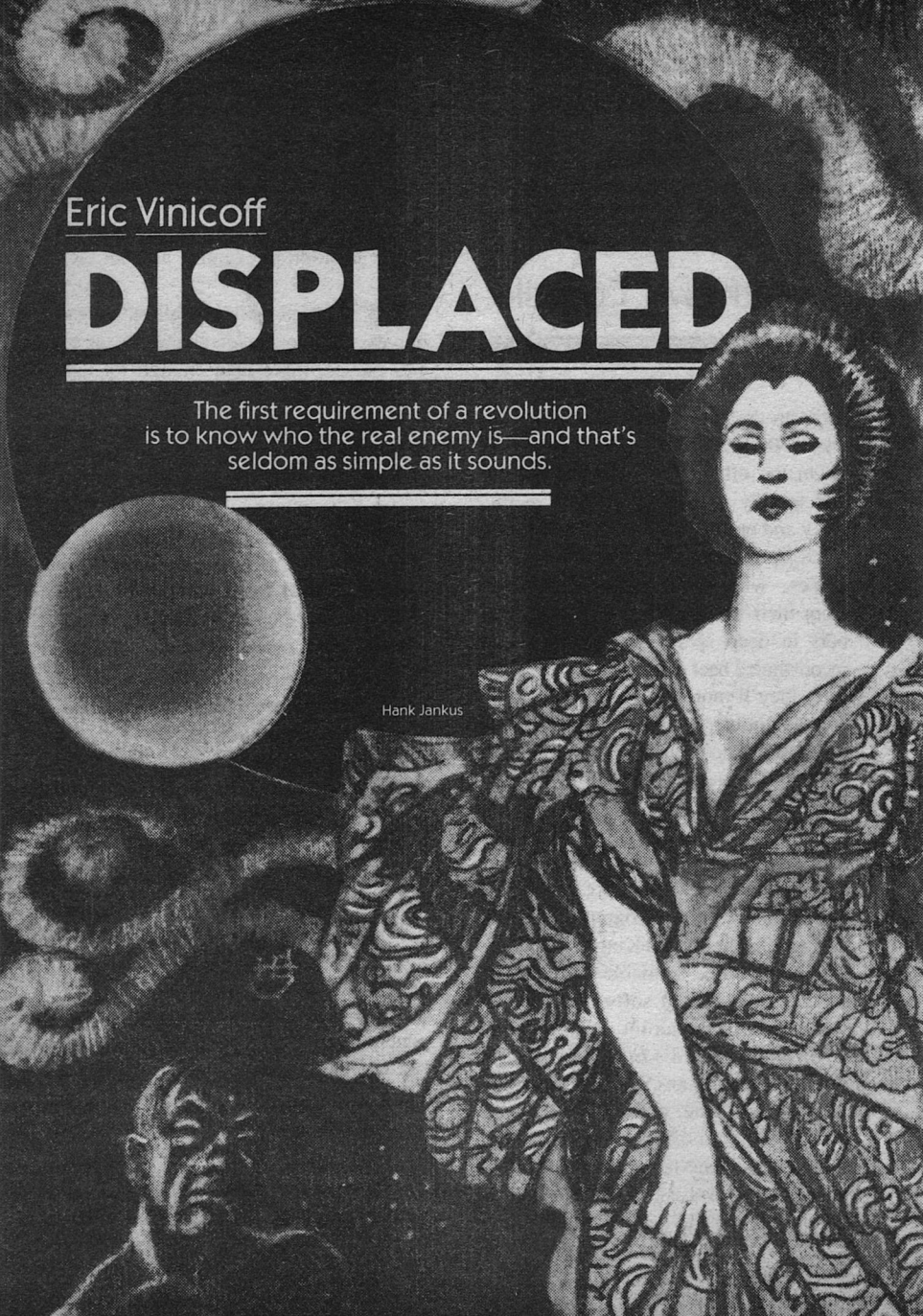
The program will not allow illegal moves and the player can store up to 120 moves, more than enough for just about any game you're likely to play.

The board can be presented in one of two ways, as a flat two-dimensional picture, or a more life-like three-dimensional representation. There are two screens, one featuring the board and current moves being run, while the other, accessed by pressing the space bar, displays a variety of useful information. There are "elapsed time" clocks that show how much time each player has taken for moves, and a complete list of all the moves made so far.

The program also displays the "best line," its best move found so far in its analysis of the game. It also shows the "current line," the move sequence that the computer is considering as the search progresses.

While you can't set the computer's level of play, as you can in some chess programs, you can adjust a variety of factors to determine how strong an opponent you want the program to be. You can tell the computer not to search its "opening book" for moves, thereby making your openings a bit easier. You can also set the program to not think ahead on your move time (or vice

(continued on page 125)


Eric Vinicoff
DISPLACED
The first requirement of a revolution is to know who the real enemy is—and that's seldom as simple as it sounds.
Hank Jankus

High Lord Nakai of the Nakai Corporation closed his eyes.

He was lying on the dais in the Temple of the Lords, in the corporate-state's port city three AUs above Sol's ecliptic. Beyond the ring of his household samurai the lesser lords were bowing. Priests were chanting a prayer of safe passage. He smelled the fragrance of cherry blossoms, felt the cold metal contacts of the headset pressing against his bald scalp.

Trips to the Nakai Corporation's extra-solar holdings were a familiar ritual. His DNA code had been transmitted by laser pulse, three months earlier, and very soon his *ka* would follow in the same manner. In 5.94 years he would open the eyes of his new body in the Barnard's Star solar system. In 5.94 years, yet less than an instant to him. Because of many such trips he had physically aged only eighty-nine years in two hundred and thirty-one years since his birth.

The moment of transmission arrived, and with it the indescribable sensation of being torn from his body.

He opened his eyes.

And was immediately concerned. Not afraid, since fear was a symptom of an undisciplined mind fighting itself. But definitely concerned.

He should have been in the VIP reception center of Ariana, the Nakai Corporation port city above the Barnard's Star ecliptic, surrounded by the welcoming ceremony. Instead he was lying on a bed in a small, inexpensively furnished woman's bedroom. Garments ranging from a formal kimono to erotic lingerie were scattered carelessly, and perfume was a reek in the air. He was alone.

He stared at his hands. Not the withered, parchment-hided hands that were rightfully his. Delicate, immature, feminine hands.

He stood and examined himself in the mirror attached to the door. The reflection was a naked attractive woman in her early twenties. He felt a primitive surge of anger at the theft of his age, the respect he had earned. Finding himself in a woman's body added to the feeling. Transsexing for other than medical reasons was considered a perversion.

He had none of the nausea or muscle aches caused by transmission, so at least a week had passed since his arrival. Apparently he had been kept under sedation. But he did feel the familiar weakness. He sat on the bed, and considered the situation.

The Barnard's Star system consisted of a small red star: Proto (short for Proto-star), a gas giant "planet" with eighty percent more mass than Jupiter, its dozens of moons, and a cometary cloud. The Toei Corporation had been chartered to colonize the system, but Nippon Electronics also had substantial interests. And of course the Nakai Corporation exercised its monopoly on interstellar travel from Ariana. Nippon Electronics was interstellar in scope, rivaling the Nakai Corporation in honor and wealth. He knew little about the Toei Corporation. It was very traditional and insular, limiting its contacts with what it considered a decadent *Uchu-giin* culture.

Somewhere in this matrix a force was moving against him for an unknown reason. It had prepared the alternative bioform. It had diverted him despite the

many security measures designed to ensure his safe arrival. It had brought him to this unlikely place.

The possible threat to the Nakai Corporation had to be investigated, and his shame avenged. He would attend to both matters. The first step was to reach Ariana and establish his identity. Since it had undoubtedly been anticipated, he would have to go about it carefully.

He found some proper clothing, and dressed himself. He had been with enough women to be familiar with their ways. Adopting them was simply a matter of internalizing the external impressions. He reached beyond his shame for the serenity to do what had to be done.

Then he gave the room a thorough examination, and learned more about the role that had been forced on him. He was Yasuko Sawaguchi, a pillow geisha. This room was her cubic in the Blue Dolphin House. The house was in Toronaga, one of the Toei Corporation cities orbiting Proto. But the most disturbing discovery was an injector kit with a variety of cartridges. He found the prescriptions in the tabletop infotrieve.

His weakness wasn't just due to transmission. The beauty of this young body was a tragic facade; the inner truth was a bewildering array of unfavorable mutations and tumors. He was dying. The medications were to keep him ambulatory for the remaining handful of months.

He was wondering what could have caused such amazingly poor health, when the door opened. A man entered. No announcement, no request for permission. High Lord Nakai stopped his instinctive order to withdraw. The man wore an expensive neosilk *yukata,* and his teeth were lacquered black. Apparently he was the master of the house.

High Lord Nakai bowed, but the master didn't return it. "Suki and you have a party tonight. Two of her regulars, engineers from the Osato works. Room sixteen for the entire night. Why aren't you in your outfit yet?"

"I don't feel well," High Lord Nakai said. He didn't intend to ply Yasuko Sawaguchi's trade.

"I've heard all of your whining I care to hear. Take some shots, and be ready by nineteen thirty."

"I'm sorry, but I can't. I'm not myself today."

"Can't! Can't! You talk as though you have a choice!" Shocked and angry, the master hit High Lord Nakai hard below the ribs. The High Lord fell on the mut-grass rug, groaning and fighting a terrible rage.

"You forget your place, woman," the master said sharply. "Fortunately we have time for a quick reminder." He took a pen-shaped electronic device from his sash pouch, and pointed it at High Lord Nakai.

The High Lord recognized it as a neuron whip, useful for inflicting pain without leaving marks except on the *ka*. He tried to roll aside. But the invisible beam caught him, engulfed him in a suncore-hot fire.

He screamed.

Yasuko Sawaguchi couldn't sleep. She ordered the bed into its sitting mode.

The bedroom filled with a subtle golden radiance. The furnishings had been wrought out of actual wood, and

the art pieces were imported from other solar systems. She wished she could enjoy the fabulous beauty with which High Lord Nakai surrounded himself. But her fear crushed all gentler emotions.

Alone in the master bedroom of the High Lord's Ariana palace, wearing the body of that ancient and powerful man, she resisted a nightmare-like paralysis. She made herself remember who she was. Why she was.

Her childhood had been stolen from her. She had been removed from the forced-growth tank thirteen years old and mortally ill. Her owner hadn't bothered to provide her with a pseudo-identity, just a general database and trade knowledge. Her earliest memories were of being sick and enduring the neuron whips of her teachers. When she had learned obedience as well as the geisha arts, she had been sold to the Blue Dolphin House.

She had fought against her use in the small ways available to her, hating her life more than she feared losing the few years that were her lot. Which was why the secret Sisterhood had recruited her. A memory implant had given her the necessary skills, and she had carried out many dangerous tasks for the cause. Seducing Tetsuo had been a Sisterhood mission. His position and dedication to the cause had made this desperate plan possible. Her falling in love with him had been an unexpected development.

She looked down at her wrinkled skin, her unarguable maleness, and she was battered by a wave of nausea. She had thought she was prepared to make any sacrifice for the cause. But this . . . this was twisted, dirty . . .

"Your pardon for disturbing you at this hour, High Lord," the door said, "but you have a visitor."

Her breath caught. "What? Who?"

"Doctor Tetsuo Koroshi wishes to see you."

She felt an almost overwhelming urge to send him away, because it hurt her to have him see her like this. She knew it was an irrational reaction. He had brought her to Ariana, supposedly for pillow service. Using his skills and authority as the director of the transmission medical section, he had secretly arranged the exchange.

No, more than an exchange, as he had explained to her several times. Transmission required that the brain of the new body be a cloned duplicate of the original. The two alternative bioforms he had created were advanced pieces of genetic engineering. Meanwhile he had modified the transmission comp programming. High Lord Nakai had arrived in Tetsuo's laboratory in her bioform, while she had begun her impersonation at the welcoming ceremony in the High Lord's bioform. Her body awaited her *ka*'s return in a LS tank.

None of which changed the fact that she was ashamed to be seen as an old man by her lover. Yet it was unavoidable. She sighed. "He may enter," she said.

The door opened, and she caught a brief glimpse of the ornate hallway and two *ronin* samurai on duty. Tetsuo hurried in. The door closed behind him, reestablishing total privacy.

Worry was clearly written in his face. He was a wide man, fifty-three years old, with fussy manners and a gentle heart. "What's the matter, my love?"

he demanded. "The med-monitor reported you were still awake."

"Nothing, Tetsuo. I . . . I was just thinking."

"You need rest more. Shall I give you a sedative?" He stroked her bare arm.

She jerked it away. "Don't touch me! Please."

He looked hurt, but nodded. "I'm sorry. My work has taught me how unimportant the body is compared to the *ka*. I wish I could convince you."

"You never seemed to find it so unimportant during our bedplay." She forced a wan smile. "Please be patient with me, Tetsuo. When this is over, if all goes well, I'll be myself again and eager for your touch." She paused, then added softly, "For a short time."

He flinched as though stabbed by a sword, and she wished she had spoken more carefully. He was a master geneticist, but he couldn't unwrite the natural laws which he knew so well. He couldn't save her. The damage to her DNA was too extensive. A clone or alternative bioform would be just as sick, just as doomed. She wondered if their inability to accept this was part of why they had embraced the probably suicidal plan.

Tetsuo took an injector kit from his belt pouch and loaded a cartridge. "You really must get some sleep, my love. May I help you?"

She nodded. He gave her the shot, then put away the kit. "Tomorrow you're scheduled to end your convalescence and speak with System Director Saeki. Are you sure you're ready?"

"Yes." She felt the warmth of the drug spreading through her, calming the anxiety stirred by his words. "I have to set up the meeting with High Lord Toei as soon as possible, before my impersonation is discovered."

She had pretended to collapse at the welcoming ceremony, and Tetsuo had taken charge of her treatment. He had used a memory implant recorded during High Lord Nakai's arrival to prepare her for her impersonation. Fortunately High Lord Nakai's last visit to the Barnard's Star solar system had been over thirty years ago. Meanwhile the Sisterhood had smuggled High Lord Nakai to Toronaga.

Each step of the plan was more difficult and dangerous than the last. But if it succeeded, it would end in freedom for all her sisters.

"Thank you, Tetsuo," she whispered from the rim of sleep. "I wish . . . there was more time. For us. It's rushing by so fast, out of control—"

His smile was tender. "There isn't any point in regretting our karma. We do what we must. Now close your eyes."

"Yes, Tetsuo. I'm glad you came—"

High Lord Nakai woke a second time on the bed in Yasuko Sawaguchi's small bedroom. He was covered with cold sweat, and shook from his nervous system's memory of the whip. A young woman was giving him a shot, speaking soothing words.

He was unused to torture. Before he could do anything else, before he could even think clearly, he had to overcome his rage. He closed his eyes, and concentrated on freeing himself from its influence. Then he looked up at the woman.

"How do you feel?" she asked with an urgency that suggested a close relationship. "The master told me to get you ready for the party. I wish a black hole would swallow him one piece at a time."

"I'm feeling better," the High Lord said, which was true. The shot was beginning to take effect. "Thank you." He remembered the name the master had mentioned. "Suki?"

"Don't worry, Yasu. I checked the infotrieve for what to give you. Is there anything else I can do?"

He nodded. "You can answer some questions for me. There's something wrong with my memory. I can barely remember my name."

"That's terrible! You better ask for a med check tomorrow. Of course I'll tell you anything you want to know, but it'll have to be while we're getting you ready. We don't have much time. Can you get up now?"

He found that he could. With her assistance he dressed in the ritual attire, then he sat while she converted his face and hair into a replica of her own stylized mask. Meanwhile she added to his understanding of Yasuko Sawaguchi and the Toei Corporation.

The *Uchu-giin*, the Space People, had spread through the Sol System and the nearest solar systems. But when they left Earth, they stopped having children. Something—maybe the lack of the lunar tidal "clock"—disrupted the menstrual cycle, resulting in infertility. All *Uchu-giin* began life as embryos imported from Earth. The Nakai Corporation held the monopoly on interstellar shipping because of the cost of building launchers, so it also monopolized the interstellar embryo business. The main purpose of High Lord Nakai's trip was to discuss with High Lord Toei why the Toei Corporation bought so many more male than female embryos.

The reason was now clear. Women numbered less than fifteen percent of the Toei Corporation population. They were property, used as geishas, servants, and child center workers. But that wasn't the worst of the Toei Corporation's perversions. It augmented its stock of females by growing degenerative clones.

One effort to solve the *Uchu-giin* infertility problem had involved the cloning technique developed for interstellar transmission and medical transplants. But the hull of a space city was no substitute for a planet's atmosphere. *Uchu-giin* genes suffered from the high radiation level. The cloned children would have been genetically damaged, increasingly so with each generation. The line of research had been abandoned.

But not here. High Lord Nakai knew why Yasuko Sawaguchi was so sick. She was a product designed for maximum profit. Degenerative clones, less expensive than adults raised from imported embryos, were adequate for many of the Toei Corporation's purposes. Such transcendental inhumanity from *Uchu-giin* shamed him to the roots of his identity.

"There, you're ready." Suki sighed as she put away the combs and pots. "I wish I had your cheekbones. Everything I eat goes right to my face."

"You did a fine job. Thank you."

Suki smiled, patted his shoulder, and said, "We had better get going. Can you handle it?"

He stood on wobbly legs. "I don't seem to have much choice."

He let her lead the way through bright lath-and-paper hallways. They exchanged greetings with other geishas, and bowed low whenever men passed. He found the eyes that looked through him almost as humiliating as the whip.

They entered a small room. Four sitting mats surrounded a low red lacquer table set with a sake flask, cups and a bowl of sweetmeats. *Shoji* screens lined the walls. A pair of doors presumably led to *futon* rooms.

Two middle-aged men soon arrived. High Lord Nakai echoed Suki's ceremonial greeting, but he stayed where he was while she went to give one of the men a more intimate welcome.

The other man walked over to High Lord Nakai. "You don't seem pleased to see me, little one," the man said. "Come here, and take my mind off a hard day's work."

High Lord Nakai tried to pull away when the man embraced him, but the man was too strong. "Please," High Lord Nakai objected. "If you're an honorable person, you won't force me against my will. I'm ill. The master of the house can make other arrangements for you."

The man smiled thinly. "They say that disrespect is an ugly trait in a woman, but I've found it can add flavor to the meal. I know how to deal with it."

He slapped High Lord Nakai hard enough to unfocus the High Lord's eyes and set his head ringing. The High Lord staggered. The man grabbed the front of the High Lord's kimono to tear it open.

High Lord Nakai hadn't found it necessary to resort to physical force for a very long time. But he had studied karate as a young man, and kept in practice because it was the only form of exercise which he enjoyed. Now he put his knowledge to martial use. He struck with all of his reduced strength, a stiff hand chop between the man's spine and skull.

It was the surest paralyzing blow the High Lord knew. With a bubbling sigh the man dropped to the floor.

Suki and the other man were staring at the unconscious man, momentarily frozen by shock. High Lord Nakai made good use of that moment. He jumped, spun, and kicked. His weakness and poor coordination almost caused him to miss, but he still possessed the total concentration of a black belt *sensei*. The other man's head snapped back as the sandaled foot hit his forehead. He slid out of Suki's arms to join his companion.

High Lord Nakai quickly slapped a hand over Suki's mouth to stifle her frightened scream. "Be quiet, please!" he whispered. "Suki!"

When she calmed herself somewhat, he removed his hand.

"Gods of our ancestors, what have you done?" she demanded. She was shaking. "Are you insane? The master will sell you to the death orgiasts for this!"

"I don't intend to give him the opportunity. I'm leaving now. Again, thank you for your help."

"But you can't escape! As soon as the master finds out you're gone, he'll use the monitor net to stop you." She

touched the back of her neck. "Remember?"

It wasn't difficult to figure out what she was referring to. Remote monitor units, the so-called "slave collars," were commonly used in conjunction with a city's comp net to keep track of children, criminals, and the mentally unfit. A stunning circuit could be added, and a miniaturized version could be implanted at the base of the skull. It would be a very efficient way to ensure obedience. Maybe those who had grown his bioform hadn't implanted a monitor unit. But it would be wiser to assume that they had.

"Are the monitor units in operation during parties?" he asked.

"Of course not, you know that. The guests would be outraged." Then comprehension came visibly to her. "We're scheduled to spend the night with . . . with them. We have until morning to get away from Toronaga. The net doesn't reach beyond the hull."

"Why do you say we?"

"You can't leave me here!" she begged with surprising intensity. "I'd be whipped to death just for being part of this! Please! I can help! I don't think we have much hope, but it's better than no hope at all!"

Something about her motivation didn't ring true, but she could be very useful. "Together, then, Suki."

They dragged the unconscious men into the *futon* rooms, and set the stage to convince a casual observer that the party was proceeding properly. The men wouldn't recover for at least several hours. Maybe it would delay the realization that Suki and he were missing.

An infotrieve request for shipping schedules would have left a record of his intention. However there might be another source of information available. "Suki, we have to arrange space passage. We don't have any yen, and we couldn't buy tickets anyway."

"Of course not, we're women." Suki's brow furrowed in concentration.

"Our only hope is to stow away aboard an outbound ship. Might anyone here remember some useful pillow talk—"

"Hush, Yasu. I'm thinking." Moments later her expression became excited. "Tashi was here yesterday. He said he's leaving tonight—he's an independent freight shuttler from NE. No time to say goodbye to anyone, or even pack. All our lovely clothes . . . No, we must go right now."

He followed her to the door, but there she stopped. "If the master spots us, we won't even get out of the house. He's always prowling through the hallways."

"We'll make it," he said confidently, taking her hand. He had learned much about the intangibles of leadership during his long life. He focused his attention on her, drew her out of her fearful uncertainty. "Come on."

She managed to appear calm as they left the room and started toward the minor house exit used by the geishas. The Blue Dolphin House was busy despite the late hour, not surprisingly considering its business. They bowed and chatted as they went.

At the exit a samurai resplendent in leather and gleaming armor stopped them with a grunted, "Where are you two going?"

"The Osato VIP cubic," Suki replied from her low bow. High Lord Nakai

bowed too, and calculated distances for a nearly hopeless attack should it become necessary. "We're to entertain two guests there."

The samurai checked his comp. "You're supposed to be working in room sixteen tonight."

"We thought so too," the High Lord said. "But at the last minute they had to return to the works, and arranged for an outcall." He was familiar with the operation of geisha houses, having visited more than a few. But in Nakai Corporation cities geishas freely chose their respected, well paid profession. Nor were they all women.

The samurai stared at them dubiously, then grunted a laugh. "Be good girls and don't shame the Dolphin, or I'll spank your bottoms raw with my blade. Go."

The door opened, and they walked into the Ginza District night. Under a holo sky dominated by red, orange, and purple banded Proto, the various entertainments competed with each other in gaudiness. Electricar traffic jammed the avenue. The walkways were crowded with male pleasure-seekers and a few geishas.

"Where should we look for your Tashi?" High Lord Nakai asked.

"If he isn't with me and he isn't gone, he must be at his favorite inn. I hope." Suki boarded a walkway, and he followed.

He was seeing a Toei Corporation city for the first time, and under other circumstances he would have found it fascinating. The technology was state-of-the-art. But the styles in everything from architecture to clothes were echoes of feudal Japan-that-was. He felt the power of the Toei dream, and almost empathized with it. Then, as he bowed to strangers who noticed him no more than the moving strip under their feet, the vision darkened.

"Here we are," Suki said. They stepped off the walkway in front of an inn named The Ringed Moon.

They entered diffidently. It was an unpretentious establishment catering mostly to spacers. They fended off crude invitations to ply their trade, while Suki studied the faces. Finally she let out a pleased yelp. "There he is! In the back."

A man sat alone in a dark booth, staring morosely at a flask of sake on the table. But his mood rose considerably when they appeared in front of him. "Suki! This is an unexpected pleasure. Please be seated, and your lovely friend too."

They slid in next to him. Suki performed the introductions. Tashi Ichiban was a slender man in his thirties, wearing a rumpled gray shipsuit. He didn't inspire confidence, and he wouldn't have held a job long in the Nakai Corporation. But High Lord Nakai found the alternatives even less appealing.

The High Lord felt a tension that he couldn't disperse. At any moment their escape could be discovered, and the monitor net used to catch them. He would die unavenged, his questions unanswered, and the threat to the Nakai Corporation unresolved.

Suki pulled back from Tashi's amorous welcome. He looked curiously at her. "I'm sure I would remember if I'd hired you for tonight. I didn't, because I'm scheduled to boost at 1120."

"Do you usually drink before going on duty?" High Lord Nakai asked.

Tashi smiled. "You don't know spacers well if you call this drinking, pretty doll. It's just a little farewell ritual."

Suki took Tashi's hands in hers. "We're in trouble," she whispered urgently. "Big trouble. We've got to get away. Where are you going?"

He was quiet for a long time, then answered, "I have a shipment for NE One."

Nippon Electronics City BS-1 was located among the rocks in Proto's leading Trojan position. High Lord Nakai would have preferred Ariana as a destination, but at least it wasn't Toei Corporation territory. Suki was apparently thinking the same thing. "Please take us with you," she asked seductively. "If the proctors catch us, it'll be our lives."

Tashi studied the flask. "I'm not going to ask what you did, because I don't want to know. Can't be worse than the way you're treated here. No respectable corporate-state would allow it. My heart says to help you. But my head reminds me that I have nine more years of payments to make on my ship, and I can't afford to be blacklisted by Toei."

"No one will know," High Lord Nakai assured him. "I'm sure a clever man like you can smuggle us out of here."

"We're willing to work our way," Suki added, kissing Tashi's neck. "I promise you a trip that will become a spacer legend."

Tashi let out a sigh, and smiled wickedly. "You know my weaknesses too well. Come along, both of you."

He summoned a cab. Its autocon found the quickest route up rampways to the low gravity core. All *Uchu-giin* cities were of the same cylindrical design. Toronaga's long axis, around which it spun to simulate gravity, held the accel/decel shaft and the Port. High Lord Nakai endured Tashi's roaming hands by holding his *ka* apart from his physical being. Suki looked scared.

They got out at the shipping terminal where Tashi rented port services. Tashi retrieved his kit from a locker, and they slipped unnoticed into a restroom. When they emerged, High Lord Nakai and Suki were makeup-less, their hair was hidden under caps, and they were wearing too-large shipsuits. They hoped to pass as men to a casual observer.

The three of them crossed the field without attracting any unusual attention from the busy workers. Tashi's ship was what High Lord Nakai had expected, an elderly cargo shuttle retired from some company fleet. The High Lord hoped Tashi had spent some of his meager income on maintenance.

They went aboard. Tashi rigged two more acceleration couches in the cabin for his passengers. Then he ran through the pre-boost checklist, and received his clearance from Port Control. "You can say goodbye to Toronaga, ladies," he announced cheerfully. "We're heading out."

A portal opened in the field's roof, and the cradle lifted the ship into the accel/decel shaft. Soon the shaft's stator rings would accelerate the ship in a ten-g launch.

High Lord Nakai was considering how to arrange transportation from NE One to Ariana, when an unbearable

sound exploded between his ears. Suki sagged in her safety web. He barely had time to realize his failure before the sound and everything else went away.

Yasuko Sawaguchi sat in the salon of one of the ships that the Nakai Corporation maintained for VIP travel. It had boosted from Ariana nineteen hours earlier enroute to Kamakura, the Toei Corporation headquarters city orbiting Proto. She was alone in the salon. Soft music filled the air, and a tea cup rested on the arm of her chair.

She stared at the far wall. The holo effect was perfect, so that she seemed to be looking through a hole in the ship's hull. She had selected a recorded view of Ariana. The city turned with stately grace, throwing off dull red sunlight. The structures which made it an interstellar port floated nearby against the starry night. A twelve kilometer parabolic antenna received passenger and message laser pulses, while a row of fat stator rings disappearing into the distance accelerated cargo drones to half the speed of light. The starkly beautiful scene drew her out of herself.

A deep chime tone rang. She gathered her thoughts, ready to continue her dangerous performance. "Speak," she said firmly.

"System Director Saeki is here as you requested," the door announced.

"He may enter."

Lord Saeki was of a type Yasuko knew well, the harried exec so knotted by work that all her arts were required to coax a sexual release. He was incapable of looking dignified even in a formal kimono. But she knew from her briefing as well as the past week that he was very clever, with a sharp eye for details.

"Good evening, Akio," she said in the casual manner that High Lord Nakai used with close business associates. "You look like you've been too busy. A good manager selects capable subordinates, then lets them do their jobs. Follow my example, and you'll live a serene productive live."

"Thank you for your advice, High Lord," Lord Saeki said after his bow. Yasuko hadn't been able to decide if his stiffness was due to respect or suspicion. "I came as quickly as I could. May I be of service?"

"Have the arrangements for the CEO conference been finalized?"

"Yes, High Lord. We will arrive at Kamakura in eight days. Suitable cubic is being leased to us for the duration of our visit, with complete extra-territoriality. A tentative schedule has been prepared for High Lord Toei's and your consideration."

"I'm looking forward to seeing his new headquarters city," she said. "I understand it's like stepping into a history vid."

"It is very . . . thorough." Lord Saeki let his disapproval of the Toei eccentricity show in his tone. "And the view of Proto is spectacular."

"I've been giving some thought to the sort of reception we should host to honor High Lord Toei and his ranking officials."

Lord Saeki looked puzzled. "I assumed we would have a dinner party as usual. In fact I have already made the arrangements."

"I appreciate your initiative," she assured him. "But I've decided on

something a bit different this time. Something I'm sure High Lord Toei will enjoy more than rubber sushi and chit-chat."

"As the High Lord wishes."

"Don't take offense, Akio. I'm not questioning your judgment. I want you to change the reception to a geisha party."

Lord Saeki assumed his official face, hiding his thoughts. "It is an interesting idea."

"I'm glad you agree. I want it to be an intimate gathering, just High Lord Toei, his lesser lords, the geishas, and myself."

"Ah . . . surely you don't mean to exclude the *ronin?*"

"I do," she said firmly. "No one would have much fun with all those somber samurai eyes watching."

"That might be difficult to arrange. High Lord Toei might consider it unsafe as well as undignified, and I don't feel it is wise for you to be unprotected either."

"High Lord Toei will be intrigued, and I can look after myself. Tell the Toei liaison I personally guarantee all will go well." She liked the taste of irony on her lips.

Lord Saeki nodded. "I will do what I can. On such short notice we will have to make do with Kamakura geishas. They are highly skilled, of course, but . . . I have heard unpleasant rumors."

"Their skill is all that concerns me. In fact I've already picked the geishas I want for the party. You'll find a list in the infotrieve." She tried to sound casual.

"As the High Lord wishes." But Lord Saeki's expression was still a polite mask.

That worried her. The party was the key to the whole plan. She couldn't make it seem more plausible to him, but maybe she could divert his attention. "When actions don't make sense, Akio, it's usually because you don't have all the facts."

"I beg your pardon?"

"There are some matters that a High Lord can't share with anyone. Not until the proper moment. The nature of our culture often makes policy by consensus impossible, which is why we have a neo-feudal hierarchy."

"Thank you, High Lord." Lord Saeki bowed, and withdrew.

The concourse of NE One's Port passenger terminal was the crossroads of the Barnard's Star system. High Lord Nakai and Suki maneuvered through the crowds toward the street exits. Suki clutched a five hundred yen credit disk in her hand, a farewell gift from Tashi. It had already been somewhat depleted buying clothes and personal items in the stores which lined the concourse.

"We're really here!" Suki said in dazed excitement. "Free!"

"Almost," High Lord Nakai responded. "You still have to sneak past the arrivals checkpoint. If they identify you, they will send you back."

"That's no problem. Tashi told me how to do it." She was overflowing with enthusiasm. "I'll go to work for a good house—I can hardly believe how much geishas earn here. I have enough yen for the first installment on a share of NE stock. In a few years I'll be a full stockholder-citizen. Me!"

"I'm happy for you," he said, and he meant it. She had been a worthy ally. "Then it's time to say goodbye."

"But why? What does Ariana have that you can't find here?"

He didn't hear her question. A demo unit in the window of a holovision shop was projecting a newscast, and he had stopped to watch.

"—looked well as he left the boarding area. According to a spokesman High Lord Nakai is fully recovered from the complications of his recent transmission."

He was watching himself. His bioform, rather, animated by an imposter for a still unknown purpose.

"High Lord Nakai is enroute to Kamakura for a CEO conference with High Lord Toei," the newscaster continued. "The purpose of the conference hasn't been announced."

High Lord Nakai considered the implications. The imposter wouldn't have arranged the conference unless it was essential to his scheme. Such a meeting was a fulcrum where a single person could shift great forces. The imposter could do serious harm there to the Nakai Corporation. He had to be stopped, and the entire matter unraveled.

"You aren't listening to me," Suki said peevishly.

"I'm sorry." High Lord Nakai turned back to her. "I have to go now. My plans have changed, and I have to get to Kamakura as fast as I can."

"Kamakura!" Shock twisted Suki's face. "The Toei headquarters city! Why there, of all places?"

"I can't explain. But it's very important."

"It's insane. The proctors will catch you for sure, and you know what the master will do to you. Besides, how are you going to get there? You don't have any yen."

"I'll make a deal like the one you made with Tashi." He bowed, and started to walk away.

"Wait," she said sharply, catching up with him. "If you insist on going there, I'll have to help you."

Again her reaction struck him as unlikely. "Why would you want to do that?"

"Because we're friends, of course. You need me. We can use my yen to buy tickets."

He would have preferred almost any alternative to practicing Yasuko Sawaguchi's trade. "Thank you. And don't worry. We'll be safe."

They went to the Nippon Lines ticket counter (a subsidiary of Nippon Electronics). Suki's remaining credit wasn't enough for two retail passages to Kamakura, but High Lord Nakai negotiated a discount for an unsold cabin in a passenger ship boosting later that day.

They used false names, since the Toei Corporation must have posted them as escaped criminals. That gave High Lord Nakai two alter egos to remember. He still thought it best not to explain his true identity to anyone, even Suki, until he could prove it.

As the *Solar Queen* prepared for a gentle three-g boost, High Lord Nakai and Suki were strapped in their cabin bunks. He used the respite from her constant chatter to consider his situation.

They had escaped Toronaga thanks to a lack of programming foresight. The monitor net had stunned them, but it hadn't been able to override the Port

Control comp to stop the boost. Suki, who wasn't a degenerative clone, had revived quickly. But High Lord Nakai had been sick for most of the trip. The ship's medkit had finally restored him to a semblance of health.

The unpleasant experience had been useful in one way. He had avoided the necessity of entertaining Tashi. Suki had fulfilled their obligation to Tashi's complete satisfaction.

But reentering Toei Corporation territory would be even more difficult than leaving it. The arrivals checkpoint would match their retina patterns to those of posted criminals, and arrest them. He had an idea on how to avoid the checkpoint, based on experiences much broader than Tashi's. They would also need convincing male disguises. That could be arranged during the trip.

And then? Then he would confront his mysterious enemy.

"The final countdown to boost is now beginning," a cheerful speaker voice announced. "Ten . . . nine . . ."

Yasuko and High Lord Toei bowed carefully to each other, avoiding any inference of superiority or inferiority. Meetings between High Lords were delicate exercises in protocol. A minor breach could have serious economic consequences.

Yasuko looked closely at the man who was the architect of so much evil. He was as imposing in person as he appeared in newscasts: tall, powerfully muscled, with blunt features and a grim expression. He wore a stylized brown *kamishimo* and *hakama* in sharp contrast to her white silk kimono. She fought down choking hate, and remembered her role.

"Has your reception been satisfactory?" High Lord Toei's voice was a harsh growl.

"Yes, thank you. You have shown the Nakai Corporation great courtesy."

They were in the formal garden of High Lord Toei's Kamakura palace. Flowers blossomed and carp swam in ponds under a bright cloudless holo sky. Cherry trees filled the air with their happy fragrance. Rows of samurai stood behind Yasuko and High Lord Toei like wary statues.

Elsewhere in the palace Toei and Nakai Corporation officials were busy negotiating the details of the many business dealings between the two corporate-states. The purpose of the CEO meeting was to settle matters of policy at the highest level.

Yasuko and High Lord Toei sat cross-legged on a bamboo mat. A woman served tea without lifting her eyes. "Your palace is a remarkable replica," Yasuko commented, looking at the high *torii* gateways and upturned eaves beyond the garden.

"It is modeled after the residence of Yoritomo, the first Kamakura shogun, just as this city is modeled after the ancient capital. Capturing the essence of our heritage within the technical necessities of modern life is a magnificent challenge. We have attempted to meet it throughout our corporate-state, but I believe we have succeeded here best."

They exchanged meaningless pleasantries for a few minutes as required by tradition. Finally High Lord Toei said, "You have come a long way to visit a minor holding in your corporate empire.

Is there a problem between the Nakai Corporation and the Toei Corporation?"

Propriety called for a carefully crafted answer, but High Lord Nakai would have countered bluntness with bluntness. "There is," she said.

"Then let us discuss it."

She had to conduct High Lord Nakai's business as cunningly as he would, or High Lord Toei might become suspicious. "It has become necessary to renegotiate subsection 7B of the contract under which the Nakai Corporation supplies the Toei Corporation with fertilized human embryos."

High Lord Toei frowned. "Subsection 7B isn't subject to renegotiation legally or politically, as you well know. Your guarantee that you will supply the quantities of embryos contracted for is the foundation upon which our culture is built. It is a great responsibility."

"I am aware of our responsibility. What you must understand is that it is to the *Uchu-giin* as a whole as well as individual corporate-states."

"Please be more specific."

Yasuko paused to recall implanted information. "There is a gender imbalance of roughly eighty-five percent male to fifteen percent female in your embryo orders. While your orders were small, it was manageable. But the Toei Corporation is thriving. The imbalance will soon affect our ability to fill the orders of other corporate-states. Embryos are after all a limited commodity."

"You must find a way to continue to fulfill your contracts."

"Which is why I am here," she said, ignoring the crude insult. "Would you please explain why you need such a high percentage of male embryos?"

"We have little use for women."

"That is an unusual attitude."

"It is a logical extension of our heritage," High Lord Toei answered. "Before the contamination by *gaijin* influences we were a male culture. A samurai culture. Women existed to be mothers, lovers, and menial workers. Now they cannot be mothers, and most of our menial work is performed by machines."

"I have never heard such a distorted interpretation of our history. The subservience of Japanese women is a myth fostered by a misunderstanding of their role. To hear it used by an *Uchu-giin* as an excuse for slavery saddens me."

"Your opinion of our way of life doesn't interest me," High Lord Toei growled. "Perhaps you should direct your concern to your own treatment of women."

"What do you mean by that?" she demanded, putting an angry edge in her voice.

"If you find our orders difficult to fill, it is because you and the other corporate-states take over sixty percent male embryos yourselves. You claim sexual equality, while you subtly perpetuate male dominance. Our policies differ only in degree and honesty."

She was inclined to agree. But of course High Lord Nakai wouldn't, so she said, "The difference is between honor and dishonor."

"I invite you into my home as a guest, and you insult me?" High Lord Toei's face darkened with rage. The samurai moved hands to the hilts of their swords.

She couldn't let this get out of hand. High Lord Toei might cancel the meet-

ing. She rose slowly, and bowed. "I apologize for my unfortunate words. I let my interest in our philosophical discussion overwhelm me."

High Lord Toei was strong enough to control his anger, and wise enough also to want to minimize the incident. He returned the bow. "I shared your enthusiasm, for which I too apologize. May I suggest we resume our discussion of business matters tomorrow?" He put a slight emphasis on the word business.

She nodded. "Before we part for now, however, I wish to thank you. I am in your debt for your lavish welcome last night. I plan to balance the ledger with a farewell to remember."

"Oh, yes, your geisha party. A curious choice in light of your views. My lords and I are looking forward to an interesting evening."

She managed to contain her smile until her party was on its way back to the Nakai Corporation cubic.

"Deboarding will begin in three minutes," the speaker voice announced. "If you require baggage service, please call for a steward mech."

High Lord Nakai sat on his cabin bunk, enjoying the low-g of Kamakura's Port. The *Solar Queen* had settled into its cradle fifteen minutes ago, after an uneventful trip. He was in no hurry to leave the ship. When Suki returned from her last minute boutique shopping, they would inconspicuously deboard in the thickest of the passenger flow.

In their carrybags were items, carefully acquired and tested, which would let them pass as men. They would disguise themselves as soon as they left the ship. Otherwise, they would be limited to the Port cubic where the female visitors from the other corporate-states were grudgingly permitted to conduct business.

Newscasts about the CEO conference had been few and uninformative. High Lord Nakai still had no idea what was afoot. His strategy called for contacting the Nakai Corporation delegation without warning the imposter or any co-conspirators. A delicate piece of work; it would be interesting to see how he accomplished it.

Where was Suki? Her mood had started to worry him. She was afraid, reasonably so considering their destination. But beyond that he detected a growing tension aimed at him. He wondered if he should confront her about it.

The door hissed open. He turned, hoping she was now ready to deboard.

Two ship's officers walked into the cabin. He considered an outraged, "How dare you enter unannounced!" But reading their expressions he knew it would be futile.

"Yasuko Sawaguchi," one of them said in an official voice, "you will come with us please."

High Lord Nakai didn't bother to deny the identity. "May I ask why?"

"Captain Tanaka will explain. You will come with us now please."

They escorted him forward into the crew cubic that passengers normally never saw. They weren't armed, but they were big, wary, and trained in the martial arts. He saw no possibility of escaping by force. Instead he used the time trying to make sense out of the arrest. Their false names wouldn't have been checked for a cash transaction, and

they hadn't done anything during the trip to arouse suspicions.

Two people awaited them on the bridge. Captain Tanaka was a competent looking officer, with a good command presence. Next to him stood Suki.

Captain Tanaka faced High Lord Nakai. "Miss Hana has turned herself in, confessing her real identity and yours too. Do you deny you are Yasuko Sawaguchi?"

"That would be pointless. A retina scan would confirm what she told you."

"Then I must regretfully detain you for the Kamakura proctors. You have been posted as escaped criminals." The captain turned to Suki. "You understand this applies to you too?"

Suki nodded. Her face was almost as pale as geisha makeup, and she was trembling.

High Lord Nakai thought quickly. Why had Suki betrayed them? Surely not for any advantage to herself; her eyes were devoid of hope. A possible answer occurred to him. If true, it could lead him to other answers. But his more immediate destination was an orgiastic temple, and he would have to act deftly to avoid it. The careful approach to the Nakai Corporation delegation was now impossible. He would have to gamble everything on a forty year old personnel judgment.

"Have you sent for the proctors?" he asked.

Captain Tanaka nodded. "They are on their way."

"I thought this ship, even in a Toei Corporation cradle, was still Nippon Electronics territory."

"That is correct. However we cooperate with the local authorities in extradition matters."

"Even when it will seriously damage your corporate-state's relations with the Nakai Corporation?" High Lord Nakai asked the question like a legendary whaler planting a harpoon.

Uncertainty flickered in the captain's face as his thoughts took a new direction. "What possible connection could a Toei geisha have with the Nakai Corporation?"

"I can't answer that. But System Director Saeki can—he's here for the CEO conference. Will you please contact him before turning us over to the proctors? If not for our sake, for your own."

Captain Tanaka didn't answer at once. High Lord Nakai could guess his inner debate. The claim was too wild to be believed, the sort a desperate criminal might make to gain time. He didn't want to embarrass himself. On the other hand, Nippon Electronics and the Nakai Corporation did a great deal of business. If his decision caused trouble between them, his career could suffer.

"I shall call Lord Saeki. What do you wish me to say to him?"

High Lord Nakai knew it would have to be an irresistable lure. "Tell him I have information for him alone concerning his High Lord's unusual behavior."

"Don't do it!" Suki shouted to Captain Tanaka. "It's a trick! She's making a fool out of you!"

The captain frowned. "Maybe you both are. We shall see. Please wait over there, both of you."

High Lord Nakai moved to the indicated observation area. Suki joined him

with understandable reluctance. The two officers kept a careful eye on them, while Captain Tanaka sat down at the com station.

"Why did you report us?" High Lord Nakai asked after a long silence.

Suki wouldn't meet his eyes. "I'm so very sorry, Yasu. I . . . had to."

"You may call me by my real name. I believe you know it."

She jerked around to face him like an activated relay. For the first time he saw calculating determination in her expression. "What do you mean?" she demanded.

"Those who stole my identity and placed me in this one didn't want me dead, just out of the way. They would plan to monitor my activities. Who better to do that than Yasuko's close friend? You helped me escape Toronaga to save my life, but sacrificed us both to keep me from interfering with your imposter."

Her control was good, but he read the confirmation of his deductions in her facial muscles.

Captain Tanaka interrupted their conversation. "I have good news, Miss Sawaguchi. Lord Saeki is coming here to speak to you. My superiors have instructed me to hand both of you over to him if he requests it." He turned back to the com station.

"Your scheme is beginning to unravel," High Lord Nakai said to Suki. "You know that I'll be able to prove who I am and stop your imposter from achieving his goal."

"You mustn't!" she pleaded. "We aren't doing anything to hurt the Nakai Corporation. We've treated you shamefully, for which I'll accept any punishment. But we're fighting for a cause worth whatever it costs."

"Your actions so far have hardly made me sympathetic to your cause. If you hope to change my mind, you had better tell me the whole tale right now."

She stared at him. He could sense she was weighing her impressions of him, making a painful decision. At last she bowed her head. "I'll tell you everything, and put our karma in your hands. We have little to lose now."

A meeting hall in the Kamakura hotel occupied by the Nakai Corporation delegation had been converted into a larger and more impressive version of the Blue Dolphin House rooms which Yasuko knew so well. The low tables were arranged in a U. She sat with High Lord Toei and his thirteen lesser lords around the outside, with High Lord Toei and herself at the head table. Next to each lord a geisha knelt and attended to his needs. Yasuko's geisha was between the tables playing a three-stringed *samisen* and reciting a *tanka* about the chrysanthemums on the slopes of Mount Fuji.

High Lord Toei tossed off another cup of sake, then slammed it down for his geisha to refill. "You are a fine host!" he yelled at Yasuko, and several of his lords echoed him. "This washes away the bad taste left by our disagreement."

"So it does," Yasuko agreed. The embryo question was still unresolved. Not that it would matter in a few minutes. "I'm glad you and your lords are enjoying yourselves."

Many flasks had been emptied, and the Toei Corporation lords were showing various degrees of intoxication. Yasuko's similar symptoms were faked.

Her flasks had contained water. Some of the geishas were serving sweetmeats, while others were kissing and caressing their lords. The conversation was loud and coarse.

"Where did you find such accomplished geishas?" one of the lords asked, his words slurred. "Are you certain you didn't bring them with you?"

Yasuko shook her head. "They are from your houses. Maybe this special occasion has motivated them." Her smile meant more than it said.

The names of the geishas had been given to Yasuko before she left Toronaga. They were members of the Sisterhood, specially trained for this mission. They had been scanned by both the Toei and Nakai Corporation *ronin* before the party. Afterwards, while inspecting them, Yasuko had covertly passed each one a small item.

She banged her flask on the table until she had the attention of the Toei Corporation lords, and raised her cup. "I wish to propose a toast."

The geishas made sure every cup was full, then retreated to respectful positions behind their lords. Yasuko wanted the eyes of the lords focused on her. Even sodden with alcohol they were smart and suspicious men, hard to trick.

"A toast to the great Toei Corporation, whose guiding hands are here tonight. You have created a warm, secure place for man in the coldness of space. You have wrought beauty from the hard-won resources of this solar system."

The lords were listening attentively, cups in their hands. The geishas were carefully reaching inside their kimonos.

"Now you face an even more challenging task," she continued. "You are going to undo the evil you created along with the good, and bring honor back to the Toei Corporation."

Pleased expressions became puzzled frowns. "What kind of a toast is that?" High Lord Toei demanded.

"A heartfelt one, High Lord, from the women of the Toei Corporation."

He opened his mouth to shout something. Fourteen ninja wires dropped over as many heads, jerking tight across bare throats.

"If you resist, you die," Yasuko said sharply.

Even the drunkest lord recognized the bite of the wire, and knew how easily it could slice deeper. No one moved. No one spoke.

"We aren't assassins," Yasuko explained. "We represent the women you consider your property. We are here to negotiate their freedom."

High Lord Toei spoke carefully to avoid severing his jugular vein. "Whatever your motivation is, you have destroyed the Nakai Corporation. Who will do business with you after this?"

"I won't argue morality," Yasuko continued, "since it is clear that you don't understand the concept. I have a commercial proposition for you. The Toei Corporation women will become stockholder-citizens with all rights and responsibilities. Their number will be increased to half of the total population. Degenerative cloning will be banned. In return, you and your lords will be allowed to live."

High Lord Toei no longer looked drunk. He looked grim and dangerous. "Why shouldn't I agree, then repudiate the agreement later as being made under duress?"

"Because I will leave here with the agreement in writing, signed by you and witnessed by me. Who will do business with *you* if you dishonor a contract?"

"Women are low creatures," High Lord Toei growled. "You don't elevate an animal above its place, even if it is a venomous serpent with fangs at your throat."

Yasuko looked at the lesser lords. Some of them were afraid, but all seemed resolute.

They had to be bluffing. The whole plan was based on the belief that the creators of such monstrous egotism would be personally selfish too. She would have to bring the taste of death to their lips, no matter how much it sickened her.

"I hate to deprive you of capable subordinates," she said in High Lord Nakai's light tone, "particularly during the coming changes. But we are going to execute one of your lords each minute until you accept the terms. Beginning now."

High Lord Toei glared at her. "Men die, but the Toei Corporation will endure untainted. We will join our ancestors unashamed."

She fought to keep from vomiting as she caught the eye of one of the geishas. "Mieko—"

A violent explosion blew a large section of ceiling down between the tables, barely missing Yasuko's geisha. A flock of tiny glistening shapes hurtled from the darkness above the hole. They unerringly speared the twenty-eight hands gripping ninja wire.

The geishas screamed. Dropping the wires, they clawed at the throwing stars. Several lost fingers to the sharp edges. Drops of blood sprayed around the room.

Seven figures in samurai armor dropped through the hole, landing with a loud clash on slightly bent legs. The door burst open. More samurai rushed in.

Four seconds after the explosion every geisha was struggling in brawny samurai arms. None of the Toei Corporation lords had been harmed.

Yasuko stood calmly between two samurai. Her serenity surprised her. Maybe deep down she had always expected this ending, so that the ache of failure was dulled. At least Tetsuo and she would find peace together after their lingering deaths. The women of the Toei Corporation would go on suffering.

The Toei Corporation lords jumped to their feet, rubbing their throats and muttering to each other. A medic team entered. Seeing that the lords didn't need them, they began treating the women.

The Toei and Nakai Corporation samurai chiefs bowed to High Lord Toei. "Your services will be remembered," he promised them. "But how is it that Toei and Nakai *ronin* are allies in rescuing us from High Lord Nakai?"

"That was my doing, High Lord Toei." Lord Saeki walked into the room, accompanied by a young woman. "We have all been the victims of a clever plot. I learned of it just in time."

It required more than a few minutes for Lord Saeki to explain the Sisterhood's plan, and even longer for High Lord Toei to accept the woman with Lord Saeki as the actual High Lord Nakai.

"Very well," High Lord Toei said

at last. "I see that the Nakai Corporation has been unwillingly involved in this conspiracy. You have my gratitude for defeating it."

"You can show your gratitude," High Lord Nakai said, "by letting the Nakai Corporation have custody of these women and my imposter."

High Lord Toei frowned. "You ask much. I wish to extract information from them concerning this Sisterhood, and then punish them publicly for the edification of our women. They have dishonored me."

High Lord Nakai gestured to his female bioform. "Do you compare the clean death they offered you to the way they have used me? I can't live with this shame unless I personally avenge it. I promise to share with you any information I acquire."

The argument seemed to impress High Lord Toei. Moreover the room was technically Nakai Corporation cubic. Any Toei Corporation interference would have a high political price. "You may take them," he grunted.

High Lord Nakai sat in front of the infotrieve in his study. He had a suite of offices at the Ariana admin center, but he preferred the comforts of his palace during his recuperation. He was supposed to be reviewing the corporate-state records for the years since his last visit to the Barnard's Star solar system. Actually he was enjoying his own true body, or rather the newest version of it fresh from a forced-growth tank. He felt very much himself again.

Yet life was changed. He couldn't undo what had happened to him since his arrival.

"System Director Saeki is here as you requested," the door announced.

"He may enter."

Lord Saeki marched in, and bowed stiffly. "Are you feeling well, High Lord?"

"I'm fine, Akio. Please be seated, and at least pretend to relax. I want to discuss a couple of things before we see the prisoners."

Lord Saeki settled self-consciously onto a divan.

"First off," High Lord Nakai said, "I want to repay two debts. One is to Tashi Ichiban, an independent cargo shuttler from NE One. We made a bargain, but I didn't fulfill my part. Buy him a new ship—a Hitachi C80-E should do nicely—with Yasuko Sawaguchi's compliments."

"I will see to it personally."

"The other is a debt of blood. Contact the *yakuza* in Toronaga, and arrange to have the master of the Blue Dolphin House assassinated. Make sure he too knows his gift is from Miss Sawaguchi."

Lord Saeki nodded impassively, and subvocalized a memo into his sash infotrieve.

"Now for a more important matter." High Lord Nakai leaned back in his chair, and looked at the oiled teak ceiling. "I'm still troubled by my experiences in Miss Sawaguchi's bioform."

"In what way?"

"Have you listened to the transcript of Miss Sawaguchi's first meeting with High Lord Toei at the CEO conference?"

"Yes, High Lord."

"So have I. Since then I've been trying to justify our own embryo pol-

icy—unsuccessfully. Tell me, Akio, why do we maintain a population of sixty-two percent men and thirty-eight percent women?''

Lord Saeki looked puzzled. ''It is a common corporate-state practice. Physical job requirements and social stability factors are analyzed, and an optimum proportion is derived.''

''So we say, and so we believe. But I'm beginning to agree with High Lord Toei. I think we've been ensuring male dominance.''

''High Lord! You can't mean that! Sexual equality is an inherent part of our social structure. Women have the same opportunities as men to achieve any goal. Eight of our System Directors are women.''

''Dominance can take many forms,'' High Lord Nakai said. ''Women have the same rights and responsibilities as men, but who sets those rights and responsibilities?''

''I beg your pardon?''

''We're a consensus society. We have to be to survive in space. The will of the majority becomes public policy, and we make sure men are always the majority. Our viewpoint dominates.''

''Excuse me,'' Lord Saeki objected. ''You speak as though wisdom is one thing for a man and another for a woman.''

''Maybe it is. We've built a way of life based on efficiency. Maybe women would have used a different meter stick. Our answer to the infertility problem, for example, has eliminated motherhood, families, and to a great extent love. Would women have chosen another way? I don't know.''

''I have never noticed any serious discontent.''

''In a consensus society you wouldn't,'' High Lord Nakai said. ''We must create true equality by balancing the number of men and women.''

''But if you are correct, won't we be damaging our consensus by having two differing viewpoints?''

''We have the self-discipline to avoid that, I'm sure. But it should be interesting to see what changes come out of the inevitable debate.''

After a moment of silence Lord Saeki said, ''I will have my staff draft a plan to balance the Nakai Corporation population in this system for your consideration, including a public education campaign. A studio will be ready whenever you wish to transmit your instructions to the other System Directors.''

''Thank you, Akio.'' High Lord Nakai turned to the com unit. ''Kuro.''

''Yes, High Lord?'' The samurai grunt came from the com.

''Bring the prisoners here.''

''As the High Lord wishes.''

Soon Yasuko Sawaguchi, Suki Hana, and Doctor Tetsuo Koroshi stood in the middle of the study. They weren't under restraint, but behind each was a wary samurai.

''Good evening,'' High Lord Nakai said in a friendly tone. ''I told our proctors to treat your co-conspirators and you with respect. Do you have any complaints?''

Tetsuo bowed low. ''You've been more generous than we deserve. We thank you particularly for the medical attention. The finger regenerations turned out properly.''

High Lord Nakai studied the three

faces. Tetsuo was ashamed and a bit distant, while the Toei Corporation women were defiant.

"I'm very pleased to be back in my own body," High Lord Nakai said to Yasuko, "and I imagine you are too. How is your recovery coming along?"

"Tetsuo and your doctors say the transmission went well. But as for my health, you know better. You can shorten the time I have left, but no one can give me more."

High Lord Nakai concentrated his attention on her. "I sympathize with your cause, but you've shamed me grievously. Do you apologize?"

"No." She met his eyes without anger or remorse. "I sacrificed my own honor to do what had to be done. Why should I care more about yours?"

He liked her answer, but didn't let it show. "I've given a great deal of thought to the proper punishment for your co-conspirators and you. I owe you all a debt of blood, particularly Doctor Koroshi who betrayed his oath to the Nakai Corporation."

"I do apologize for my actions," Tetsuo said softly. "However I don't regret them. I chose the lesser of two evils."

"A debt of blood," High Lord Nakai continued, "and another debt too. There were safer ways to prevent me from interfering. I assume I was shown Miss Sawaguchi's life to educate me?"

Yasuko nodded.

"It was presumptuous, but it worked. The older I get, the deeper the ruts of my wisdom are worn. You taught me things I wouldn't have learned otherwise."

He turned to Lord Saeki. "Since this is a matter of corporate-state security, I'm taking jurisdiction under the bylaws."

"Yes, High Lord."

"All of the eighteen conspirators are hereby banished. They are to be transmitted to the Sol system as soon as possible, and delivered to Earth. Doctor Koroshi's personal funds are to be transferred with them, so they won't arrive as paupers."

"As the High Lord wishes."

Joy fought with wonder in the faces of the prisoners, and finally won. They bowed low.

Except Yasuko. She stared at High Lord Nakai. "While you're enjoying your mercy, remember the women of the Toei Corporation. They will go on enduring the evil you saved."

"Desperation is no excuse for stupidity," High Lord Nakai said. "Your scheme was hopeless from the start. I intervened to save lives, including yours."

"It could have worked!"

"You're wrong. Your enemy isn't a handful of powerful men. It's a way of life accepted as proper by every man in the Toei Corporation. Even if you had forced the lords to agree, the stockholder-citizens would have voted them out of office as soon as they tried to make changes."

Yasuko was quiet, her thoughts turned inward. Lord Saeki and the other prisoners were watching intently.

"You claim to sympathize with our cause," Yasuko said at last. "The other corporate-states will too, if they hear our story. Together you can make the Toei Corporation end its slavery."

"Corporate-states don't interfere in

the non-economic affairs of other corporate-states."

"So you'll just turn away and pretend nothing is happening?"

"What would you have me do?" High Lord Nakai asked. "Wage war against the Toei Corporation? There is a very good reason why corporate-states don't have any military forces. People who live in glass houses don't dare throw stones."

"You could threaten to cut off your embryo and nutritional supplement shipments. The Toei Corporation would have to do whatever you tell it to do, to survive."

High Lord Nakai shook his head. "I would never so disgrace the Nakai Corporation. It wouldn't work anyway. If we were to become unreliable, Nippon Electronics or somebody else would build launchers and take over the interstellar transportation business."

Yasuko ran out of arguments. The prisoners stood like mechs from which the power cells had been removed.

"Short-term thinking seems to be a characteristic flaw of youth," High Lord Nakai said to Yasuko. "Changing social attitudes takes time, usually a great deal of it."

"Is that how you convince yourself you have no responsibility to help?"

"Quite the opposite—it's how I intend to help. Your scheme tried to deny reality. I'm going to alter it by solving my own problem."

"Your problem?" she asked, looking confused.

"I came here to correct an inventory imbalance, a shortage of male human embryos and an excess of female ones. I made a good faith effort to renegotiate our contract with the Toei Corporation. Since that failed, I'll have to take unilateral action. We're obligated to supply the quantities ordered, but there is flexibility in certain other terms."

"I don't understand."

"We're going to ship the Toei Corporation all female embryos, until we get our inventory situation straightened out. It shouldn't take much more than a century." ■

• Scientists have to admit that they do not know how to bring about the major advances of science. There are no rules or methods that allow one to specify what needs to be done now to make possible a great step forward in a few years time.

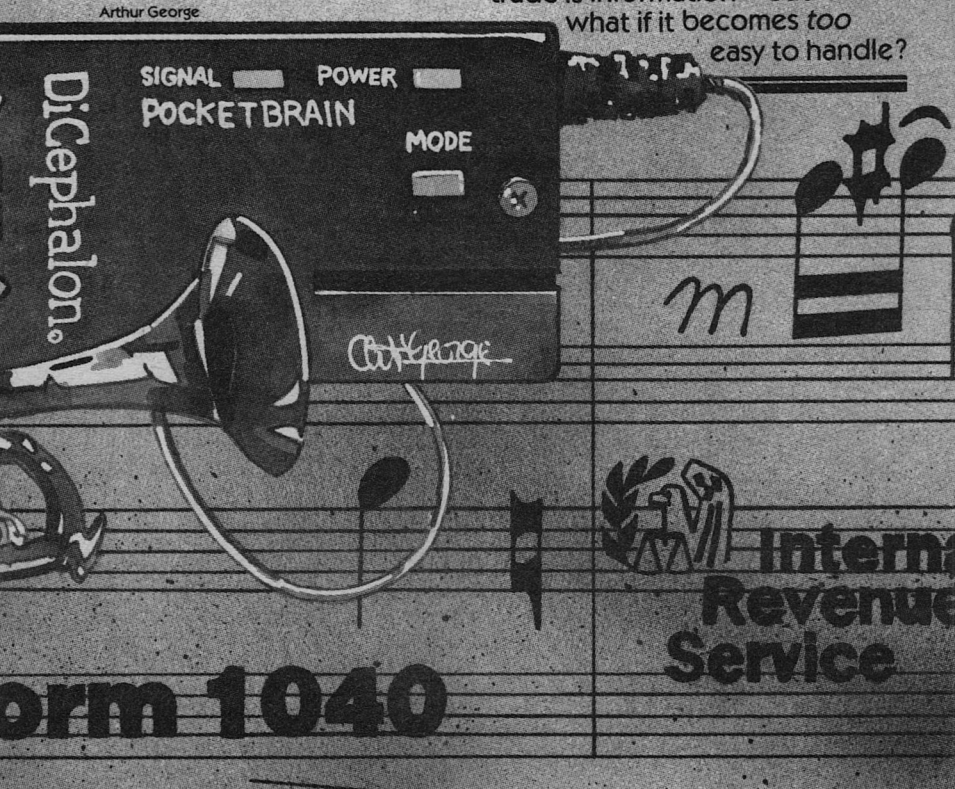
Dr. Thomas Gold.

Submitted by G. Harry Stine

Rob Chilson

THE BUREAUCRATIC BRAIN

A bureaucrat's stock in trade is information—but what if it becomes *too* easy to handle?



"It isn't as if we had had him arrested," said Fred FitzGerald.

"It may be worse, from his point of view," said Steve Woodley. "An arrest you can live with, but we've forbidden Nadler to practice his art."

"Oh, come! He played his sax long before he got his pocket brain," Fred said. "And having him leave it at the Center is only a temporary measure."

Steve shook his neatly-kempt head doubtfully. Woodley was the IRS Service Center's Labor Relations Officer. It had been his idea to require Chris Nadler to leave the pocket brain at work nights.

"I thought so myself, but I'm beginning to wonder if there is a solution," Steve began, smoothing his natty tie.

June Friedman, Chief of Personnel Branch, wagged her head, her long jade earrings jangling. "Our intentions don't matter at this point. Nadler has grieved the order requiring him to leave it here."

"He's not a member of the Union," said Fred. He tapped his fingers on the polished table in the Labor Relations Office. "Processing and Records is a non-bargaining unit—"

"Doesn't matter," said the Labor Relations Officer. "All employees have the same right to union representation. And the union is bound by the terms of its contract to represent him if he requests it."

"Which he may," said June. Processing and Records was one of her units in Personnel. "Besides, even if he doesn't, he has grieved it and has demanded a hearing from Employee-Management Relations. Are we within our rights in forcing him to leave the pocket brain here?"

At first it hadn't occurred to Fred that there was any doubt. Chris Nadler was a lowly clerk in Personnel, with access to the Official Personnel Folders and all confidential information about the Service Center's 3,800 employees. Nothing wrong with that, till he had bought this new-fangled pocket brain—and had *memorized* the addresses, Social Security numbers, and many other confidential bits of information about *each* of them. Every night he took it all home with him.

And one night he had revealed the address of a fellow employee.

She had gone one Friday night to the club at which Nadler and his group happened to be performing, had become drunken and obstreperous, and been ejected—and had been counseled for it. It gave the Service a bad name and if repeated was grounds for firing. But she was too drunk to drive, and too obstreperous to reveal her address for the cabby. Nadler had given it to them.

She reported him the following Monday morning for violation of the Privacy Act of 1974.

"Revealing the mere list of names of employees here could be bad enough," said Fred, sweating at the thought. Steve Woodley had questioned Nadler after the other employee's complaint, and counseled him about violations. That had been reported to Fred FitzGerald at the time. Fred had consulted June Friedman about the Privacy Act and gotten back to Steve with commendable speed, and Steve had suggested forcing him to leave the little computer with its load of restricted information at work. That was two days ago.

Fred looked gloomily around the La-

bor Relations Office. It was painted the same lemon-yellow color as his own office, only a shade less nauseating than the yellow-green of the hallways of the Service Center.

"No, actually if he revealed the names of all employees here, it wouldn't be in violation," said Steve. He ran a thumbnail over his neat mustache, looked worried nevertheless. "The Privacy Act permits the release of names of employees, their salaries, their grade—but not their step—and the location of their place of employment."

Fred looked at him. "Yes, but it's one thing to release the fact of a given person's employment here. It'd be another to release a *list* of such employees. Anyone who wanted, say, to advertise to Federal employees could simply check them off in the phone book. And as for harassment—"

"Is he actually leaving the brain here?" Steve asked. "Or are we going to have to search him or something?"

Fred looked at June, who hesitated and ran fingers through her frosted locks. "I asked Virginia Spencer, but she hasn't gotten back to me." Virginia was chief of Processing and Records Section.

"We must settle this as soon as possible," Fred said. "Each night we force him to leave the brain here increases his grievance. Next thing you know he'll be claiming damages."

"Well, we can't predict how it'll go," said Steve, troubled. "We are not justified in seizing his personal property. But really, can we permit him simply to carry it all off with him? He's memorized entire OPFs. Carrying *them* home with him would be an obvious violation, but—

"How about that, June? Doesn't that make it a violation, to carry *copies* of the OPFs home?" Fred asked.

June considered it, finally shook her head. "I don't think so. In the case of the OPFs, anybody can read them who sees them. In the case of the pocket brain, nobody but Nadler can read them, even if they become aware he has them on him."

Fred slumped. "I was hoping to be able to report to the Director that we had solved or at least *could* solve the problem."

"It's a new area," said Steve gravely. "No law or rule covers it yet."

Fred FitzGerald glanced into the mirror in the men's room, touched a comb to his thinning hair. He felt like a fool. It was true that he had a question or two about his health insurance. Normally, though, Fred would have asked Virginia Spencer, Nadler's immediate supervisor; he felt foolish, and a little angry with himself for it, for using it as an excuse to speak to Nadler. Exiting the rest room with an angry shrug and an automatic duck under the door, he sought out Processing and Records.

It was cold in P&R as usual; here in mid-summer the girls were wearing sweaters. Facilities Management never seemed to get it right. Nadler was P&R's receptionist, occupying the desk nearest the door of P&R, a tall burly fellow with a bristling red beard and long hair. Processing and Records was a room jammed full of desks piled high with papers, at which a dozen women worked steadily.

Nadler was standing behind his desk, his huge hands deftly flipping back turquoise or startling purple forms and date-stamping their undersides. Each form was paperclipped to the cover of a thick manila folder, an Official Personnel Folder. Nadler stamped and laid them aside, humming the while in a pleasant baritone.

"Can I help you?" he asked.

"Yes, I have a few questions about my health insurance," Fred began.

"Chris! Six-six!" one of the women called.

"Just a moment—" Nadler pushed a button and picked up the phone. "Chris speaking . . . Sure . . . No, we don't need that information, just leave it blank. . . . No, we don't need the Geographic Location Code, either. Right . . . right. And don't forget to sign at the bottom."

When he had hung up, Fred said, "I'd like to look at the Postal Supervisors's health plan brochure—"

Nadler got him one from behind the giant power files, two machines each seven feet long and eight feet tall, full of OPFs. Fred paged through the brochure, glancing from time to time at Nadler. The burly fellow went on stamping forms until they were all done, then he pulled up a black loose-leaf binder, opened it, and extracted a page. This he inserted into the typewriter at his left.

Another employee entered and approached him; Nadler laid his left hand on the typewriter's mouse and looked up inquiringly. "Yes, may I help you?" The typewriter screamed three times as its old-fashioned letter-quality dot-matrix head ripped across the page; then it ejected the sheet.

"Boy, that was fast," said the employee. "You didn't even type it!"

"Easy for a pocket brain," said Nadler, tapping his shirt pocket. Fred now saw the white thread of the neuro-antenna looping his neck. Nadler replaced the page in the binder and flipped its pages. "What can I do for you?"

"I sent in a bond last pay period and it wasn't on my statement."

Nadler got her name and said, "I remember that. The 1192 came in on Friday after the processing for that pay period was over, so it was too late to affect that check. I input it next week, though, so it should be on your next check. Okay?"

She nodded, the typewriter screamed five more times without a touch to the keyboard, and Nadler changed pages again, paused to answer the phone.

"My God," Fred said, as impressed as the employee. "I had no idea a pocket brain could do that."

"Best investment I ever made," said Nadler, hanging up the phone and grinning through his beard. "Though I never expected it to be so helpful here at work." There was a faint shadow in his expression, but he did not look accusingly at Fred, who felt guilty.

"Typing I'm not so hot at, so when I realized what the brain could do, I talked Virginia into wangling this fancy Superprint typewriter, which should be on a Branch secretary's desk. I bought the mouse myself; Supply doesn't have any. The Service Center is really backward, you know?"

Clumsily, feeling that he was making

a mistake, Fred said, "You bought it for your music?"

"Yeah, right." Nadler nodded eagerly. "See, pocket brains can do all kinds of things for artistic types. Writers don't pound keyboards if they have pocket brains; they can do word-processing in their heads, like I'm doing here." The Superprint screamed counterpoint. "Artists don't take color notes; now they have perfect color memory, a thing no human ever had before. And a musician—Mr. FitzGerald, I've got perfect pitch!"

Fred knew how rare that was. He nodded, but his mind was on the typing. "You aren't even looking at the typewriter."

"Well, see, this Superprint was developed to work with ultravolant computers, as a light-duty printer. Signals flow both ways; I know what it's doing." Again the typewriter ripped into motion.

"What are you doing?"

"Logging these obsolete pieces of paper in."

They were Standard Form 52s, prepared by the various Branches and sent to Personnel: requests for promotions, reassignments, etc. At each step they were logged by control clerks like Nadler making Dickensian entries in ledgers by hand.

As Fred looked at Nadler's log, he could see line after line of crabbed entries in two colors of ink, from before Virginia had gotten him the Superprint.

"Wait a minute," said Fred, startled. "You're making the entries without referring to the 52s—"

"Oh, yeah, when I date-stamped them I glanced at each one, got the request number, all the pertinent information."

Fred swallowed. He had been told that Nadler had memorized thousands of bits of information, including a number of whole folders, and had not been surprised. But to see it in action . . . "You can remember six or seven items on each of two dozen documents after a single glance?"

"No, but I can record it." Nadler pulled the brain out of his pocket and showed it to Fred, who looked at it with interest. He had seen pictures, but never a real one.

It was about the size of an old fashioned pocket watch, a little slimmer. On its face was a heraldic double-headed gold eagle, the emblem of the Di-Cephalon brand. The neuro-antenna looked like a length of nylon monofilament fishing line, pulled out of the top and looped around his neck.

"Hey, Chris!" one of the women in the Section called. "You know where Ellen Cumpton works?"

"Yeah, she's in Underreporter, but was detailed to Document Perfection. That detail's about to run out," Nadler said. The Superprint screamed again.

"What's her Social?"

Nadler called out the employee's Social Security number without stopping to think.

Fred shook his head. "I can see how memorizing all that information can speed your work. I didn't realize it was so helpful for the whole Section."

"Not memorized, just recorded. Yeah, I need that stuff all the time myself. The real problem here is finding the OPFs during the hiring and busy seasons."

Nadler grinned briefly, put the binder away.

Virginia was after him for another file clerk. Fred managed to grin back. "The brain wouldn't be much help there," he observed. "How much stuff do you memorize—I mean, record—on each employee?"

"Just the stuff I need constantly. I record Treasury Notes each time it's printed off. A computer listing of all employees, used for mailing the Service Center's newsletter. I also have the Service Center phone book recorded, so I can locate anybody quickly. . . . Yes, can I help you?"

A young woman had come up behind Fred. She wanted a letter of verification of employment, giving the fact of her employment at IRS, her salary by the hour, that she was Seasonal, and the date of her latest return to duty. Nadler got her extension and said he'd call her when it was ready. "I'll probably have it this afternoon, maybe tomorrow, if Virginia gets time to sign it."

"I suppose the DiCephalon will help you there, too," Fred said.

"I could write that letter now," Nadler said. "It's not like these verifications where a mortgage company is asking for last year's and this year's income. Have to research that on the microfiche."

Nadler broke the stack of OPFs down into smaller piles, picked up one of the stacks, and carried it to the desk of one of the appointment clerks. Fred gloomily watched him return, uncertain why he'd come here.

"You can't play your horn without it?" Fred asked abruptly, the health insurance brochure forgotten in his hand.

"I can, but not as well as with it. It's the difference between being good and being great. Look, Mr. FitzGerald, we don't care what critics say, natural, artificial, robotic, my ass. We want to be the best we can be. The whole group uses pocket brains. Right here," he slapped his pocket, "I have millions of pieces of music in memory—note-perfect. I'm not going to give that up."

Fred nodded.

"Chris! Six-Three!"

Nadler answered the phone, "Chris speaking. Okay . . . that's your Social Security number, not your badge number . . . That's right, just draw a line through that block. . . . No, section three's for the bank. . . . In section two, put IRS on the left, and on the right, P.O. Box 24551. . . ."

Fred nodded farewell to him and went on to the terminal room, the ominous name of which usually made him smile. It was full of rattling computer terminals and staffing and appointment clerks inputting SF-52s and other forms into PERMITS.

Virginia Spencer's eyes kindled when she saw him. The Chief of Processing & Records was furious. "Fred! When are we going to go to ultravolant computers? PERMITS was down for two hours this morning, and we have hundreds of actions to input. In the old days we typed our SF-50s by hand and we never got this far behind!"

Fred shrugged. "Maybe never," he said. "Ever since Nixon's enemies list was published, Congress has been leery of giving IRS any up-to-date equipment." He added, "I just saw Nadler and *his* little ultravolant hard at it. First pocket brain I ever saw."

Virginia looked at him suspiciously.

"Are you really going to make him go on leaving it here?"

"I don't think we have a choice, do we? The risks are too great. Suppose someone borrows his pocket brain? Or he and his fellows get them mixed up?"

"I prefer to look at it strictly from the point of view of the Privacy Act," said Virginia. She looked like someone's wonderfully spunky granny whose red hair had faded to warm pink. But she drank coffee so strong it corroded the spoon, chain-smoked, and, after hours, took her bourbon straight. Fred had never made the mistake of thinking her soft. "He committed a violation in a perfectly understandable circumstance, has been counseled, and that should be an end to it."

"Oh, come, Virginia, you know Personnel case files are full of fuzzy things where no precise law reaches. We are being careful with Nadler."

Fred became aware that the girls at the terminals were listening, though the clatter of their fingers had not slowed. For a moment he compared those flying slim figures with the smooth working of the Superprint while Nadler looked casually away, and the terminals struck him like a nineteenth century factory . . . old, clumsy, and quaint.

Before Virginia could speak, he went on hurriedly, "Where are you going to put the brain? We certainly don't want it stolen." It was worth some thousands of dollars.

"With the coffee money, I suppose, in Carmen's cabinet."

"That sounds satisfactory. And we'll have the hearing as soon as possible, get this thing settled soon." Fred escaped as quickly as he could.

On the way out Fred went by Nadler's desk again and heard him on the phone, discussing a Personnel form with an employee: "No, block eleven you leave blank. Block twelve is for your allotment: one percent of your salary, divided by twenty-six. . . ."

Wonder how many Personnel forms there are, Fred thought, and how many of them Nadler routinely deals with. He appeared to have memorized—recorded, that is—all of them and could discuss them as if he had them before his eyes. He *did* have them before him. Shaking his head in awe, Fred went soberly back to his garish, yellow-painted office.

Only when Sharla reminded him did Fred remember the Director's speech. "Right, thanks. And call June Friedman for me, will you, Sharla? Have her come and see me at her convenience."

In his office Fred pushed the thought of Nadler aside, read and initialed a report, signed several papers, and buzzed Sharla to ask her to get Bruce Kurowski on the phone. Bruce was Chief of Facilities Management Branch, the other of the two major Branches in Fred's Division. The third Branch was tiny Training and Development. Bruce's Branch managed the nonhuman resources of the Center: the machines and equipment, etc.

Bruce answered and they briefly discussed Annex One. The Center was too big for the Main Building, so they had a couple of annexes, including this one, leased from GSA. The trouble was it was a decrepit building, originally built in 120 days in 1942 by Pratt & Whitney, to build B-25 bomber engines, and scarcely changed from that time. IRS stored tax forms in it, and its leaky roof

was of concern: they had distributed fourteen million 1040s the last year alone.

They concluded gloomily that they would have to hang on and try to patch it up. To renovate would be too costly, and they didn't want to move: the Annex was just down the street, comfortably close.

Finished with urgent work, Fred had time for the Director's speech. Tom Provan, the Director of the Service Center, had been invited to give a speech before the JayCees, and, flattered, had spent a lot of thought and effort on it. He had written a speech on bureaucracy and was showing it around to people whose opinions he valued.

One part of it Fred found very refreshing. Provan divided "bureaucrats" up into "necessary," defined as those who contributed to the organization's primary purpose, and "unnecessary" —those who did not contribute directly to that purpose.

For instance, the IRS Center existed to process tax returns. Anybody who worked in, say, the Director's Office, or the Equal Employment Office, contributed nothing directly to that effort, and could be called "unnecessary."

But, the Director insisted, EEO, for instance, was mandated by Federal law because of a feeling by the people of the Nation that some people were being or might be unfairly discriminated against. It was just so with the "bureaucrats" who worked, say, in Employee-Management Relations. EMR was the employee's first line of defense against mistreatment.

Such organizational units as these, then, served useful social purposes in their own right, but also contributed to the smooth flow of the "main effort" of the Center, thereby not merely enhancing that effort, but making it possible. For if the employees's rights were not respected, ultimately no work would be done. Hence in the Director's view, there *were* no truly unnecessary bureaucrats. He would not deny that there might be more in a given office than might be needed—though he himself had never experienced that happy condition!

That set Fred to thinking, and when June Friedman came in he looked up and asked her, "When we hire a new person, how many forms does he have to fill out?"

Taken aback, June jangled her jade earrings, but said, "I don't know. Half a dozen or so, I suppose."

Fred started counting on his fingers. "The application, the investigation, Federal and State W-4s, the address form, the investigation form—"

"That's six already." June tossed her frosted locks back, her earrings again jangling. "He also has to fill out a city/county tax form. He has to sign releases for the investigation. Is it important? Every one of those forms has to be processed by the girls in Recruitment and in Processing and Records, and PERMITS is a real bottleneck. SILVER is no better."

"I've just been reading the Director's speech, the one he proposes to give to the JayCees," Fred said, showing it to her. "Why don't you run a copy? Tom would appreciate any comment—he's really serious about this speech. I thought it'd be good to give him a little ammunition in the form of information.

Can we find out how many forms a new hire fills out?''

June nodded her head. ''I'll ask Diana Mulcaster.'' Chief of Recruitment Unit. ''Was that all you wanted?''

For a moment Fred was blank, then remembered. ''Oh—no, it was about Nadler.'' Fred couldn't remember Nadler's first name, and for a fleeting moment he wished he had a pocket brain himself, bizarre though the thought was. He knew nothing about computers.

''I've been thinking about him too,'' said June, her frosted head bobbing again. ''And I don't think we can stop this sort of thing forever. I've been talking about him to Virginia, and I can't wait till the Government outfits all of our employees with pocket brains.''

''Oh, that's ridiculous! Even cheap ones cost a couple of thousand, and for three thousand, eight hundred people? —But about the hearing—it had occurred to me that I know nothing about computers, you know nothing, Steve Woodley knows nothing, Virginia works with them but knows nothing about them. If Nadler did appeal to the union for representation, it's just possible that they'll send Ben Mann—who does know. Maybe we'd better have someone there who also does. Who would you recommend?''

''That's a good thought,'' she said, and frowned for several moments. ''I think I'd suggest Truman Nyles.''

''A good, solid choice—in both meanings of the word,'' said Fred.

The Director sent for Fred next day. Tom Provan was a tall, heavy fellow, almost as tall as Fred, with thinning gray-brown hair and sharp features. Fred went over the alternatives on Annex One with him. Gloomily, Provan said, ''And even repairing the roof is only a stop-gap. Soon we'll have to have another annex; we simply haven't personnel enough to do the work. Oh, how about that fellow in Personnel, with the pocket brain?''

''We're meeting with the representative from the union this afternoon. I understand he left the brain in the office last night, again. No idea how long it will take to arrive at some decision. Leaving the brain here, I gather, is not a permanent solution.''

''It *is* his brain, after all.'' The Director grunted. ''Keep me posted on that. I'm glad we caught it early; I shudder to think of that fellow walking around with all that restricted information in his pocket. We'll probably have to make him leave it at home. —Oh, I got word today from National Office—they've okayed that training you requested. So tell your girls to pack for Cincinnati.''

''Wonderful. I'll tell Bruce.''

''Fine, fine. By the way, Fred, do you have lunch free? I wanted to discuss my speech with you—''

''No, I have a meeting.'' Fred glanced at his watch. ''In fact, I'd better be on my way. But I'm very impressed with the speech, Tom. I may be able to help you with it—I'm researching the number of forms a new hire has to fill out just to be brought on board. 'Bureaucrats' must process all those forms—and many of them are mandated by various social concerns.''

''Legitimate concerns, I might add.'' Provan smiled. ''I maintain that at least in the modern world, such 'non-pro-

ductive' tasks as caring for the employees are essential, if the work is to be done. In the future we'll be caring for their children, too."

"I wonder how few people still work outside of bureaucracies? In my division I have several whole units—EMR, Disclosure—that could be called, in one sense, non-essential. But as you say, the Service Center couldn't operate long without them."

"Well, that's as *I* see it," the Director said modestly, glowing. "So long as it takes thousands of people broken down into scores of units to tackle major tasks, such 'non-essential' units will be essential."

"And that is the definition of bureaucracy," Fred suggested. "An organization devised to deal with large projects, which have been broken down into steps each small enough for a person or small group to handle."

"That's very good, Fred," said the Director enthusiastically. "May I quote that?" Writing, he added, "It even turned out—'steps small enough'—turned out that computers didn't help. We now have a whole Division dedicated to the care and feeding of computers. By the way, the last time I talked to National Office, it didn't look too hopeful for converting to ultravolant computers."

"Pity. The ultravolant itself will be obsolete before we get it."

The union did send Ben Mann, a fat brilliant fellow with a red face, who frowned at Fred. "I'm not used to seeing a Division Chief sitting in on these discussions."

"The Director is concerned about the case and asked me to sit in," said Fred mildly.

Truman Nyles, late in arriving, trod heavily into the Labor Relations Office and wedged his massive barrel-shaped frame into a chair at the other end of the long table. Mann frowned from Fred to him, and back to Fred.

"Very well. Now—" he said abruptly—"the Service's thesis is that Mr. Nadler's violation of the Privacy Act was minor in itself, but that he might at any time do it again. But it has presented no evidence that he has in fact contemplated doing so. Yet on this flimsy ground you have deprived him of his very expensive property, with which he pursues his art, and without the Constitutionally-mandated 'due process of law.' " Mann sat back with the expression of a man who has just laid down four aces and a king.

Steve Woodley and June Friedman represented the Service; Fred sat to one side. Virginia had not come. The natty Steve said easily, "Mr. Nadler has not been deprived of his property; we're here to see how he can enjoy the unrestricted use of it without threatening the Privacy Act, or any other law or rule of the the Service. I'm confident that we'll find a way."

Mann nodded, seeing nothing to counter yet.

"We're leaning toward forcing him to leave the pocket brain at home," said Steve. "It seems to us to be the surest way to guarantee compliance with the Privacy Act. Mr. Nadler has already committed a minor breach of the Act, and has been counseled. We do not feel that he is likely to repeat the lapse. But we are looking to the precedent we

would set, if we permitted him to carry all this restricted information around with him. How many thousands of Personnel employees are there in IRS across the Nation? They're not all going to be above temptation. Would you care to have your name and address freely available to any such employee?''

Mann stared at him for a moment, brushed his hand across the air. ''Beside the point. The point is the illegal and unfair action that deprives this innocent man of his property.''

''Have you a compromise to offer?''

Mann hesitated, said, ''Mr. Nadler does not wish to leave his pocket brain at home, if that is the decision. He says he finds his job difficult enough to do even with it, and it eliminates hours of tedious trotting around looking up information that should be centralized anyway.''

That they hadn't expected. Fred and the others exchanged glances; he supposed that was why Virginia hadn't come. She didn't want to lose it either.

''Did you know that he has developed a program that enables him to calculate the Service Computation Data for everyone?'' Mann said. ''You only have to name a person for him to give you the date of the next SDI.''

Fred had never worked in Personnel, but had a vague grasp of how much pencil and paper figuring went into the incessant recalculation of WGIs. It had to be done for each Seasonal employee upon each return to Pay Status.

Steve shook his head slowly. ''Leaving the brain home would be the simplest solution.''

Mann said, ''And what if you saw him wearing a neuro-antenna around his neck—would you search him?''

That was a thought.

''It's not forbidden to bring your own equipment to work to help you do your job, after all,'' said Mann.

''This is a little different than bringing your own pens,'' said Steve Woodley, irritated.

Fred was troubled himself. The thing was, neuro-antennas were ubiquitous around the Service Center. The National Office had ruled that stereo horns with neuro-antennas were permissible, since the induced nerve signals didn't drown out voices, as the old headphones had. But beyond that, supposed they searched him—itself probably illegal—and found he *was* wearing a pocket brain? How much force did their ruling have?

''Furthermore,'' said Ben Mann, implacably, ''you can't force him to leave the brain at home until you devise a way to get all the restricted information out of it. Did you know that he has recorded the IRM? Also the FPM.''

Everyone but Truman Nyles stared, dumbfounded. The DiCephalon was the size of a *small* pocket watch; Fred had seen wrist watches that were bigger. It was impossible to believe that the Internal Revenue Manual could be crammed into such a tiny thing. The IRM filled a glass-fronted cabinet five feet high and three feet wide, four rows of thick loose-leaf binders. —Loose-leaf, that revisions might be added; and it was always being revised. *No one* knew the IRM.

And the IRM was merely a gloss on the Federal Personnel Manual.

June toyed with a bracelet that matched her earrings and looked at Truman

Nyles. "Would it be possible to separate the restricted files, Truman?"

"It would take a few days," said Nyles. Truman Nyles was a big man, whose voice was a heavy bass burble that emerged from his thick neck with the seeming of effort. "All these pocket brains are self-programming, have to be. All Nadler would have to do would be to think some cue word, such as 'Personnel,' every time he used his brain at work. That would soon become automatic, with the brain helping him do it. Within a few days he'd have tagged every byte of personnel data with this label. After that he could do anything with it he pleased."

"I don't see where that gets us," said Steve Woodley dubiously. They looked at each other, troubled. Ben Mann looked at his counterpart.

"Truman?"

"Only thing I can think of is to have him download all the personnel records onto a mnemobubble every night. Shouldn't take but a few seconds. Leave the bubble here; they're about the size of a pea, and very cheap, a couple bucks. He could leave it in his desk. Does he have a bubble-blower?"

"A what?" Fred asked.

Ben Mann nodded. Truman continued, "These pocket brains need a lot of work. Some already have bubble-blowers built in, but not the Di-Cephalon; you have to plug into a thing that's like a disk drive was for the old silicon computers. If he doesn't have one, there's one in Computer Branch for the desk-top ultravolants; belongs to Arlen. Nadler could come in and download and wipe his memory file every night, and reload every morning."

Again Ben Mann nodded. Steve Woodley looked pleased; June looked hopeful. "We'll have to give him the combination to Computer Branch's door," Truman added. That was no problem.

"Mr. Mann?" Fred asked.

Mann said, "I'll present it to my principal, but I see nothing wrong with it, as a working compromise."

Neither do I, thought Fred, almost delirious with relief. National Office will be pleased. The Director will be pleased. And so will Virginia Spencer.

Virginia's pleasure was short-lived. Chris Nadler took his SF-7 card out of the Kardex several days later. On it he typed a future date and *Failed return from coffee-break* on it, by way of a resignation. Virginia was furious when she reported it to Fred.

"Mind you, it would've happened anyway, Fred," she said. "The pocket brains made his jazz group so good, they're not even a jazz group anymore—they play anything they have the instruments for, and a lot that they don't. They're going full-time. Now where the hell am I to find a replacement?"

Fred saw Nadler in the hall later that day and asked him how long he was staying.

"A couple weeks, to train my successor and to get some bookings. We'll be traveling; a couple more pay checks will come in handy. Don't worry, Mr. FitzGerald, it was nothing you did. I don't mind downloading every night."

"So the pocket brains have made you all pro caliber?"

"Yeah. Mind you, we were pretty

good before." Nadler wagged his untidy red beard complacently, in startling contrast to the sickly green of the walls. "But now we've got an impossible repertoire. And it's true that our playing has gotten better. See, I'm blowing my horn, say, and naturally every now and then I miss a note. My fingering's good, but who's perfect? But the pocket brain can take my practice sessions, record the correct fingering, discard the incorrect ones, and play it back to me when I'm performing. This is not mechanical, like they say, because it's *my* synapses that are recorded and played back, and they're played back to *my* fingers, which are different than anyone else's. See?"

Fred did see. "It enhances your performance by editing it."

"Yeah. That speeds up the learning process enormously. I bet you could learn to play the guitar in a week. Mr. FitzGerald."

The Director gave his speech to the JayCees and it was received so well that he began to speak of expanding and polishing it, and taking it on the road. Fred had given Tom Provan many facts and figures to bolster his argument. When a summons came from Julie, Fred assumed it was about the speech again. But Michael Boulanger, Chief of Tax Accounts Division, was with the Director.

"Ah, Fred," said Tom. "Here, what do you think of this?"

The Director handed him a sheet of paper. Fred turned it to one side and looked at it. It was a weekly Individual Performance Report generated by PERS, the Performance Evaluation Reporting System. This was for a Tax Examiner. It gave figures for Actual and Adjusted Volumes, for Production Rate and Doc's Reviewed, which meant nothing to Fred. But—Documents in Error—zero. Error Rate—also zero. The figures for Quan under Program Effect and Time Weight Factor meant nothing, but Qual was impossibly high.

"Just how does this Production Rate compare?" he asked.

Mike Boulanger said tersely, "She's doing three people's work. With zero errors."

Fred nodded, mused over the sheet for a moment. Then he turned to the Director. "This is no mere Personnel clerk. The woman has access to *tax* files. Fortunately we already have an answer, of sorts. But we can't have a thousand or so Tax Examiners traipsing into Computer Branch every night and morning. Buy three dozen bubble-blowers? Forbid them all to use the pocket brain?"

"Surely it's not that serious," said Tom Provan. "It's only one employee—Nadler's leaving—"

"One today; a thousand tomorrow," Fred said shortly. "I forgot that pocket brains are not an isolated phenomenon. They'll be made in the millions; already hundreds of thousands have been sold. It isn't going to be simple to deal with them. Look, Tom, as time goes on they'll get cheaper. Thousands of our employees will have them—they'll wear them like underwear, everywhere they go, without thinking. To work. Confidentiality of the tax records *cannot* be maintained under such circumstances."

"True," said the Director, shaken. "We'll have to forbid the use of pocket brains."

"She's already protested to the union," Mike said. "It was badly handled, but even so—"

Fred shook his head. "My God, aren't we going to have any control? Surely we can forbid them to use pocket brains. —But would we have to search them to make sure they weren't? We're not going to do that, God help us."

Mike said, "We can scan their PERS sheets and spot the users. But if they force us to let them use pocket brains—"

Troubled, Fred said, "Tom, it may be impossible for the government to *not* provide employees with pocket brains, just so it can lock them up at night."

"Oh, that's out of all reason. The expense—"

"I agree with Fred," said Mike unhappily. "We can fight a rear-guard action on this, but we'll lose. I sampled one of them at a computer store." He shook his head. "You can't imagine how it feels to be suddenly a genius. I'm going to buy one next week. Soon everybody'll have one. There'll be a national outcry if anyone tries to prevent people from bringing them to work."

"There are precedents for the government's supplying things and taking them away when not in use, primarily in the military," said Fred. "I don't like it, but it's the only long-term solution I can see. I don't even trust it. I suspect that—Jesus! the Nation may have to give up the income tax itself, if confidentiality can't be maintained! But anything less than supplying them and locking them up is unworkable."

"Can't we have them all download their files every night, as Nadler's doing?" the Director asked plaintively. "We can buy bubble-blowers—"

Fred shook his head. "I never realized it, but I trust Nadler. You see, it's all internal. A person standing by can't be sure he's really wiped his own file. You can check the bubble to see if the files are copied onto it, but all commands are internal—he just wishes it to happen. Suppose he doesn't wish to wipe his own memory, only to copy? Are we going to take the time to check every pocket brain every night? But can we trust all those Tax Examiners? Remember what even *one* breach of confidentiality can mean to the Service—"

Tom Provan nodded slowly. "You're right. It will be expensive, but supplying them with pocket brains—eventually —may be the safest way to go."

Mike said grimly, "The expense may not be all that high. When this gets going—when they've all got pocket brains—it's going to be closer to five people's jobs for each worker. Why, we could cut the whole Service Center down to, oh, eight hundred people. Less."

"Hard to believe," Tom Provan said dubiously.

"Oh, yes," said Mike. "Consider Data Transcribers. How fast can they key enter? But with a pocket brain, they could just scan the document, lay it aside, scan the next, and so on, and download their files into the central computer every hour.or so. Shut-downs wouldn't stop them."

Remembering how fast Nadler worked, Fred could believe it.

Mike added, "Tax Examiners would have it nearly as easy. And consider all the rules and regs a Tax Examiner has to know—now they'll all know everything."

"Eight hundred or fewer employees," said the Director, shaking his head. "Personnel, for example, would only need one out of five jobs, too—but with only eight hundred people, it would need *proportionately* even fewer." He shook his head. "And there's Quality Assurance Branch—who needs them?"

"Training and Development wouldn't be needed," said Fred, remembering what Nadler had told him about learning on the brain. He handed the PERS sheet back to Mike and tried to picture the largest employer in the Nation laying off four out of five employees. "It settles the problem of Annex One—both Annexes. That's assuming there *is* an IRS, if we can't maintain confidentiality. And Washington—Washington will be a ghost town!"

"There'll be heavy attrition among top management types; small organizations don't need high-powered executives," Provan said, apparently following up his own thoughts. "A college kid with a pocket brain—" He managed to smile wanly.

Fred's smile was equally wan. He had hoped some day to be a top level executive himself. *Protected species: the Bureaucrat, now nearing extinction . . .* He cleared his throat. "About your speech, Mr. Director—don't be in too much of a hurry to expand and polish it. . . ." ■

The Alternate View

THE FITS AND FLOPS OF FUZZY LOGIC

G. Harry Stine

Anyone who has ever worked with a computer knows that it's a device which works with absolute logic. It's a perfect slave that will do exactly what you tell it to do and only what you tell it to do, providing it can do what you instruct it to do in the first place.

Human beings don't operate the same way. A human is a lousy slave who perhaps will follow instructions and orders and maybe not, depending upon mood and motivation and a score of other non-logical factors. People aren't logical and never have been; logic is something we've invented in an attempt to make order out of chaos. Some people can be trained to think logically and some have the basic talent. Those persons go on to become computer programmers because they can think in "machine terms." A quarter of a century ago, programmers all had to think and program in machine language, which was extremely difficult and time-consuming. Constantly expanding computer memory capabilities have permitted translation-type computer languages to be developed, the "high-level" languages such as BASIC and FORTRAN and PASCAL in which the human can program a machine in human terms.

A big problem faced by computer engineers and marketing people was and still is making the computer "user friendly." Some incredible software has thus been written to permit computers to be "user friendly." Many of these programs are so long and complex that they take up a large percentage of the available computer memory. And, in spite of it all, computers continue to be maddeningly logical and therefore somewhat alien to humans. Computers are perfect slaves, and we're not used to having perfect slaves around.

These factors were quite apparent to Gene Roddenberry more than twenty years ago. (Gad, it's been that long since *Star Trek* first ran in prime time! By the way, those original episodes are holding up quite well in spite of nearly a quarter of a century of technical changes and new scientific data.) Mister Spock was a hybrid creature whose mind had been trained in a logical alien culture. Thus, Spock was the perfect foil for fencing with human foibles and was, perhaps unbeknownst to Roddenberry, also the organic embodiment of the inorganic computer, the always logical machine.

Move over, Mister Spock! Instead of human beings becoming more like their super-logical computer slaves, people have been making computers more humanlike!

Much of this came out of research on "artificial intelligence" (AI), a hypothetical field of computer programming which presumes that we know what "intelligence" is and can therefore duplicate it artificially in a machine. (Of course, three types of intelligence are known to exist: animal intelligence, hu-

man intelligence, and military intelligence. . . .) Those people who are enamored of AI perhaps have something other than what they've bargained for, and AI still has a very long way to go before you can leave a computer to manage the store while you're on vacation. But AI is getting there. AI researchers are beginning to learn more about human thought processes.

Human language mirrors almost precisely human thought processes and perceptions. When each of us stops to consider it, we discover that most of our thinking is done in the words and with the structure of the first language we learned, our "milk" language. For most of you reading this, that language is English. You think in English. The fact that all humans do not think alike is evident to those who know something of philology. (Look it up; it means more than you might believe.) A person who speaks Chinese thinks differently than one who speaks Russian who thinks differently from one who speaks Swahili who thinks differently from one who speaks English. A Frenchman thinks in French and a German thinks in German. I had a Pennsylvania Dutch great aunt who thought in German and whose English sentences came out: "Look the window out and see the man go the street down." It was understandable to me as a child although the sentence structure is quaint and definitely *not* English!

Human language is *not* logical and it is *not* precise although it precisely mirrors our thinking. It's full of indefinite, alogical terms. These allow us to cope with the fact that a high temperature of 35° F qualifies the day as being "cold" to someone from Los Angeles while a "cold" day to someone from Maine isn't "cold" if the temperature gets above 10° F. Whereas a high temperature of 10° F certainly qualifies the day as being a member of the category of cold days nearly everywhere, a 35° F day has only a partial or "fuzzy" membership in the set.

AI researchers are breaking some fresh ground through the recent development of "fuzzy logic" for computers. Fuzzy logic is beginning to appear in both hardware and software. It deals with such intuitive constructs as "very," "rather," "always," "usually," "rarely," "small," "medium," and "large." These and other terms like them have to do with relationships—i.e., they're relative to something else. They also have effects that are stronger or weaker than an arbitrarily established norm. These concepts play a major role in human decision making and evaluations. But, until the development of fuzzy logic principles, computers couldn't handle these aspects of everyday human thought processes.

In the example above of the relative nature of "cold" days, partial membership in any given set is expressed in terms of an index such as 0.4 on a scale from 0 to 1. When used in the field of data communications, fuzzy messages are defined as "vectors" (which are not the same "vectors" that you would use in trig, dynamics, or vector analysis) whose elements usually aren't 0s and 1s of the usual digital bits. They're called "fits" instead of "bits." A 4-fit message might have a four-dimensional (not the same "dimensional" concept used in physics) vector that reads

C = (0.3, 0, 0.8, 0.4). This vector has each bit weighed with a fractional value which expresses some degree of belief or verification, turning it into a fit.

The "crisp" or non-fuzzy message closest to C is determined by adjusting each fit to the nearest whole bit value. For example, the nearest crisp message to C might be A = (0, 0, 1, 0) while the crisp message furthest from C might be B = (1, 1, 0, 1).

This measure of "entropy" (not the same entropy that you encounter in physics and thermodynamics) for fuzzy sets was developed by Bart Kosko, a staff engineer with Verac in San Diego. Obviously, it's called the Kosko Theorem. When talking about fuzzy logic, entropy is closely related to the information content of a message which deals with unpredictable, chaotic situations that appear in otherwise non-routine yet informative events. Claude Shannon, the originator of information theory, would enjoy this expansion of information theory into fuzzy logic.

To determine the fuzzy entropy of a message, the Kosko Theorem computes its distance from the crisp messages nearest and farthest away. The first of these computations becomes the numerator of a ratio while the second becomes the denominator. The resulting ratio is the fuzzy entropy of the message.

Fuzzy entropy is defined, therefore, over the range from 0 to 1. It's obviously zero in the limit where the fuzzy message is crisp. The fuzzy message has its maximum uncertainty when it's equidistant from all crisp messages: X = (0.5, 0.5, 0.5, 0.5); the fuzzy entropy thus becomes unity and the set is then called "pathological."

What's far more interesting is that fuzzy logic isn't just another academic exercise. Fuzzy logic is extremely useful for examining and quantifying rules of thumb that most experts apply to their areas of expertise. Furthermore, anyone can get in the water. Both fuzzy logic hardware and software are now available.

Some of the hardware came out of the VHSIC (Very High Speed Integrated Circuit) technology funded by the Department of Defense. TRW Rancho Carmel AI Center in San Diego has a VHSIC Fuzzy Associative Memory (FAM) that consists of three double Eurocard boards. In December 1985, AT&T Bell Laboratories announced a chip incorporating fuzzy logic designed for real-time response such as missile command and control, robotics, and manufacturing operations; thus far, it's been used only in-house.

On the software side, the Fuzzy Logic Production System (FLOPS) came from the efforts of the Kemp-Carraway Heart Institute in Birmingham, Alabama, to computerize the classification of echocardiograms (ultrasound images of the structure and motions of the heart) to the same level of expertise exhibited by a highly-trained cardiologist. FLOPS runs on the IBM PC (everything seems to be PC-compatible these days!) and sells for only $195. Basically, FLOPS is a fuzzy logic "shell" around which other fuzzy logic systems can be created. The FLOPS package has a fast parallel processing capability which can be used for processing a lot of data in a short time, looking for patterns in

noise, storing contradictory and ambiguous information in fuzzy sets, and resolving the contradictions to yield a crisp output.

What is fuzzy logic moving toward? Obviously, a new form of information theory.

It's also telling us something else.

Some of the hardware came from R&D done for the Department of Defense. Some of the hardware came from private R&D. The software thus far has come from private sources—in one case, from biomedical research. Taken as a whole, fuzzy logic may probably be ranked as a purely serendipitous development. It is also a consequence of itself! Fuzzy logic processes and systems developed fuzzy logic!

Moral: Technology comes from the strangest places and usually has the strangest imaginable bedfellows. ■

ON GAMING

(continued from page 79)

versa). Most important, you can set the "line depth," the number of moves ahead the program analyzes to find the best move. Last, time clocks can be set and adjusted to put more or less pressure on the program to find its move quickly.

There is also a collection of games for your perusal, which the program will replay, and twenty classic chess problems for you to solve when you don't have time for a complete game. The games include a couple of micro-computer chess tournaments, including the final game from the *Personal Computer Games* magazine Home-Computer Chess Championship. Colossus beat ten other home-computer chess programs to win the tournament without losing a single game.

(And unlike a tournament with human players, I bet there was no pouting about lighting, chair placement, or hypnotic spells from the audience.)

The chess problems offer the typical "mate in three moves" puzzlers that can be devilishly intriguing. In these problems, White has to mate black in a certain number of moves by discovering the best possible move sequence.

I found Colossus Chess IV to be a highly entertaining chess program. And while I didn't enjoy losing to the program, much as I didn't enjoy losing to the gum-popping ten year olds with their chess tutors who frequented my local chess club, the games remain very exciting.

But if you feel you need an extra edge, simply hitting an escape key will quickly terminate the computer's search for the best move.

If it's really important for you to win, just don't give the program any time to think. ■

●A man about to speak the truth should keep one foot in the stirrup.

Old Mongolian Saying

Larry Niven

THE SMOKE RING

Part Three of Four

"Civilization" and "savagery" are peculiarly relative notions, but there was no doubt that the people of the Cluster had things the treedwellers could use. Getting them, however, might require sacrifices not made lightly. . . .

Vincent Di Fate

SYNOPSIS

Levoy's Star **(Voy)** *is the ashes of an ancient supernova, a "cold" neutron star of half a solar mass, probably on the order of a billion years old.*

A gas giant planet circles Voy at 30,000 kilometers. Goldblatt's World **(Gold)** *orbits within, and continually leaks its atmosphere into a gas torus surrounding the neutron star.*

A gas torus is inherently thin; but at the median line the air is thick enough to breathe. It has the appearance of a green-tinged **smoke ring:** *clouded by water droplets, and green with life that has been evolving in free fall for a billion years. The Smoke Ring is illuminated by a G-type companion star, and includes rock and water and soil lost from Goldblatt's World during its first catastrophic approach to Levoy's Star. Its volume—the foggy region dense enough to support life—is around thirty times the Earth's volume.*

Five hundred years ago, men entered the ecology, via the interstellar ramship **Discipline.**

Sharls Davis Kendy *(once a Checker for the State on Earth, now a computer program for* Discipline*) does not remember a mutiny. He must have edited those memories himself. He knows only that he abandoned his crew to their fate within the Smoke Ring.*

Surely the tools and knowledge the mutineers took with them will eventually help them to rebuild within the free-fall environment. Once they have something like a civilization, Kendy can help them rebuild the State. For more than five hundred years he waited in the L2 point outside Goldblatt's World.

Recently, the Smoke Ring's last working Cargo and Repair Module left its orbit within the Smoke Ring. A dozen inept pirates brought the stolen **CARM #6** *close enough for Kendy to communicate, before their craft dropped back into the Smoke Ring.*

Humankind is few but has spread far. Some settled the cotton candy jungles, fluffy puffs of vegetation that grow up to several kilometers across. Some settled the tufts of the integral trees. These trees grow up to a hundred kilometers long; tidal effects hold them vertical to the neutron star. The tufts are the only place in the Smoke Ring where one may live under (minuscule) gravity.

Humans have turned strange. Tree-dwellers run around two and a half meters tall. Jungle dwellers grow taller yet. Deformations are common—legs of different length, even no legs—and are not considered handicaps. Their toes are like stubby fingers. Humans of normal size are called "dwarves." They may be poor material on which to build a new State; but what else is there?

Kendy waited twenty Earthtime years, then set forth to find CARM #6. He now knows that his twelve contacts have settled a sixty-kilometer tree. It presently orbits west of the fourth Lagrangean point, the point of gravitational equilibrium sixty degrees east of Goldblatt's World. They call themselves **Citizens Tree.**

Citizens Tree had lived in peace and quiet for fourteen years by Smoke Ring counting. The carm can be used as a motor for the tree; and nothing terrible can happen to a mobile tree. But they've stayed clear of other tribes.

That ended with the arrival of a burn-

ing tree. Five living refugees reached the trunk; the sixth, **Wend,** *died of her burns.*

Booce *and* **Ryllin** *and their three living daughters* **Mishael, Karilly,** *and* **Carlot** *come from what Citizens Tree calls* **the Clump:** *L4, the fourth Lagrangean point.*

Booce calls it the **Admiralty.** *Civilization there houses more than a thousand people, not counting children. They sell a wide variety of earthlife crops, and Citizens Tree has none. Booce and his family are loggers: they use a steam rocket to find trees, push them home and sell them for lumber. They tell incredible tales of a civilization far beyond that of Citizens Tree. They speak of the Library, a source of knowledge not available to citizens like the Booce family, but only to officers.*

They brought wings. Most of Citizens Tree has tried flying.

Kendy is desperate to learn more. Ideally, he would like to use the Admiralty as a kernel for the new State. And the Library Booce spoke of sounds like the control panel from a ruined CARM!

Should the citizens investigate the Admiralty for knowledge and earthlife seeds, or should they avoid both knowledge and danger by moving the tree even further from the Clump? Arguments split the tribe. Booce with his tales of marvels, and Kendy working through his secret contact with Jeffer the Scientist, manage to arrange a quasi-legal expedition using the carm.

The crew that sets out to meet the Admiralty includes **Clave** *as Chairman,* **Booce,** *his youngest daughter* **Carlot, Jeffer the Scientist** *as Captain,* **Debby,** *and* **Rather,** *eldest son of Minya and Gavving (or possibly Mark.)*

Rather is a dwarf. He's the only citizen, aside from Mark, who can fit into the invulnerable armor stolen from London Tree: the silver suit. To fourteen-year-old Rather, the lure was irresistable. He was a dwarf of uncertain parentage; but he is now the **Silver Man.**

They will not risk the carm by taking it into the Clump (though Kendy desires exactly that). Their intent is to arrive as loggers.

The voyage has featured adventure enough.

A love affair has developed between Rather and Carlot. Booce would prefer that Carlot marry another logger, perhaps one of his rival **Hilar Belmy's** *sons; but he has not interfered.*

Under Booce's guidance the crew has moored the carm to a tree and used its main motor to push the tree east. Meanwhile they have severed the in tuft, which is the usual method of sailing east to the Admiralty: the wind-differential pushes on the out tuft only, the tree accelerates west and drops nearer Voy, and the tighter orbit moves it east. But the carm has saved them considerable time. Lastly they have rebuilt Booce's steam rocket, Logbearer.

They will arrive wealthy. Kendy steered them to a tree that had been impacted by a massive chunk of metals. Metals are rare and valuable throughout the Smoke Ring.

Jeffer doesn't trust Kendy. His intent was to keep his contact with Kendy a secret. Now Kendy has arranged for Rather and Clave to hear them speaking

together. That leaves all three open to persuasion.

Somehow Kendy must open direct communication with the Admiralty.

That has become considerably more difficult. When a happyfeet (mobile) jungle attempted piracy against Log-bearer, *Kendy maneuvered Jeffer into burning them all with the carm's drive flame. Murder is shocking to these people. The three who don't know about Kendy—Debby, Booce and Carlot—now distrust Jeffer himself. Jeffer holds that against Kendy, too.*

Kendy must use what he has; and what he has to barter is knowledge. Persuade, advise; wait.

SECTION THREE: CIVILIZATION

Chapter Twelve: Customs

Year 384, day 1992, by heliograph:

Station Two to *Gyrefalcon*. *Swallow* reports large incoming log east of Admiralty. Master unidentified. You will rendezvous for customs duty if convenient. Location of log at day 1990 was two-nine-oh degrees flat, five degrees north, two-eight-oh kilometers radial. Acknowledge.

"Rice, did this just come in?"

"Yes, sir. I was scraping the hull when I saw the light blinking near the Market. Took the message and came straight in, but I don't know how long the helio was blinking."

Petty Mart Wheeler thought it through. *Gyrefalcon* carried six crew; *Swallow*, two. The Navy preferred that civilians notice the big armed ships. In the act of paying customs they should remember what they were buying. So.

"Where are we?"

"I'll find out, sir." Spacer Rice turned toward the instrument closet.

"No, not you. Bosun Murphy, take our position." This was not an urgent mission. He'd use it as a training exercise.

The dwarf nodded cheerfully; her flame-red hair swirled around her. Her short but powerful legs shot her across the cabin to the instrument closet. She chose what she needed and went out.

The long hair would have to go when she reached higher rank. Pity. But dwarves were rare, and Bosun Sectry Murphy must be trained quickly. . . .

Through the hatch Wheeler could see a blue light, tiny and intense: a Navy heliograph, reflected Voy-light blinking near the east limb of the whorl. Red hair and a squarish feminine face suddenly blocked the view. "Petty, we're at two-sixty-five flat, six south, two-forty klomters."

"And we've got better than half a tank, right?" Murphy nodded. "Get on the heliograph. We'll rendezvous with the log. Jimson, Rice, get us ready for a burn."

The thick, disordered sky made Rather dizzy. If he fell into that he would be more than ordinarily lost. He climbed with care. Clave and Debby trailed him.

There had been hard work followed by a long climb. They were all tired. Rather's fingers and toes were starting to cramp. But the rocket was in sight, a hundred meters out . . . if that direction was still *out*.

The log was rising through the Clump's eastern fringes. Wind slapped at Rather from ambush, here, there, everywhere, as if he were embedded in a flock of

terrified turkeys. Clouds ran in peculiar directions, not east-west, not flattened spirals, but shallow in-out curves. A line of small green puff jungles flowed in an arc that was not tidelike at all. Confronted by such strangeness, Rather's bewildered eyes sought the one unchanging reference point.

Voy turned blue-white and steady . . . twenty-five degrees east of the stump of the in tuft! Choppy clouds blurred the sun. Shadows pulsed, blurring and sharpening. Overlaid on those, Voy's faint, sharp blue shadows lay in skew directions. Children learned not to see Voy-shadows. They told nothing, for they never moved, never changed, never distracted the eyes.

The tree had turned; the trunk was pointing *wrong*.

Booce and Carlot waited at the rocket. Debby called, "Booce! How can you stand it?"

"The tide? I grew up in it. You'll get used to it. The Happyfeet do."

"The shadows are making me sick to my stomach," Debby said.

Rather's own stomach was queasy. "Carlot—"

"We're almost home." There was no mistaking her joy. She *liked* it here. "Look, we've got the pipefire going."

"I'll start the water." A smaller pod had been carved into *Logbearer*'s new cabin. Booce crawled inside. "Tether yourselves."

The rocket cone pointed east. Rather poked his nose into the small hatch. "Booce, are you slowing us again?"

Booce's voice echoed. "What? No, tide's different in the Clump. We'll push west, straight toward the Dark." He pulled a wooden plug from the water tank. He inhaled, put his lips to the hole, and blew.

Rather withdrew his head to watch the completed rocket in action. Yellow-white coals glowed within the iron firebox that had given them so much trouble. The iron glowed dull red. A fourth pod nearby was filled with water in case the plates didn't hold together.

At the nozzle end of the rocket —"Nothing's happening."

His answer was the sound of Booce inflating his lungs. Then the rocket went Chuff! and sprayed steam.

"It's going, Booce," Rather said, and looked in.

Booce's face dripped with water. He was coughing and choking while he pounded the plug in with the heel of his hand. His glare was murderous.

CHUFF, CHUFF, Chuff chuffchuff-chuff . . . The rocket settled down. A row of cloud-puffs became a steady stream jogged by the play of capricious wind. Rather felt no acceleration. It would be gentle, with so great a mass to be moved.

Carlot came up behind him; her long fingers found his hand and enclosed it. "Father? Shouldn't we—"

Booce sounded like his throat was still full of water. "Yes, go play lookout on the west face, you two. Watch for Navy and anything we might hit."

The maelstrom revealed itself to them as they circled the trunk. Flying was a continuing wonder to Rather, but Carlot did it better. She kept darting ahead, then circled to urged him on. At a vantage point on the west face they doffed their wings and rested.

The Clump was a whorl like a tre-

mendous fingerprint. Inward, matter thickened. There were puzzle trees, distorted cotton candy jungles, the much smaller puffballs that Carlot had pointed out for him (''fisher-jungles''), and greenery that was totally unfamiliar. Ponds took odd shapes in the distorted tide. The sky was thick with birds: sky-horses, triunes, and a thousand tiny red and yellow darts converging on a puff jungle. Everything moved in arcs, tighter near the center of the whorl, and darker. The center itself was almost black, but motion could still be seen there.

The triune families were hard to spot, but two had turned to observe the passing log. They were fat sky-blue cigar-shapes with wide triple fins: male and female and child, linked along their bellies. Three slender blue shapes flashed violent-orange bellies as they converged on the red-and-yellow bird-swarm: another triune family, separated to hunt.

A thin stream of cloud cut across other patterns of cloud-flow. Rather spotted it in the moment before Carlot pointed. ''There. Navy.''

''How do you know?'' Rather saw only a dark point at the end of the line of cloud.

''It's coming toward us. Customs. They'll make a burn and intercept us in a day. Oh, *treefodder.*''

Rather laughed. She'd borrowed his curse. ''What?''

She showed him.

Far in toward the Clump's dark center, in the thick of moving matter, was a broad, flat ring-shape with a pebbly inner surface . . . angular structures in pastel colors . . . blatantly artificial. Could it really be as big as it looked?

He judged its size by an even larger natural object nearby: a tree with one tuft missing. The log was smaller than their own, Rather thought. At its midpoint he could make out a rocket-shape, cone and tank and angular cabin.

Carlot said, ''I know that rocket. *Woodsman*. Dad won't like this. They could just as easily have been out another damn year.'' She looked into his eyes. ''We won't have much time together. The Belmy family owns *Woodsman*. Dad wants to marry me to Raff Belmy.''

''Will you do it?''

''Shut up.'' She pulled him against her by the slack of his tunic. ''I don't want to think about it. Just don't talk,'' she breathed into his ear, and he obeyed. It crossed his mind that Booce should be told of these things. But there would be time. . . .

Gyrefalcon found the log easily: bigger than average, with both tufts severed. It was making its burn: a wavery line of cloud behind it was beginning to arc over. The rocket would be behind the trunk.

''Instruments,'' Wheeler instructed. ''Rice, get us a rendezvous track. Murphy, the neudar. That dark blemish in the wood—''

''I see it, sir.''

He waited and watched. His crew moved well, Bosun Murphy in particular. She hadn't yet used the neudar under field circumstances. She moved slowly, but without mistakes. That would reflect well on Wheeler.

''The blemish is dense. Metal,'' she said. ''Kilotons.''

''Now the rocket.''

GLOSSARY

BRANCH—One at each end of an integral tree, curving to leeward.
BRANCHLETS—Grow from the spine branches and sprout into foliage.
CARM—Cargo And Repair Module. *Discipline* originally carried ten of these.
CHECKER—Officer entrusted with seeing to it that one or a group of citizens remains loyal to the State. Checker's responsibility includes the actions, attitudes, and well-being of his charges.
COPSIK—Slave. (Derives from *corpsicle*. In the State, corpsicles had no civil rights.)
COPSIK RUNNER—Slavetaker or slave-master.
DARK SHARK—a predator of the Clump Interior.
DAY—One orbit about Levoy's Star, the neutron star. A *standard day* is an orbit of Goldblatt's World.
"FEED THE TREE"—Defecate, or move garbage, or die.
FISHER PLANT—boll-shaped, reaches toward ponds with a long water-inflated root.
FISHER JUNGLE—is a large fisher plant with sting. May attack big birds as well as ponds.
GO FOR GOLD—rush headlong into danger, or disaster, or battle.
GOLD—See *Goldblatt's World*. Secondary meaning: something to avoid.
GOLDBLATT'S WORLD—Gas giant planet captured after Voy went supernova/neutron. Named for *Discipline's* astronomer, Sam Goldblatt.
HAPPYFEET—Mobile tribes. (An Admiralty term.)
HONEY—Sticky red fluid, used as a lure for treebugs.

"I can't see anything—"

"Behind the midpoint."

"Oh! I can look *through* the wood!" She tried it. "Mmm . . . something . . . metal, not much. Our own iron rocket nozzle would show a mark like that."

"Rice?"

"We need a burn, Petty. Fifty degrees planar, zero axial, a hundred breaths of burn and we'll go just past."

"Give us the burn, then all hands suit up. Spacer Rice, you're in the cabin, on instruments. Murphy, on the pump."

Gyrefalcon carried a glass alcohol tank and a pair of water tanks. Its valve system had been rifled from the hulk of an ancient Cargo and Repair Module. On long voyages, standard practice was to spray water into the alcohol flame as working mass. Water could be replaced in domains beyond the Admiralty's reach. Alcohol generally could not, though some of the happyfeet tribes carried alcohol distilleries for trade with the Admiralty.

Wheeler and Jimson tethered themselves carefully at the steering platform above the motor. Murphy began to pedal. Pedals could be extended, but a dwarf on the bicycle always delivered more power. Wheeler put his hand in the airflow to test it, then started the alcohol flame. He checked his crew's handholds before he increased the flow.

Thrust pulled at his skin and his bones. He ran water into the flame. Thrust rose again, and heat bathed the inner surface of his straining legs.

Rice called down from the cabin. "Cut it!"

Petty Wheeler reached below his feet for the alcohol valve. The roar died to

a hiss: water on a hot surface. Next, the water valve. *Gyrefalcon* fell free.

The log was nearer; the plume of acceleration was gone. Using the binoculars, Wheeler found a pair of human shapes on the near side.

"They're not giving us much attention," he said.

Murphy took the binoculars. Presently she said, "They'll have time." She looked until he took them away.

The Navy ship was bigger and more elaborate than *Logbearer*. It arrived in a wave of warm steam, and paused a hundred meters from the center of the midtrunk. Four men emerged and flew toward them.

Logbearer's crew waited outside the cabin.

"They're fast," Debby said.

Booce chuckled. "Never try to outfly the Navy. Navy wings are different, and the men are picked for their legs."

They were closer now. Rather suddenly gripped Booce's arm. "Booce, they're wearing silver suits!"

"*Ah!* Rather—"

Rather eased his grip. "Sorry."

"Well, *watch* that. It's only Navy armor."

"But it looks—"

"Just armor. There are three vac suits in the Admiralty, and we aren't important enough to see one. Incidentally, they'd love to make it four."

Closer yet. The armor didn't cover them. All wore helmets: head-and-shoulder pieces with an opening for the face. Some wore additional plates. And one was a dwarf.

Their wings! They pointed a little forward, as the foot did; they folded on the forward kick, and snapped open on the back-kick. *The Scientist should see this,* he thought.

They left their wings on even after they touched bark.

The dwarf was a woman. Red hair showed around the helmet before she lifted it. Pale skin, pointed nose and pointed chin; hair like flame streaming from a tree afire. Her chest plate stood several ce'meters out from her chest. She was five or six years older than Rather, quite lovely, and Rather's height.

She caught him looking and smiled at him. He forgot that he could move. Her eyes were blue, and they danced.

He was blushing, and Carlot had caught it, and Rather looked away in haste. And watched a long, long man kicking toward them.

The globe helmet was much larger than his head, with an opening for his face . . . like the silver suit's helmet with the faceplate missing. Seperate curved pieces protected his thighs, back, upper arms, and hips. Those were wood painted in silver; but the head-and-shoulder piece was of hammered metal. Wide nose, dark skin, black cushion of hair: he might have been part of Booce's family.

He recognized Booce (and ignored his crew). "Booce Serjent? You may remember me: Petty Wheeler. Welcome home."

"Good to see you again, Petty. You'll remember Carlot—"

She smiled brilliantly. "Good day, Petty Wheeler."

"Oh, yes. You've grown, Carlot."

Booce said, "These others are Clave and Rather Citizen, from Citizens Tree, a few hundred klomters west of us.

HONEY HORNETS—Deadly insects. They secrete nerve poison.
INTEGRAL TREES—A crucial plant.
JUNGLE—describes almost any extensive cluster of plants.
LEVOY'S STAR—A neutron star, the heart of the Smoke Ring system. Named for its discoverer, Sharon Levoy, Astrogator assigned to *Discipline*.
PRIKAZYVAT—Originally, Russian for "command." Presently used to activate computer programs.
SMOKE RING—The thickest region of the gas torus that surrounds Goldblatt's World in its orbit around Levoy's Star.
SPINE BRANCHES—grow from the branch of an integral tree.
STET—Leave it the way you find it.
STING JUNGLE—Smoke Ring plant, generally houses honey hornets
SUN—a G0 star, also called *T3*, orbits Levoy's Star at 2.5 × 108 kilometers, supplying the sunlight that feeds the Smoke Ring's water-oxygen-DNA ecology.
THE CLUMPS—the L4 and L5 points for Gold. As points of gravitational stability, they tend to collect matter.
TREEFODDER—is anything that might feed the tree: excrement, or garbage, or a corpse.
TRIUNE—A Smoke Ring bird, large and often dangerous.
VOY—See LEVOY'S STAR.
YEAR—One passing of T3 behind Voy. Half of a complete sun-circuit, equals 1.384 Earth years.

DIRECTIONS:
OUT—away from Levoy's Star.
IN—toward Levoy's Star.
EAST—in the orbital direction of the gas torus.
WEST—against the orbital direction of the gas torus. The way the sun moves.
SOUTH—to the left if your head is Out and you're facing West, or if your head is In and you're facing East, and so forth. Along

Debby Carther we hired before we left."

Meeting strangers was outside Rather's experience. Booce had told him what to do. He said, "A pleasure to meet you, sir," and held out his hand.

"Pleased." The Navy man's handshake was strong for a jungle giant. "I'll speak to you later, Rather. Clave, Debby, a pleasure. Booce, do you have anything to declare?"

"Yes. One log, forty klomters or thereabouts. If you want to measure it yourselves—"

"No, we'll just take half the manifests as you sell it off."

"And the Wart," Booce said complacently. "Our one bit of luck, and a happyfeet tribe almost made off with it."

"That mucking great chunk of metal halfway in?"

"Heh. You've found it already? We haven't measured that either, but it's thousands of tons. Petty, we'd like the Wart classified. We won't get so many thieves that way."

"All right, but if happyfeet attacked you—"

"I don't want to file charges. They got away, but we hurt them, and I don't want them to know who. They might want to come after us with friends."

"That attitude makes life difficult for the Navy, Booce. We'd rather chase them down. You're sure? . . . All right. We'll want our taxes in metal."

"Fine. I want to keep that makeshift firebox until I can buy more sikenwire. It's not pretty, but it works. Barring that, I'll sell the entire lode to the Navy right now, if you can tear it out and tow

it home. Take it off my hands," Booce said.

Rather couldn't help himself: he stared. *But what if he takes you up on it?*

Petty Wheeler laughed. "I don't have alcohol to tow it and I can't authorize that kind of expenditure. But we'll inspect it now, and I'll send a team to cut our share loose after you're moored."

Petty Wheeler's crew began searching *Logbearer* inside and out. Rather's momentary inpulse was to stop them. But Booce showed no surprise . . . and of course there was nothing aboard *Logbearer* to be found. Meanwhile the Navy officer turned to Rather and said, "Rather, was it? You should consider joining the Navy."

"Why?"

The man smiled. "The pay is good, particularly for a tree dweller, if you can get in. We'll shape you up and teach you things you should know, like how to win a fight. You'll be holding civilization together. The personal advantage is, you're the right shape. You noticed Bosun Sectry Murphy? Short, with red hair—"

"Yes?"

"She'll be wearing a vac suit within six years. Guardian is the highest rank there is, unless you were born an officer. You could do the same."

"I'll have to think about it."

"Talk to her yourself. Ask Booce, for that matter. Booce, we'll fly down and inspect your Wart. Would you like to ride with us?"

"I'd be delighted." Booce looked around at his crew and added, "We'd *all* be delighted."

Gyrefalcon's hull sported handholds everywhere. The Navy men spaced *Logbearer*'s people high along one flank. There were shelves for feet and straps to circle a waist (or just under the armpits on Rather). "Fighting vessel," Clave whispered to Debby. "They can cover the hull with archers."

Three Navy worked aft, around the motor. They ignored the civilians.

Something green was trying to grow on the wooden hull. Fluff, maybe. The wood had been scraped recently. Rather noticed that much before the rocket fired.

If Wheeler was trying to impress a barbarian dwarf, he succeeded. The rocket roared and spat flame. Rather felt his blood settling into his legs. The log's rough bark surged past, accelerating. Aft, Wheeler and Murphy used toothed gears to point the nozzle. In a way it was more impressive than the carm. You could *see* how it all worked.

The roar of the motor would cover his voice (and the fear in it.) Rather asked, "Why don't they let us inside?"

"Classified. Nobody knows what's in a Navy ship," Carlot said. "We

Levoy's Star's south axis. Direction of the Ghost Child.

ROCKET—Term refers only to the steam rockets used by the Admiralty and Seekers.

NORTH—opposite South. Along Levoy's Star's north axis. Toward the Blue Ghost.

DOWN and UP—usually applied only where tides or thrust operate.

SPIN, ANTISPIN, DARK—and SKYWARD are directions within the Clump.

The general rule as known outside the Clump is, "East takes you Out. Out takes you West. West takes you In. In takes you East. Port and Starboard bring you back."

haven't seen the whole crew, I'm sure of that. Rather, I noticed you staring at the, um, red-haired woman?''

Rather told a half-truth. ''She looks short. I mean, it's surprising, because she's the same size I am. Mark never looked short.''

Carlot seemed to relax. ''Well, no. He was bigger than you when you were growing up.''

Wheeler moved the nozzle ten degrees to port. The ship slewed around, spraying flame. He swiveled the nozzle starboard; the rotation slowed and stopped, and *Gyrefalcon* decelerated. It eased to a stop less than a hundred meters from the blister in the trunk.

''The bandits almost had it torn loose,'' Wheeler observed.

Booce nodded.

The same four Navy personnel accompanied them to the Wart. Three set to examining the blister that had grown up around the metal, and the machet-chewed wood that extended far back behind it. The fourth sought out Rather. ''Petty Wheeler said you might have questions to ask me,'' said Bosun Murphy.

Rather was not really thinking of joining the Navy. He didn't say so. ''I don't know enough to ask good questions.''

She smiled enchantingly. ''Ask bad ones. I don't mind.''

''What are the vac suits? Why are they important?''

''They're old science, as old as the Library. They're invulnerable,'' she said. ''The highest fighting rank is Guardian, and that's the rank that wears the vac suits. There are supposed to be nine Guardians. We've got eight. This—'' She rapped her helmet, then the plates on her thighs. ''—It looks like this, but all over. You'll get as high as Petty just because you're the right shape, and then you find out if you actually fit into a vac suit.''

''Do you?''

''I don't know. I haven't got that far yet.'' She looked down at her protruding chest plate, unhappily. ''Maybe I won't fit. I'd still keep my rank at Petty. Understand, you have to be qualified, you have to be trained. It's just easier if you're the right size.''

''Training. What's it like?''

''They'll put you through exercises. You may think you're strong—you're a tree dweller? I can see the muscles. But Petty Wheeler could tie you in knots. After you've been through training you could tie *him* in knots. I could, I think, and you're stronger. Your people, do they use polar coordinates to find themselves?''

''No.''

''They'll teach you how to find yourself in the sky. You'll learn how to count, if you don't know—''

''I can count.''

''You'll learn how to work a rocket, not a steam rocket but a Navy rocket. They teach you how to obey, too. You want to go in braced for that, Rather. A superior officer tells you to fly, you fly, wings or no.''

It sounded unpleasant. ''Where do the Navy ships go?''

''Mmm . . . Where do you come from?''

''Citizens Tree. A little west of the Clump.''

''You're not likely to visit your family. We don't see many tree dwellers. We send ships outside the Clump, but

not often, and never more than a few thousand klomters. Mostly we cruise the Clump itself. We collect taxes, of course—''

''Yeah.''

''We fight the wildlife. Dark sharks and other things. Citizens find a drillbit nest, or honey hornets, they call us and we burn it out.''

''Triunes too?''

''Oh, no, the triunes got the idea fast. They never attack us. Some of them like us. There's a guy, Exec Martin, he hunts swordbirds with triunes. Nobody knows how bright they really are, but they can be trained.''

''Why do you burn honey hornets? Booce says they're valuable.''

Her expression soured. ''Honey is contraband. Put just a tip of a fingernail's worth on your tongue, you dream wonderful dreams. Then you can't stop. Use a little more and you die in ecstacy. Some people will pay a lot for that.''

Honey is suicide. Rather hadn't realized that Booce meant it literally. He thought it over, then said, ''But it's their choice—''

She shook her head. ''Not my decision. Then there's detective work, and riot control, and rescue work. We don't specialize much. You learn to do all of that, but first you learn how to fly a ship.''

''What happens to cadets who fail? Murphy, what happens to *dwarves* who fail?''

''Nothing. I mean, they're out of the Navy, of course. They hire out or they build a business, maybe they go diving in the Dark for mushrooms and fan fungus, or they go logging. Hell, what does a logger do if he fails at something?'' She looked closely at him. ''What's the matter?''

''I'm having trouble with this. There're more people here, so there's more places for people, right? If you can't hunt or do earthlife farming, you just try something else?''

Murphy nodded brightly. ''Next question?''

Would we see each other if I joined up? May I call you Sectry? ''Thank you, Bosun.''

''Any time,'' she said, and sprang away. She coasted parallel to the bark, toward Wheeler as he emerged from behind the Wart.

''It's big,'' Wheeler called. ''Booce Serjent, you've made your fortune.''

''Recouped it, anyway. The first thing I'll do is rebuild *Logbearer.*''

''Yes . . . Well, I've seen enough. Eight thousand tons or so. Those scars on the metal—''

''We used the saw to get the slabs that make up the firebox. It worked better than I'd hoped. It's a good substitute for sikenwire, and the saw's not damaged.''

Wheeler nodded, satisfied. ''Can we lift you back to your ship?''

''No, we need to cover this somehow before we reach the Market.''

''I think you're worrying over nothing. How could anyone steal anything this *big?*''

''With saws . . . Well, you may be right.''

They watched *Gyrefalcon* steam toward the Clump interior. Something bright twinkled at the bow. ''He's calling home,'' Booce said. ''They use

mirrors to bounce Voylight where they want it."

"What happens now?" Clave asked.

"Wheeler thinks I sawed off more metal than just those plates for the firebox. He'll watch to see if I sell it on the black market. He could have bought the Wart on the spot, but he thinks I'll give him a better price if he waits. A few days after we dock I'll get an offer. It'll be too little, and I'll boost them a bit and then take it so I can stop guarding the metal—"

"What do we do *now*, Booce? Jeffer must be going crazy waiting for us to call in."

"We're still being watched."

Gyrefalcon was tiny now. Its steam trail was dissipating. Clave asked, "Can they still see? Have they got something like the carm windows?"

"A box they hold to their eyes. Clave, we'd like some way to disguise this mucking great chunk of metal."

So *Logbearer*'s five crew swarmed over the Wart, taking their time, just looking at it from all angles, as if there were some way to hide a conspicuous pucker in the honest wood of a tree. The sun crept from zenith to pass north of Voy. And presently Debby said, "Booce, you've seen more trees than any of us. What kind of a thing causes this kind of scar?"

"Something hits the tree . . . could be stony, it doesn't have to be metal. I've seen this kind of gap with nothing in it at all, just chewed wood healing over. I never did figure it out."

Debby wondered, "Ice?"

Booce's face went . . . stupid? Mouth agape, eyes drifting. He said, "Heh. Yes! A chunk of ice could smash a tree, then melt."

"Still doesn't do anything for us. What else? Disease? Is there something that builds nests? Or the tree bugs could chew just in one place—"

"Sure, a honey pod could hit a tree, and the bugs would chew a huge hole . . . give me a breath, Debby." Stupid again: thinking. "We can do it. Twenty days to reach the Market. Okay. We need a fisher-jungle that's got termites, and we need to look like we've been through a disaster, but we've got that already. I *never* thought I'd come home with a pod for *Logbearer*'s cabin!"

"What do you need from us?" Clave asked.

"Stay here, talk to Jeffer. The rest of us will fly up the trunk. This is *nice*. If Wheeler wonders why we're still hovering around the Wart, he'll see us hiding it!"

Rather swallowed his protest, because Clave was saying, "You don't need Rather. I want him."

"Stet." Booce had his wings on. "Come, children."

Chapter Thirteen: The Termite Nest

From the Citizens Tree cassettes, year 5 SM:

THE LAGRANGE POINTS

Matter tends to collect in the fourth and fifth Lagrange points (L4 and L5) of Goldblatt's World. These regions appear less turbulent than the storms around Goldblatt's World itself, but we have postponed exploring them in depth.

We inspected only L4. The more or less stable region is 600 km across.

Mapping the equipotential tide curves gets us nested crescents. What shows to the eye is a misshapen whorl dwindling east and west into the arc of the Smoke Ring proper.

The whorl is green around the periphery, darker and browner near the center where accumulated matter becomes thick enough to block sunlight. Tide-stabilized plants don't thrive here. We've found familiar life forms—triunes and cotton candy jungles—but also some specialized life forms not seen elsewhere.

Deep radar indicates solid masses within the dark inner regions. None are large.

We have wondered why the Clumps never condensed into one large body. Perhaps life itself acts to remove matter from the inner regions. The fisher-jungles's roots disrupt large ponds. Saprophytes feed in the dense core, then fire spore packages away into the Smoke Ring. Birds are forced out by famine or population pressure. . . .

It made his head hurt.

Jeffer ate as he read. When he reached the end he doggedly scrolled back to the beginning. His students had found it bewildering. So did Jeffer, but he had an advantage over his students. He had Kendy.

If Kendy would call!

Today he had hunted the sky. He'd returned to the dead fisher-jungle trailing a sizable shieldbird. A small fire near the carm had cooked his catch. He was getting good at it. Sandwiching the meat between two of the shieldbirds's bone plates cooked it tender without scorching it.

He almost choked when the carm suddenly spoke. "Jeffer? This is Clave. Jeffer, can you hear me?"

Jeffer swallowed hard and said, "Prikazyvat sent to pressure suit. And about treefeeding time, too! Are you alive?"

"Jeffer, we couldn't get to the helmet. The Navy searched *Logbearer*. Even after they left they were watching us. Where are you? Are you hidden?"

"Clave, I found something good. Do you remember Booce's description of a fisher-jungle? A green puffball a klomter across, with a long coiled root. It reaches out to put the root in a pond, but there's poison on it and it can attack life forms and kill them and draw them in to rot—"

"Right. They're not supposed to live outside the Clump."

"Maybe so. This one's fifty klomters from the Clump fringes, and it's dead. The axis trunk is hollow. There's a Navy ship coming this way. It's not likely they'll want to sniff around a fisher-jungle, but I've got the carm moored inside the hollow anyway. When it goes away I'll tether it above the root so the carm can get some sunlight. Where are you? I can't see anything."

"I'm in the dark. I'm in that channel we chopped past the Wart. We haven't moved the silver suit yet."

Jeffer remembered extending the work done by the happyfeet. His back and shoulders still ached. "We should have let the happyfeet do more of the carving."

"It was worth it. Booce was right. The Navy knows if you're carrying metal. This Petty Wheeler citizen knew about the Wart, but he didn't look for anything behind it."

"What's the Clump like?"

"Crowded. We'll have the log moored in twenty days. Booce has a way to hide the Wart. He's afraid of thieves, and we can't use the silver suit to win a fight, because—"

"No, of course not."

"—Because they'd recognize it. Jeffer, they've got *three* silver suits. It's a mark of high rank. Dwarves are in good shape if they join the Navy, and Rather's had an offer."

An offer. "Rather, you there?"

Jeffer heard Clave's distant yell. Presently Rather said, "Here."

"You had an offer to join the Navy? What was said? What did you tell them?"

"I didn't take the Petty seriously. The idea is to learn something about the Admiralty, buy some earthlife seeds and get back to Citizens Tree!"

"We want to know about the Navy too."

"I learned a little—"

Clave interrupted. "How serious are we? Booce, what has the Navy got that we want to see? I'm not so eager to see the inside of a Navy rocket that I'd feed one of my—"

"The Library! The cassettes! What's on the Admiralty cassettes?"

"All *right*, Jeffer. What makes you think Rather could get to any of that? Booce might know, but he isn't here to ask."

Jeffer finished the shieldbird meat while he thought. "Ask him when you get the chance. Now, I'm getting terminally bored here. Are you free to move the silver suit into the rocket?"

"No. It's too easily recognized," Clave said.

"How about just the helmet?"

"We'll have to ask Booce, but . . . I think not. Let's get Kendy in on this. Are you in contact?"

"He said he was changing orbit. He'll be back in another day. Clave, I wish you could give me some kind of a view."

"I'll think of something. Jeffer, Rather's waving at me."

"Scientist out."

"Clave? You'd better see this."

"What? I was talking to Jeffer." Clave crawled out of the cavity behind the Wart. "Oh."

From out of the crowded sky came a shapeless thing colored a dead yellowish brown. Its outline was fuzzed with a jittering motion that caused the optic nerves to twitch. It was coming straight at them, and *Logbearer* was behind it.

"Get out of its way, Rather, it's going to hit! Got your wings?"

They fled. The thing fell toward the Wart with a faint, frightening buzzing sound. Myriads of black flecks swarmed around it, insects much smaller than honey hornets.

It struck the crater around the Wart, and deformed like soft mud.

Logbearer bumped the trunk more softly. Debby emerged from the hatch in the forward pod. She stared hard at the intrusionary mass. She called, "It's going to stick."

Booce answered from inside. "Stet. Spread the honey."

Debby waved at Booce and Rather, but that was all the attention she gave them. She began spreading red sticky

honey around the rim of the crater.

The swarm of insects followed her. When she closed the circle, most of the insects had migrated to the honey.

"Done!"

"Good. Get aboard. Clave, Rather, I've got to moor this thing. Want a ride?"

Clave bellowed, "Booce, you get out here and answer some questions!"

Booce's head popped out. He thought it over, then flapped to join them. He looked indecently self-satisfied.

"It's a termite nest," he said before Clave could ask. "We'll say we didn't have any choice, it was the only tree around and we had to get back to the Clump because . . . I'll think of something."

"Uh huh. The honey?"

"Encouragement. When the termites run out of honey they'll eat wood. They'll bond the nest to the Wart."

"What about the silver suit? Were you just going to leave it?"

"Where would it be safer?"

"Jeffer's all alone in the sky. He'd go crazy!"

Booce's grimace told it all. Clave said, "He's the Citizens Tree Scientist, and he is *not* a crazy murderer. He was in a fight with our lives at stake, Booce, and he used what he had. It was more powerful than he thought it was—"

"He used it twice."

"Booce, if you've ever been a happyfoot bandit yourself, tell me now."

Booce was astonished, then amused. "Oh, really! No, I'm *not* protecting my own kind. I'm *not* defending bandits that prey on loggers. Granted they'd generally rather attack some tribe of helpless savages. Your suspicions are right there, Clave, but it doesn't mean I *like* bandits. I wouldn't have burned a whole damn tribe either!"

"Uh huh. You would have sent them away without hurting them so much. How? Describe the procedure in detail."

"I can't do that. Jeffer hasn't told any of us how to fly the carm! Clave, the Scientist is not to burn any tribe, ever again. I'm telling you, not him. *You* are to stop him."

"I'll tell him. Now what?"

"Oh . . . we'll leave everything but the helmet where it is. Jeffer's scientific eyes are in the helmet, right? Those little windows in the forehead? We'll moor it in the next. He'll have a view. We'll be spending enough time around the Wart; we'll talk to him then."

The carm with its cameras was hidden in a dark place, the pressure suit was in another, the incoming recordings were days old, and in present time Jeffer wasn't present. Kendy skimmed the recordings. He was learning more through *Discipline*'s own senses.

Logbearer was easy to follow: forty kilometers of tree with tufts missing and a metal mass off-center, now rounding the starward limb of the L4 whorl. Maintaining contact wasn't going to be easy here. *Discipline*'s new orbit had twice the period of Goldblatt's World, with periVoy falling north of the L4 point. Tilting his orbit out of the Smoke Ring plane allowed his instruments to penetrate less of the garbage in the Clump; but the log and the CARM and all of Kendy's citizens would be circling

that center on long kidney-shaped paths.

At least he wouldn't have to burn more fuel. If he could establish relations with the Admiralty, his present orbit might suffice for hundreds of years.

Savages in a thriving civilization would find trouble sooner or later. Patience. Some emergency would force Jeffer to bring the CARM into the L4 point. Then he must open the airlock to the Navy. . . .

One problem at a time. Wait. Learn.

Jeffer entered the cabin before Kendy passed out of range. There was fresh pink blood on his tunic and more on his hands.

"Kendy for the State—"

"Hello, Kendy. How can we—"

"Jeffer, if Rather has an offer from the Navy, I want him to accept."

"You would. Rather didn't sound too enthusiastic. Neither am I. How can we get away with not hiding the silver suit?"

"An excellent question." Kendy was using light-amplification, but it only showed him iron ore and chewed wood. Clave and Rather had departed the hiding place. "If the Navy has pressure suits, they'll recognize yours. I thought of disassembling it, but they'd know the helmet too. We would ruin the camera if we tried to dismount it, and the electrical source is in the helmet."

"So?"

"Patience."

"Feed your patience to the tree, Kendy. I've got a cryptic entry under 'Lagrange Points—' "

"I've had three hundred and eighty-four years to learn patience. You are almost out of range. Can you feed yourself there?"

"Sure. There's hand fungus, and flashers living on the bugs, and some other things. In a way it's like learning to hunt all over again—" The link was lost.

A chance to examine the Admiralty's military arm from inside! But Rather wasn't *enthusiastic*. And Kendy would have to talk Jeffer around before his arguments could even reach the boy.

Patience . . .

Chapter Fourteen: Docking

From Logbearer's log:

Year 384, Day 1700. This trip we need not fear happyfeet.

I fear Jeffer the Scientist. I fear the secrets we hide from the Admiralty and the secrets the Scientist keeps from me. But I owe a major debt to Citizens Tree.

Day 1710. We've found a simple way to hide our empty crewmember. May I never have the chance to thank the happyfeet for making it possible.

Day 1780. We've gone for more pods. One has become our cabin, one stores extra water in case a fire spreads. Returning with a pod for *Logbearer*'s cabin grates in my soul, but it will surely hide the wealth we carry.

Day 1810. Making paints gave more trouble than I expected. The colors are still poor, but will suffice. We've painted the honey hornet logo across *Logbearer*'s cabin. Now we'll see what can be done about my crew's wings.

Day 1996. Entered Admiralty space. *Gyrefalcon* has registered log and metal for customs. Assessment to follow.

Day 2000. Log nearing Market. Metal concealed from all but Navy. Conditions optimal.

Day 2015. Docked. Sent the crew off with Carlot. Would have gone with them if I could. I never dealt with tree dwellers before. I can't guess how they'll react.

I miss Ryllin. I never in my life had to weave so many threads at once.

A fat, baby blue torpedo cruised slowly along the Serjent log, moving closer to where Rather and Carlot stood watch. Suddenly it split along its length, and four slender blue-and-orange triunes dived on some tree-dwelling life form.

Rather pointed. "Four?"

"Sometimes triunes have twins."

"I've never heard of that."

"You never saw one of those, either." She pointed out a triangular shadow. "That's a Dark shark. They don't usually come this far skyward. They're dangerous. All teeth, no brain."

"Skyward?"

"Dark, skyward, spin and antispin. We use all the normal directions too."

"How do you keep it all straight?" Rather reached to wrap his legs lightly around her waist. She did not respond.

A ball of green fluff stretched a quarter-klomter of curly tail toward a passing sphere of water.

Booce, Debby, and Clave were around the log's horizon, ready to use the rocket if anything came near. Carlot and Rather kept watch from the east. "We can still keep our eyes on the sky," Rather pointed out.

Carlot pounded his kneecaps with her fists, briskly. "Who's watching *us?*"

"I don't mind triunes watching. Maybe I even like it."

"What about the houses?"

"Houses?"

"You'd say *huts*. Look—"

Beyond the Market, beyond Carlot's pointing chin, six cubes were strung along a spire of wood with a rocket tank and nozzle at one end. "That's Captain-Guardian Wayne Mickl's household," Carlot said. "He's one of the richest officers."

"It isn't close."

"That one is."

A structure floated against the Dark, a cube festooned with platforms, extrusions for tethers, water pods, and other things for which he had no name.

"That's the Hillards, I think. And that puff jungle is the Kerians."

The sky was full of puffballs. The one Carlot pointed out bore a big K with other letters within, too small to read. Carlot said, "Crew live in those if they're too poor to buy wood. Usually they clip a logo in the foliage."

Rather laughed. "Okay, I'm convinced." Another puff jungle was marked with a slender figure-eight. "If you're rich, you build with wood?"

"Yes."

"Your family has a house."

"We find our own wood! I'll show you if it comes around. It wasn't finished when we left, but I know the design."

"We're poor, aren't we? Citizens Tree is poor."

"You live poor. The carm makes you rich, except that you can't use it . . . and there's your share of the Wart, once Father sells it. Rather?"

"Speaking."

"I think I'm going to marry Raff."

Rather turned to look at her. The sudden black emptiness in his belly was entirely new to him, yet he couldn't feel any surprise. He got his lips working. "Would you be better off if I went somewhere else?"

She was having trouble meeting his eyes. "I haven't seen Raff in three years. Rather, I think he'd be happier if he didn't know we've been—"

"Making babies. I won't announce it."

"All right. But I wouldn't push you into the Navy just to get rid of you! Don't ever think that! I don't know if it's a good idea or not. I don't think for Citizens Tree, and I don't do your thinking either. Don't give up the idea just to stay near me."

"I have no intention of joining the Navy." Rather turned back to the sky. He was still on watch.

Now that he knew what to look for, the sky danced with structures. Puff jungles were everywhere, more of them toward the Dark, and some were marked. There were wooden cubes and clusters of cubes, elaborately colored in bright primaries. He could pick out wind-curdled lines of steam crossing the Dark.

He said, "People change in three years."

Carlot said, "Sure. Maybe we won't like each other. We'll see. I'm telling you, Rather, if we get along I'll marry him. Belmy was the first of the logging concerns, and it's the most powerful."

The helmet had been in place in the termite nest for some twenty hours. Kendy ran the record through his mind, classifying, deducing, making notes. When he reached present time he went back to the beginning.

His mental model of the Admiralty was shaping up nicely.

There were more new planets than new animals. Animals showed the same modified trilateral symmetry here as they did in the Smoke Ring proper. There was a clear absence of tide-stabilised plants: hardly surprising.

The buildings were interesting. Everything less primitive than a carved-out cotton candy plant was built in rectangular solids. It was as if they still built to resist gravity . . . but not quite, for addenda sprouted at any angle, and openings might appear in any of the six walls. They looked like Escher had designed them.

Some houses had a big square fin sticking out from one corner. The Clump was turbulent. In infrared Kendy could see little whirlwinds, "dust devils" with no dust in them. A house would tumble and keep tumbling without that fin.

Unless it was attached to some larger structure.

Why was there only one Market? It didn't look difficult to construct. Houses were scattered through the outer Clump. Most would have no neighbors at all most of the time. There was no need for such isolation. It was inefficient and lonely.

The tree's attitude changed continually. The view through the helmet camera wavered with it. Kendy was getting only glimpses of the Market, but he could integrate them.

Many of the structures were moored

by concrete to the Market frame. Too bad. Kendy would have liked to offer them concrete. If he ever got their attention he'd have to have something to offer, some bit of knowledge to make their lives better. He knew the pattern that would make them a thriving, Smoke-Ring-girdling State in a hundred years; but there had to be something quicker.

Electricity? The Clump never had true night either. How did they light their houses?

He recognized a glass tank from one of *Discipline*'s seeding missiles, emitting a sharp spike in the light spectrum: chorophyll. They'd made it into a hydroponics tank. The faceted hemisphere nearby was an old survival tent sheathed with wood, with transparent facets left open. Other structures on the ring were made from Smoke Ring materials: mostly wood, but one was a cotton candy jungle tethered to a mast.

A building beyond the Market sported a broad picture window: the windscreen from a CARM. Otherwise, no glass anywhere. No sand?

Crew drifted among the buildings like leaves in an autumn wind. Half-grown children flew in groups tended by one or two adults. . . .

I've got to know more. Can I find a way to move the helmet into the Market?

Booce was in position at the rocket, with hot coals ready and Debby and Clave to watch and to steer. The sky was thick with debris. One might hope that Carlot and Rather would keep to their watching . . . but at least they'd have their chance to talk.

A Navy ship had them in clear view. Supervising, to make sure that the log came to rest a safe distance from the Market. A larger rocket pulled free of Belmy's log and steamed toward *Logbearer*.

Booce and his damaged tree would arrive in a blaze of publicity.

He was returning like a beggar.

But of course there was the Wart . . . and the silver suit behind it. He would have liked to lose that. The worst the Admiralty could charge him with was "concealment of vital resources," but that was a heavy charge. Was it worth the risk, to be able to talk to Jeffer the Scientist?

Not that he had a choice.

He was almost home. The Belmy log was ahead of them, eclipsing the Market. The tuftless end looked chewed. Belmy had sold some of his wood.

Woodsman was prominent in the sky, arriving nozzle-foremost. There was no mistaking that elaborate superstructure, four cubes surrounding the water pod, each painted a different color, each bearing the small black B logo. Handholds everywhere, and a steering platform around the nozzle, with a carved rail. The nozzle was mounted a little out from the rest so that replacement water pods could be inserted easily. Hilar Belmy was coming to greet him.

"Almost time," he said, and saw Clave and Debby nod acknowledgment. Booce pushed his coals into the firebox. The fire would need time to catch. "Belmy docked his log behind the Market, of course. We're going to have to dock behind him. Then it gets unpleasant."

Debby asked, "Why not dock just

ahead of the Market?''

''Because that's where the Admiralty docks its ships.''

''Booce, if you're expecting a fight, you'd better tell us now. Also, what weapons—''

''Bloodthirsty woman. No weapons, no fight. It's just . . . I'm coming in behind Hilar Belmy with a fuel pod for my cabin and a log damaged in two places. Checker only knows what Hilar will think. He'll change his mind when he finds out about the Wart, but. . . . That log still has one tuft.''

So?''

''Why on Earth would Hilar Belmy leave one tuft on a log?''

Clave asked, ''Why didn't we?''

''Wind. You can bring a log to its mooring with one tuft on, but it's tricky. It usually means you ran out of honey or bugs . . . hmm?''

''What?''

''Just a passing thought. *Hello, Hilar!*'' His crew stared. They had never heard so cheerful a sound from Booce Serjent.

Woodsman vented steam, decelerating. Two men rode the platform above the nozzle. They were tall: taller than Booce. Their necks were long, like Ryllin's; there was a great-grandmother in common. Black hair, gray hair, otherwise nearly identical.

The black-haired man waved joyfully. Booce couldn't tell Belmy's sons apart, but that must be Raff, and Carlot would be waving back.

Gray hair was Hilar. He looked good: sturdy, prosperous, a few kilos more massive than his son. ''Booce! I thought I'd offer you a tug. How. . . . Did you have some trouble?''

''That we did!'' Booce's shout became less effortful as Belmy's rocket drew closer. ''Hilar, thanks for the offer, but I'll bring her in myself.''

''Stet,'' Hilar Belmy shouted back. *Woodsman* slowed and stopped fifty meters from the trunk. ''Join us after! I want to talk business.''

''Stet.'' Booce dropped his voice. ''Now let's do this *right*. Debby, stand by the water pod. Clave, I'll need you to help me turn the rocket.'' *Logbearer* looked ready. The firebox was dull red; white light glowed through the cracks. The plates had never fit exactly, but they didn't seem to be coming apart. *Logbearer* was tilted nearly parallel to the bark.

Booce entered the cabin. He blew into the flow port (**CHUFF** CHUFF chuff chuffchuff . . .) and emerged panting. ''Clave, not quite yet . . . now.''

They heaved against *Logbearer*'s fuel pod, tilting the rocket in its bark nest to keep it pointed straight toward the Market. Condensing live steam drew a line across the sky. *Woodsman* stood well clear. The log turned as it approached Belmy's log; and the rocket turned in counterposition, and the log's sluggish motion slowed, slowed, stopped.

Booce dove into the cabin. He knocked the plug loose from the flow port and jumped away. Warm water globules followed him out. ''I've spilled the water. Debby, hose down the firebox. We're in place.''

The firebox hissed. Globed in invisible water vapor, the coals went out immediately. The gap between the two logs remained constant.

"And *that* was a nominal docking," Booce said in satisfaction.

Carlot and Rather came around the curve of bark. Booce called to them. "Well done, my crew! I'm crossing to *Woodsman* to see what Hilar wants. Carlot, why don't you show these people the Market?"

Carlot reached him well ahead of Rather. "Speak to you in private?"

They flew clear of the others. Booce asked, "Have you been making decisions?"

She nodded, jerkily. "Raff probably expects to see me."

"Then you decide whether to take him along. Will Rather behave himself?"

She hesitated. "It's not a good idea."

"I'll make your excuses to Raff. Blame everything on me."

Clave and Debby followed Carlot. Rather hung back a little. Flying too close to Carlot would be uncomfortable, now.

They passed close to *Woodsman*. It was Rather's first good look at Raff Belmy. He was dark-haired and tall, three meters or close to it, with long arms, long symmetrical legs, stiff black hair, and a short beard. His neck was like his father's: long and graceful, but the lines of muscle showed strongly. If you liked tall, Raff was a good-looking man. He waved energetically as they flew past, then ducked into a cabin. There must have been hasty conversation in there. When Raff Belmy emerged he did not follow.

"I'd have liked to talk to Jeffer first," Clave said softly.

"Let him wonder," Debby answered. "We'll have plenty to tell him when we get the chance."

They passed the Belmy log, and the Market was huge in their sight.

The wheel was ten to twelve klomters in diameter, and a hundred meters broad. The inner surface was partly covered with . . . houses? They surely weren't proper huts. They glowed with color. Most were cubes and oblongs, but there were other, stranger shapes: a faceted hemisphere, a wooden cylinder, a larger cylinder as transparent as the carm's bow window.

Carlot shouted back at them as they flew. "We learn all about the Market in school. It started out as a beam carved along the entire length of a log, three hundred years ago. The Admiralty ran it through a pond to soak it. Then they used tethers to bend it in a circle. Before that, the Market was only shops tethered together."

This tremendous made thing . . . this was wealth. Rather felt the fear and the awe of any savage approaching a civilized city.

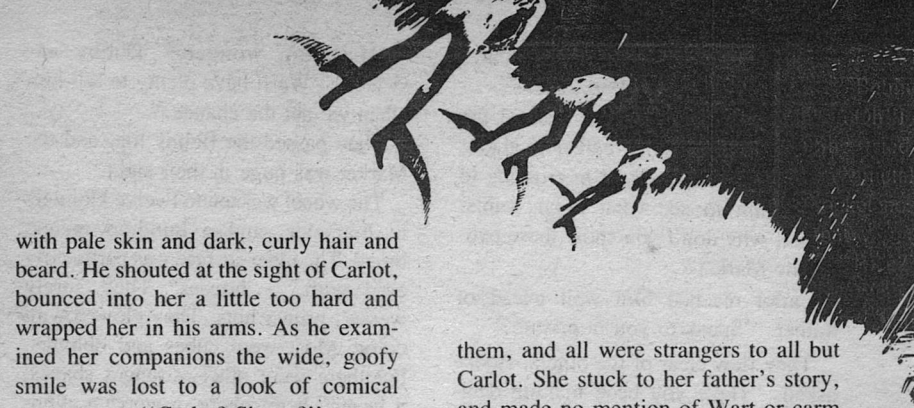
People were flying to meet them.

"The older shops are funny shapes. Balls and geodesics. That glass cylinder is the Vivarium. Vance Limited grows earthlife there." Carlot noticed that all three of her charges were dropping behind. She turned in a half-circle and rejoined them. "Are you all right? Tired?"

Rather answered for the others. "It's a little frightening. Who are those people?"

"Friends. Traders. I'll introduce you. Raym! Crew, this is Raym Wilby—"

He was an older man, a jungle giant



with pale skin and dark, curly hair and beard. He shouted at the sight of Carlot, bounced into her a little too hard and wrapped her in his arms. As he examined her companions the wide, goofy smile was lost to a look of comical amazement. "Carlot? Shorts?"

She rebuked him. "Raym, these are some of the citizens who saved our lives when our tree caught fire. Hey John, hey Nurse!" Others were arriving. Carlot squirmed loose; clasped hands or toes; chattered introductions. John and Nurse Lockheed were brother and sister, and looked it, with angular faces (shaved, in John's case) and white-blond hair. Long-headed Grag Maglicco was in the Navy as a Spacer First. Adjeness Ṣwart was small for a jungle giant. Her hair was black and straight, her nose curved and sharp. She worked in the Vivarium, Carlot said.

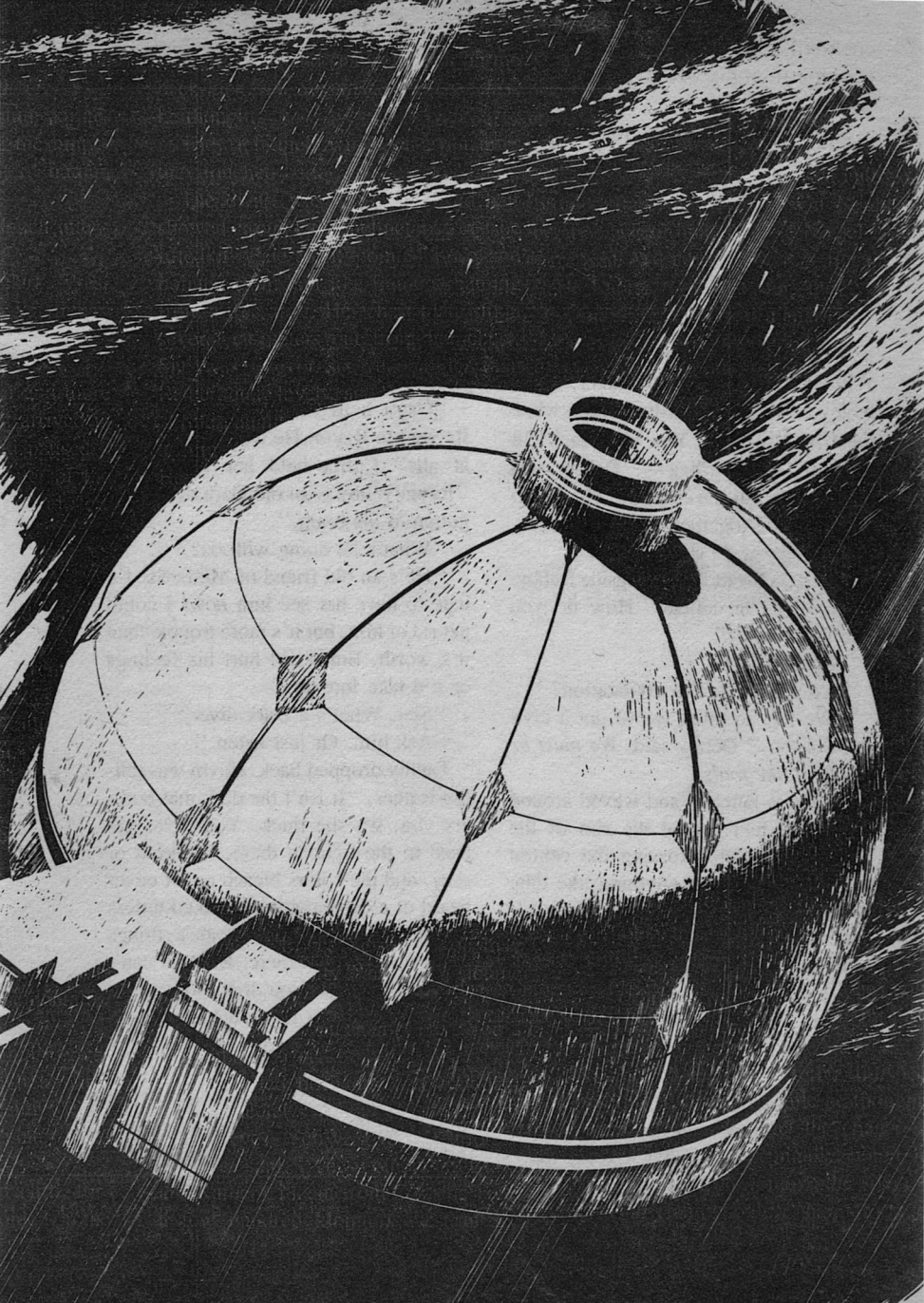
Half a dozen others reached them and Rather started to lose track. Raym would be thirty to forty years old; Grag would be a little younger. The rest were around Carlot's age. Jungle giants all, and expert flyers.

Carlot told her tale as they flew toward the Market. Other strangers joined them and she had to start over. Now there were a dozen jungle giants among them, and all were strangers to all but Carlot. She stuck to her father's story, and made no mention of Wart or carm or silver suit.

The Citizens were uncharacteristically quiet. There was too much to see, and they were surrounded by as many strangers as there were adults in Citizens Tree.

Debby was finally ready to admit that it had been a mistake. She wanted to go home.

She hadn't been with Anthon in hundreds of days. Booce was afraid of his wife, Jeffer seemed to be married to the carm, and Clave . . . the best she



could tell, Clave was vastly enjoying his vacation from his wives. She was in a sexual desert.

She had other reasons for being on edge. The Market covered a quarter of the sky. No bigger than a small tree, it was obtrusively a *made* thing, made by the ancestors of these crew.

They didn't look that powerful. They flew a little closer together than Debby found comfortable. Easy to guess why: they'd been flying all their lives. Raym Wilby was chattering to Rather. "The bugeyes, they get whistling drunk when the fringe blooms. You just reach out and pop 'em in a bag—" Debby tried to follow it, but she couldn't. The Lockheeds stayed together, off to one side. Maybe they were shy?

Adjeness Swart flew alongside Debby. Cheerfully she called, "How do you like the Market?"

"Impressive."

"Your first visit to civilization?"

"We like to think we've got a civilization too," Debby said. *We must be gawking like fools.*

Adjeness laughed and waved around her. They had passed the rim of the Market and were crossing the central gap. "If you've got anything like this, the Admiralty would like to know it." And as Debby was throttling the urge to tell this smug Clump dweller about the carm, Adjeness asked, "How much can you see of the Admiralty from your tree? Why haven't any of you come here before?"

"Some didn't want us to come at all. We didn't know what we'd find. Maybe things we wouldn't like. Excuse me." Debby kicked hard to reach Carlot.

Chattering companions surrounded Carlot. Debby tried to ease inconspicuously among them, just to listen . . . but she hadn't counted on Admiralty manners. The locals drifted away from Debby and Carlot and left them to talk.

Carlot looked at her questioningly. Debby said, "I'm afraid I'll say too much."

"Adjeness?"

"Yeah. It isn't just the questions, it's her treefeeding superior attitude. Carlot, I feel so *small.*"

"Can't help you there, but . . . go fly next to Raym. He won't let you talk at all." Carlot held her voice low. "Raym Wilby is an old Dark diver. It's gotten to his brain."

"What's he doing with us?"

"He's an old friend of Mother's. I'd hate to have her see him now! I could get rid of him, but it's more trouble than it's worth. Either I'd hurt his feelings or it'd take forever."

"Stet. What's a Dark diver?"

"Ask him. Or just listen."

Debby dropped back. Raym was telling Rather, "It isn't the dark that bothers you, it's the thick. Your eyes get used to the light in there. It's kind of gray, and the colors bleach out. I never heard of a diver getting wrecked unless he was a damn fool, because things don't move fast in there. But you can't move fast either. You drift. Sometimes you get lost, you forget which way is out. You come out never knowing how many days you were in."

Rather asked, "Why do you—?"

"Credit. On a bad trip you only come out with mud, but Zakry pays high for mud. A good trip, you can come out with your hull covered with blackbrain

or walnut-cushion or fringe." Raym grinned, and Debby realized what it was that bothered her about Adjeness's toothy smile.

Rather said, "This makes you—"

"No. You never hold onto it."

"—Rich?"

Teeth. Raym was an older man, yet he still had half his teeth. Adjeness must be Debby's age, but her smile was all teeth, with only three or four gaps. The rest were youths: no teeth missing at all.

Angular huts surrounded her. Debby fought vertigo. Down in all directions; no tide. The Admiralty crew were forming a line as Carlot led them toward a huge transparent cylinder. They had flown all their lives. Their grace made Debby feel clumsy.

Debby eased into line behind Rather. The starstuff cylinder had an opening at one end. Debby brushed it with her wings as she went through. None of the others did.

Chapter Fifteen: Half Hand's

From the Citizens Tree cassettes, year 80 SM:

> We've found a fungus with important medicinal properties. . . .

Woodsman's door had been braced hospitably open. A guest need only grip the rounded edge as he flew past, set his wings in the racks, and swing himself in. Booce entered an atmosphere rich with blackbrain tea.

Jonveev Belmy was a small woman, not much more than Clave's height. Booce had watched her auburn hair turn gray over the years, but it was still long and thick. She was busy at a turning cookglobe. She stretched a foot to meet Booce's hand.

Her grip was strong. "Booce, I'm so sorry about Wend. Is Ryllin all right?"

"She's fine, Jonveev. We're doing business with Citizens Tree, and that's where she is now." He wondered what Jonveev was thinking. Her concern was real, of course; but she had never dealt with Booce himself. In business matters Ryllin and Jonveev did the talking.

Jonveev swung the big globular teapot round her head to settle the water, then quickly opened the spigot. Steam puffed. Hilar wrapped the teapot in cloth and passed it to Booce. "I never saw a log come home like that. Do you want to talk about it?"

Booce sipped and swallowed. He liked his tea hot, and this was just off the boil. He savored old memories as much as the powerful, bitter taste. He said, "Not a lot—"

Hilar waved it off. "Oh, then we'll—"

"I have no wish to drive you crazy at this time."

"Tell us a story," Jonveev said.

He told it long. Carelessness and bad luck; the fire; Wend dead, Karilly mute with shock. "There was a tuft tribe waiting to rescue us. They helped rebuild *Logbearer*. We found a tree." Booce hesitated. "We were only half a thousand klomters from the Clump, Hilar, and we might've had to go halfway to Gold to find a better choice. It was big and it was close and we wanted to go home."

"I never saw termites on a tree before."

"A new breed, maybe. They're dying now. They haven't done that much damage, and it's a lot of wood."

"That it is. We have a problem,"

Jonveev said.

The tea had come round again. Booce sipped and passed it on. "I notice you managed to sell some of your wood."

"Some. Then the whole Market saw you coming and the orders dried up. I could have sold at a loss, but Jonveev thought—"

"I thought we might reach an agreement," she said. "The merchants can't whiplash us if one of us announces that his wood isn't for sale."

Booce smiled. Such things had been done, but—"We'd have to give them time to believe we mean it. Thirty sleeps or so. That'll cost one of us."

"We're willing," Jonveev said. "We'll want something in return, of course."

"Speak further."He sipped. The bitter taste of blackbrain fungus was the taste of civilization and hospitality and homecoming. He wished with all his heart that Ryllin was here. If Hilar was tiptoeing round the edges of a risky venture, Ryllin would have known at once.

Jonveev said, "Booce, we'll agree not to sell our tree until the next midyear. What I want is a loan at reasonable interest. Or I'll offer you the same deal."

Booce was silent.

"The loan would be, say, ten-to-fourth chits. Enough to keep one of us going for nearly a year." She affected not to notice Booce's sudden mirthless smile.

"I don't have that much on hand. And you, I suspect, don't need that much—"

"We'd need it if we don't want to short-change some of our other concerns. But we can float such a loan and recoup it by selling our wood. On the other hand, whatever you're doing with . . . what was it, Citizens Tree? It's bound to bring you money, but not soon, stet? But you have a house that's never been lived in."

The tea caught in his throat. Booce swallowed carefully, managed not to sputter. He said, "Ryllin would wring my neck."

"Well, then, you can't do it," Jonveev said instantly.

On second thought. . . . He could put the house up for sale, to buy time. If he set the price high, buyers would hang back and wait, because the Serjents were supposed to be broke. If the Navy bought the Wart metal soon enough . . . he'd have to take a lower price, but he'd be able to keep the house.

But what did the Belmy have in mind? What would a loan do for them? It would be eating interest—"What interest?"

"We'd pay fifteen percent until the next midyear, or take the same."

That was high but not out of line. His first niggling suspicion began to look like the truth. "I'll sleep on it," he said.

Wickerwork ran around the inside of the glass bottle and across the center; wickerwork everywhere, but you had to look twice to see it beneath the plants and mud. The mud was at the interstices, held in place by nets. Plants grew from the mud, bearing red and yellow spheres and cylinders. Leafy vines strangled the wickerwork, the mud, and everything else in sight.

It was a jungle with curving corridors through it. Debby felt a sudden terrible homesickness for Carther States . . . but

the jungle of her childhood was drab compared to the Vivarium.

The old man who watched from within one of the openings was an elderly, undersized jungle giant. In the humid warmth he wore only a loose pair of short pants. His knees and elbows were knobby; his skin was yellow-brown, and there was something funny about his eyes. He watched the growing crowd in some surprise. He said, "Late, Adjeness."

"Zakry, these are customers," Adjeness Swart said firmly. "They've been living without earthlife since Checker knows when."

"*Have* they." The yellow man brightened. "Well, we can't have that. Carlot Serjent, how good to see you! Adjeness, why don't you show the crew what they've been missing?"

Carlot and the yellow man disappeared into the greenery. Adjeness Swart said, "Clave told me that. No earthlife crops. Is it true?"

"Almost," Debby said. "We've got turkeys."

Raym Wilby guffawed. Adjeness was suppressing a laugh. "Turkeys, stet. Try this." She reached into a jungle of vines and plucked forth a red sphere. She sliced it apart with her knife and offered wedges around.

It was juicy. Its taste was strong. Debby chewed and swallowed, trying to decide if she liked it.

Rather plucked a slender yellow spike from the muck. Adjeness intervened. "Not that, Rather. You have to cook that. Try this. Don't eat the skin." The sphere Adjeness sliced up for him was orange outside and in. Rather bit into a wedge, and his eyes got big.

Being back on Earth would be like this, Debby thought. Alien. She recognized almost nothing.

There were people darting among the plants. They glanced incuriously at the intruders, then went back to what they were doing. Some sprayed water at the mud globules or the plants themselves. One was pushing a plant ahead of him; muddy pale apendages waved naked at one end. An older man floated slowly along an aisle, turning as he flew, to see in all directions.

Debby tried a slice of the orange sphere. The sweetness, the wonder of it almost paralyzed her. "Treefodder!"

"That's an orange. This—"

"I can see that." Debby reached at random. "What's this, a yellow?"

"Plum. Not quite ripe."

It was bitter, sour. Adjeness gave her a dark red spheroid from another part of the plant cluster. "This should be better."

It was.

"You wouldn't want to spend all your funds on fruit," Adjeness said. "You'll want legumes too, but they have to be cooked. Let Carlot take you to Half Hand's Steak House before you make any final decisions. Unless you're really rich? Then you can buy everything."

Clave said, "I'm not sure what we can afford. I haven't heard any prices."

Adjeness nodded. "Here. Eat everything but the center, and you can eat that if you want to. Apple."

Rather asked, "Clave, did you eat like this in Quinn Tuft?"

"No. Hey, corn! We had corn before the drought. Here. Strip off the leaves. Now the silk too." He smiled, watching Rather bite into it. "Just the outside,

and it's supposed to be cooked."

"It's okay this way. Leave the white stuff?"

"Stet."

Raym's hand sneaked into a bush as if without Raym's knowledge. Three red objects each the size of his thumb went into his mouth all at once. Debby was nearly sure Adjeness had caught it. She only smiled.

Carlot and the slant-eyed man emerged from a leafy wall. Carlot's voice was just slightly ragged. "Crew, Zakry Bowles is our host here. We'll go look at the prices after we know some of what we want. How are you doing?"

"Carlot, it's wonderful!" Rather burst out. "Oranges, plums, I think we want everything in sight. Zakry, can you eat everything here?"

"Almost. Every plant has something you can eat growing on it some of the time. These potatoes, you can't eat what you see. The root's down there in the mud. You don't eat the inside of an ear of corn—"

"Clave told me."

"Or the pit of a plum."

"Oop."

"What did you do, swallow it? It'll come out all right in the end. Let me show you what else we've got—"

Bean vines grew mixed with the corn. They seemed to want to take over everything. "We stopped growing tobacco long ago," Adjeness said. "Only the officers had fire handy, and they weren't buying enough. This is lettuce." Lettuce was leaves. It wasn't as sweet as foliage. Strawberries were as startlingly good as oranges. Squash looked like jet pods. Zakry was enjoying himself.

They went back to the entrance to examine a list of prices. Clave memorized the numbers he was interested in. "Why so much for strawberries and bananas?"

"Strawberries keep dying. I don't have bananas. Can't grow them here at all. They need tide. The Navy buys them off some tree dwellers east of here, when they get the chance. Clave, you haven't established credit yet—"

"Credit?"

Zakry Bowles spoke slowly, enunciating. "You haven't shown that you can pay. But you can pick out what you want now, then come back later, pay me and collect it."

"What we want is stuff we can grow in a tree."

They discussed that at length. Rather joined in; there were things he would not go home without. Debby eased over to Carlot. "What's got you upset?"

"He won't give me credit. We came in with a pod for our cabin and the Belmy log already in dock. Well, Dave Kon owed me money. I'll go see him. Excuse me."

Zakry was urging something else on them: a greenish-yellow fruit with an obscene shape. He showed Debby how to remove the peel. Clave laughed when Debby bit into it, but it was good. Carlot was talking to the Lockheeds, and they were nodding.

She came back. "I have to talk to Dave Kon. You'd be bored—"

"You're leaving us?"

"Stet. Stay with the Lockheeds. I'll meet you at Half Hand's Steak House."

Half Hand's was across the Market.

They flew through rain. Droplets flew from the edges of their wings. Rather

breathed through his nose; from time to time he snorted out water. Debby and Clave were doing the same. The locals had donned masks of gauzy fabric, except for Raym, who breathed in the rain as if he cared not at all.

Half Hand's was a faceted dome adjoining a smaller, less symmetrical structure. You could see through some of the facets on the big dome: they were starstuff fabric. The rest was gray concrete. One six-sided facet had been cut away, and a wooden door hinged into the opening.

Grag Maglicco, the Navy man, suddenly asked, "Have we all got sticks?" He assessed the blank looks correctly. "Go on in. I'll join you, couple of breaths." He swerved aside, headed for an angular hut twenty meters along the wheel.

The inside was concrete too: concrete troweled over a structure of starstuff, outside and in. The concrete bore paintings of intriguing complexity and a variety of styles, but Rather caught only glimpses of these through a wall of citizens.

Half Hand's was full. Men, women, and children made a hemispherical shell around the newcomers, their toes clinging to two-meter poles protruding from the concrete. There were no foothold poles in the windows, so those stayed clear.

From an open hexagon on the far side drifted smoke and cooking odors. Nurse Lockheed led them that way. She called through the opening. "Half Hand?"

A man came out of the crowd behind her. "Hi, Nurse. You got money?"

"No. Put it on the Serjent's tab. I have a party of eight."

There was nothing wrong with Half Hand's hands. He was a jungle giant, mostly bald, and his arms and legs were corded with muscle. He said, "Serjents? I heard—" Full stop. "Sure, I'll give the Serjents credit. What do you want?"

"Let's see the kitchen."

"Nobody sees the kitchen." Half Hand was peering past Nurse Lockheed. "Shorts?"

"Tree dwellers. They've never seen anything like your kitchen."

"Nobody sees the kitchen."

"I did," Nurse said.

Debby pushed her way forward. "Half Hand? I'm Debby Citizen—"

"Pleasure," he said gravely.

"I wonder if you'd be interested in a description of a kitchen in a tuft."

Half hand studied her; nodded. "Just you. Nurse, the special's moby."

"How old?"

"Eight days ago, a shipful of Dark divers took a moby. Special is moby till we run out. Sausage cost you three times as much. No turkey today."

"We want vegetables, lots, all kinds. Couple of kilgrams of moby too, not too rare."

"Moby's ready now. Vegetables soon. You, Debby, you cooked in that tree?"

"Some."

Half Hand beckoned her in.

Rather could feel the eyes. With a conscious effort he *looked*. Of the forty or so diners, only a dozen or so were watching what was happening at the kitchen entrance. Even those concentrated more on eating: their right hands kept pale wooden sticks in constant motion. The eye-pressure still made him

flinch.

Grag Maglicco rejoined them. He passed out pairs of sticks of pale wood, no bigger than the branchlets a tree dweller was used to.

A woman brought them a two-kilgram slab of meat, black on one side, pink on the other. John Lockheed took it on his knife. He flapped toward the wall, pushing the meat ahead of him. Diners edged aside to give him room or to avoid getting grease on their clothing.

Nurse had to urge them. "Come on."

There were too many people.

But Clave followed Nurse, and Rather followed him.

There was room. Nurse talked to some of the locals around them. John carved chunks from the meat and passed them, knife to sticks. Moby meat was *good*. Tenderer than swordbird, richer than turkey.

Grag's own sticks—every Clump citizen's—were ornately carved. Some were wood, more were bone. Grag caught Rather looking. He showed Rather his own bone sticks. "You carve them yourself. Circle would mean I'm married. Spiral means I'm looking. A bird would say who I work for. Outline around the bird would mean I own the company. What I've got is the rocket, 'cause I'm Navy. You'd want a honey hornet, for Serjent Logging. Change life style, start new sticks."

John Lockheed pointed out a clump of customers to Clave. Tall men and women, a dozen or so, and a few infants; isolated, clustered close as if for protection. Peculiar footgear, thick-heeled sandals with toes protruding. "They're happyfeet. Half Hand should make them check those shoes at the door," John said. "They're for fighting, for kicking."

"Lupoffs?"

"Yes. Why?"

"No reason," Clave said.

Gourds of red liquid passed among the diners. One came within reach, and John took it. He drank, then passed it to Clave. "Fringe tea. Don't take too much."

It went from Clave to Rather. Its taste was bitter and sweet, not unpleasant. John stopped Rather from passing the gourd to Raym. "Too much in his blood already." Raym grinned and nodded.

Debby and Half Hand joined them; they made room. Debby said, "He's got four citizens doing the cooking, all women. There's a major fire against the back wall, held in by sikenwire. The kitchen's got maybe twenty windows in it, and Half Hand closes some of them to get the breeze he wants, keep the fire going and the smoke out. He's roasting a slab of moby the size of two men. It's black on one side and raw on the other, and he slices off the charred side.

"There's also . . ." She waved a hand and a foot as if trying to describe without words. "I thought it was a ball of hard stuff like the Vivarium. Inside, a froth of water and live steam, and cut-up plants."

"It's a bag," Half Hand said. "Keep it turning, the vegetables cook even. Draining the water is the tricky part."

"I saw them do that. They open the bag and throw the whole glob of cookwater at the lee windows and catch the vegetables in a net."

"Ho! Vegetables are ready then." In

fact three jungle giant women were already flying around the dome's curvature, passing out what they carried.

"We use an open pot," Debby told Half Hand. "Tide keeps it in, whatever you're cooking. We cook meat and vegetables together. If you don't keep stirring it it all bubbles out."

"M'shell!" Half Hand waved one long-toed foot in a half circle, and the nearest of the kitchen women came toward them. She served red and yellow and green vegetables into small-mouthed bowls. Half Hand said, "We only serve earthlife plants. A man wants foliage, he gets it at home. Meat's different. We take what we get. Nothing turns up, Sanchiss has a turkey farm Darkward."

The vegetables: some were good and some were not, and some you couldn't decide right away. Clave was making notes as he ate. Food that wasn't eaten went into a wooden barrel. From time to time one of the women replaced the barrel.

Grag Maglicco was asking Debby, "Has Booce been wondering where his house is?"

"He hasn't done anything about it yet."

"Well, we saw Serjent House a few days ago. It was twenty degrees spinward of the Market and maybe fifteen klomters skyward. Doesn't look like anyone's disturbed it. Can you remember to tell him?"

"Stet. Tell me something else?"

"Sure."

Debby waved around her. "I'm surrounded by teeth. How can so many of you keep most of your teeth?"

Grag fished in his tunic and produced a stick like a third eating stick, carved the same way, with a tuft of bristly vegetable matter at the end. "Scrape your teeth after you eat," he said, and grinned at the tree dwellers' dubious looks.

Another gourd of fringe tea came past. Rather was thirsty; but nobody was taking more than a mouthful, and he didn't either. He passed it to Grag, who drank deeply and sent it on.

"Why do they call you Half Hand?" Debby asked.

"My great-square grandfather was Half Hand. Stuff that moved the old carm sprang a leak, froze his hand. Grandfather was Half Hand too. Got bit while he was Dark hunting. Now me. Soon or late, I lose it." The idea didn't seem to bother him. "Raym, sell me some walnut cushion?"

"Not this trip. Next time."

"I need it. Goes good with potatoes. Green beans, too."

"Next time for sure," Raym promised.

Nurse Lockheed laughed and said, "He can't. He doesn't have a ship."

Carlot was shocked. "Raym? You lost your *ship?*"

Raym nodded without looking at her.

Half Hand quietly moved off toward the kitchen. Nurse reached out and lifted Raym's chin. "Tell them the story, Raym!"

It was the last thing Raym Wilby wanted. Some of the locals were looking embarrassed. Clave was quick enough to catch it. "If it's story time, I'll tell you about the breakup of Dalton-Quinn Tree."

Raym's ship was forgotten as Clave

talked.

Rather knew the tale too well. What he noticed was the rise in the noise level. Half Hand's was turning boisterous. Clave's words were just perceptibly slurred, as if he were sleepy; yet he was animated, frenetic, as he relived what had been the end of the world for him and for Rather's ancestors. Rather himself was feeling strange.

Half Hand was back. "Look out the window or go outside," he said. "See something."

"Water," Rather said clearly.

"What?"

"Water, not fringe tea. Does something to my head."

"Oh. Get you water, stet. *M'shell!* I'll fix it. Tree dwellers shouldn't drink too much fringe. Get to a window, boy. Thank me later."

The nearest window was crowded, but Rather managed to get his head into the grouping. He watched three kitchen women carry garbage barrels outside and fling their contents across the sky. Nothing happened for a time. Rather continued to watch. He felt as if he were dreaming. Fringe?

He dreamed that triunes abruptly converged from all directions, splitting into individuals as they came. Rather shouted: not a warning, just an incoherent yell.

The women heard. They looked at him in the window and laughed. Slender blue-and-orange torpedos dove among them. The wind of their passage sent them tumbling. In twenty breaths it was over. The triunes moved away, regathering their families. The garbage had vanished. The women kicked to stop their spinning—and not one had been touched by the predator birds.

All the strangers around Rather were laughing at him.

The only good thing about it (he decided as he returned to his pole) was that nobody else had gone to a window. Grag and Debby seemed mostly interested in each other, but the rest were held spellbound by Clave's storytelling. He spoke of the foray into the Carther States jungle—

He was on the verge of describing the London Tree carm! "Clave?"

"Me, I didn't notice most of this, what with my broken leg. Yeah?"

"Drink some water. This fringe is strong."

John Lockheed said, "Yes, you're not used to it," and passed Clave the water gourd. Clave drank, and drank again. Rather was given a gourd, and he couldn't understand how he had become so thirsty.

Then Carlot was there and it was all right, and Rather was free to go to sleep.

Kendy saw them streaming toward the log like a covey of brightly-colored birds: young men and women stretched like taffy. Wings patterned in primary colors flapped behind, making them seem even longer. Each pattern was different. Birds must find each other in the sky.

The helmet microphone picked up giggling and snatches of talk. Some flew with skewed clumsiness, drunk on alcohol or other recreational chemicals. Kendy ran the record again, but the noise factor was too great; the words wouldn't come clear.

They passed out of the helmet's view and were gone.

Chapter Sixteen: High Finance

From the Citizens Tree cassettes, year 926 State

CHECKER

Officer responsible for the attitudes and emotional well-being of the citizenry, and for their benign relationship to the State.

Booce started tea when he saw them coming. He looked them over as they entered. Nurse Lockheed had the giggles. Her brother was furious.

Booce smiled at them. "Half Hand's?"

"Right. Fringe tea." Carlot wasn't happy.

"It was strange," Debby said. "We ate . . . well, we tried everything. Clave made a list—"

"I hope we can afford it all," Clave said. "Where'll we grow it? We'll have to plant the out tuft and make the lift cables twice as long."

The teapot went among the half dozen Clumpers who had returned with *Logbearer*'s crew. In a dozen breaths it was empty.

"Ryllin was kind enough to lend me some stuff," Booce said. "The teapot, some blackbrain, some cookware. Carlot—" He frowned. She should have brought supplies from the Vivarium and the Market shops.

She handed him a translucent blanketleaf folded lengthwise. There was food within: vegetables, a slab of cold moby meat, and a baked sweet potato. "Half Hand gave us credit."

"That'll be breakfast. Jonveev fed me."

John Lockheed sensed what was happening. "Many thanks, Booce, and we'd best be going."

Raym showed his astonishment. "We just got here!"

"Raym, *now*. Come on, Nurse. Booce, we're sorry about your trouble, but it didn't ruin a good evening. It's good to see you back safe. Carlot—" He stretched his toes to clasp hers. Then the whole covey of Clumpers moved out into the rain, shooing Raym and Nurse ahead of them.

"Now why did they do that?" Clave asked.

"They know we have to talk about money. You don't do that in front of strangers," Booce said. "All right, Carlot."

"Zakry won't give me credit. We'll have to forage the trunk for food. I went to Dave Kon. He still owes for a klomter of wood from our last trip. He wouldn't pay me. He offered full payment if we'd sell him a klomter off the new log at two times ten-square. I turned him down."

"Right. That mutineer thinks we can't afford to hire a judgement! See, Clave, the Admiralty won't convene a civil court unless both sides can prove that they can pay court costs. Loser pays. But the Navy knows we have the Wart! One way or another, we'll get money or credit. Carlot, I think I know what Hilar has in mind. Burl."

Carlot thought it over. The tree dwellers watched with no sign of comprehension. She said, "Risky. Nobody knows how."

"Hilar can afford to take the chance. He brought his tree in with the tuft still on. He asked for a loan and offered decent terms. Usually the tree dies, but sometimes—"

Debby suddenly said, "I remember. The idea is to let a tree grow without tide. The wood's supposed to twist into knots?"

"Right. But trees aren't really built for that. I wonder if Hilar knows something? If he can get money to live on, he can grow his burl while we sell our wood. He'd like to get the money from us, if we had it."

"We should be asking Jeffer about this."

Booce grimaced. Then, "Sorry. Debby, you're tree dwellers, you *should* know a lot about them, but you've never seen a tree growing outside of tide."

"You wouldn't grow burl yourself, stet? Belmy's not a fool or he wouldn't be richer than you, stet?" Booce bridled, but Debby went on. "He knows something you don't, something about burl. Jeffer the Scientist knows a *lot* we don't. Let's ask."

"Burl," Jeffer said musingly, watching the faces in the bow window. Debby was hiding anxiety. Booce had asked his question with some belligerence. This had been her idea, not his. *Are you any good at all? Prove yourself, Scientist!*

Blue lines of print scrolled across the faces.

Integral trees grow well in a wide range of tides. Low atmospheric pressure kills them faster than low or high tide. In dense air and very low tide they might survive. In free fall they die. Otherwise we would find trees growing naturally in the Clump.

Booce was talking. "Hilar thinks he's got me by the seeds. He offered me a loan if I withdraw my tree from sale, but he's not serious. It'd break me. I'd be paying interest, and no way to get it back. Of course he doesn't know about the Wart metal."

"Do you really need to know if he can grow burl? Booce, you're satisfied that he's *trying* it. You only need a short-term loan till you can sell your metal. The Belmys aren't your enemies, are they?"

"No, they're friends. Who would I talk to if I couldn't talk to other loggers? But Hilar would *love* to have me carving the dumbo on my sticks, and all the loggers want to be richer than, say, the architects. Jonveev won't loan me money unless she thinks I can pay it back. Or if I've got some kind of collateral . . . hell."

A tree should continue to grow if there is sufficient tide to pull water and nutriment into the treemouth and to work the internal veins within the trunk. Spin the log, Jeffer.

"Tell them about the Wart," Carlot was saying.

"I didn't want to. I guess . . . I've got to. It'd be better if I knew *exactly* what Hilar's planning."

"He'll spin the log," Jeffer said.

"What? What for?"

"Spin tide, Clave. It's a scientific thing. Here, pick up that pot or whatever and throw it round and round your head. Arm's length . . . like that, stet. Feel the pull? Like tide, isn't it? Belmy'll use his steam rocket to start the log spinning, not enough to tear it apart, just enough to keep some pull inside the tuft. The tree needs tide to move its food around—"

"By the State, I believe you're right."

"But the, uh, growth patterns would still be screwed up, with Voy going round and round and weird Clump tides going every which way. I've never seen burl, but isn't that what you want, Booce? Grain that doesn't grow in straight lines? He'll spin it just enough to keep water and fertilizer in the tree-mouth."

"Yes. Okay."

Losing contact.

Hilar and Jonveev waited, wearing polite smiles, until Booce had finished talking. "Burl," Hilar said. "It sounds interesting but risky."

"Hardly cost-effective," Jonveev said.

Booce said, "There are other values. It would be indecently lucrative if it worked. You'd have done something nobody else could." They did not comment, and he went on. "Let's assume, just for talking purposes, that you've been considering a burl tree. Who else would you let in on the secret?"

The Belmys looked at each other.

"You'd need masses of tree food. Mud, say, from deep in the Dark. Would you buy it from Zakry? Or haul it yourselves, with *Woodsman*?"

Jonveev sighed. "All right, Booce. What have you got in mind?"

"*Logbearer* could haul the mud to feed the tree. The whole Market knows that my last trip failed. They won't be surprised when *Logbearer* becomes a Dark diver. Let them think I'm looking for fringe and blackbrain while I haul mud for Zakry."

"Mmm," said Jonveev.

"One more thing. I've got eight kiltons of metal buried under the termites."

Their faces were quite blank. After a moment Jonveev said, "That's not portable money. You still can't offer us a loan, not until you sell it."

"An excellent point. Hilar, Jonveev, what I want is this. First, you do your damndest to turn that half-tree into burl. Second, I need a loan—"

Hilar was laughing.

"A short-term loan to let me spend money like an old Dark-diver while I wait for the Navy to buy my metal. I'll pay twenty percent to the crossyear, and I need ten-to-third chits. I'll pay part of it back in mud at the same price Zakry pays. The rest at the crossyear, and I'll hand you another five times ten-to-third. That'll save any project you had to short-change. It's not a loan, though. It buys me half the burl."

"*Half!*" Jonveev exclaimed.

"So."

Caught! Jonveev Belmy laughed and said, "We hadn't thought of spinning the tree. But can you really afford to risk that many chits? You're moderately rich now. Why not stay that way?"

"I like the odds. I've got some crew who think it might work, and they're tree dwellers. I think *you* think it'll work, and that helps."

"Two-fifths of any burl, and we want five times ten to the third chits. We'll get you your loan, but at forty percent to the crossyear. Mmm . . . I'll hand you our cash on hand and give you the rest in ten days."

Booce said, "I'll pay thirty percent to . . . to ten sleeps past the crossyear. The Navy might just hold me up for that long. And classify this. If the Navy knows I took a loan, they'll know I'm

still under pressure. I want them to *move*."

Hilar laughed. "Where else could it have come from?"

"I'll visit the house before I start throwing money around. They'll think I had it in the house."

And all of this was reported in garbled form, through Clave and then Jeffer, who had never dealt with finance, to Kendy, who never had either. But Kendy had sketchy records of the capitalistic societies that had died with the formation of the State, hundreds of years ago.

It was a hell of a way to run a civilization. These people *needed* him.

Jeffer, seated before the CARM camera, asked, "Do you understand any of this?"

"Yes, but it would be difficult to explain. What matters is that your citizens will have their earthlife seeds."

"Yeah." Jeffer stretched unselfconsciously. "That's good. We'll have to talk fast when we get back to Citizens Tree. The seeds'll help, and we'll carry fresh food too, something they can eat right then. Are you getting what you wanted?"

What Kendy wanted was still beyond his reach. He said, "I've learned some things."

"Tell me."

"The Admiralty is self-sufficient. They're a successful culture, but the crime rate must be high. Otherwise they would need fewer Navy ships, and the houses would have more openings." Kendy displayed the picture the pressure suit camera was sending from the Clump. Small green outlines flickered as Kendy pointed out ships, then the few but massive doors on nearby houses. "They've settled the outer shell of the Clump, but they only venture gingerly into the dark center. Their infant mortality rate must be as bad as yours. When they add up their population they don't count children, any more than you do."

"I never noticed that. Hmm . . . London Tree didn't either. Is it because so many children die?"

"Yes. Wait a thousand years and the death rate will have diminished. There's nothing else to be done."

"I never thought there was. While I've got your attention, Kendy, I found a listing on the Clump. Lagrange Points, it's called. What do these words mean? Equipotential, saprophyte—Something's happening."

A steam rocket emerged from the fog and rain. It came to a halt fifty meters from the helmet camera. "Navy," Jeffer said unnecessarily. "I wonder . . . that's Booce. And a silver suit!"

"I see them. An equipotential is the curve on which some force or energy level is everywhere equal. It might be gravity or tidal force or magnetic force. A saprophyte is a family of plants that doesn't use light. We'll see some if Clave can take the helmet into the Dark."

Four men flew toward the camera: two in Navy armor, one standard-issue pressure suit, and Booce Serjent. The pressure suit was better kept, cleaner and shinier, than the Citizens Tree suit. There were big Navy-style fins at the ankles. The design painted on the back was repeated on one shoulder and on

the fins: a broad green ring with a blue dot at the center.

Kendy tried to make contact with the suit radio. He found nothing. Either it wasn't on, or the frequency had wandered over the centuries.

The helmet was thrown back on its hinge despite the rain. The face inside was a rounded anglo face, without the soft elfin look of most Smoke Ring citizens: a "dwarf" face, shaved, sprouting an Earth day's worth of dark shadow.

The "dwarf" looked around him. "This was clever, Booce. Do you have torches?"

"I'm sorry, Captain-Guardian. We can make some up."

"No need. How do I get through this muck?" The dwarf had no accent.

Kendy gloated. No accent! He spoke exactly as a State citizen would have. The officers must learn their speech from the Admiralty Library!

They were drifting out of view. Kendy switched to the fish-eye lens. He and Jeffer watched the Captain-Guardian take his wings off and tether them to lines on his chest, shin-sticks uppermost. The two lower-rank Navy men pulled up an edge of the termite nest. The "dwarf" squirmed in. Sudden yellow light flashed through the hole.

Jeffer asked, "Does that light come from the pressure suit?"

"I'll show you how to work the helmet light. Later."

The "dwarf" popped out of the hole. "There's a respectable store of metal here. We'll have to wait for the Council to convene before we make an offer per kilton delivered. Unless you're prepared to accept an immediate offer of, say, two times ten-to-fifth chits for the whole chunk?"

"I can get two or three times that on the Market."

"Perhaps. If we come to an agreement I can give you payment within ten days."

"No, thank you, Captain-Guardian. I'll wait. Maybe I can earn some money Dark diving. Can I offer you tea?"

"You wouldn't want to have to sell your new house. Two and a half."

"No. I should point out that you've been seen coming here. There's a happyfeet jungle in dock, and they might guess what that means. Also I'll be expected to hire an exterminator. I can't hide the metal much longer."

Mickl snorted and waved to his escort. They departed.

Booce waited until they were well away. Then he moved face-on to the camera. "Jeffer?"

"Here."

"That was Captain-Guardian Wayne Mickl. Officer by birth, but his effective rank is Guardian. Keeping him happy is a good idea."

"He didn't look happy."

"If he's too happy, we got robbed. Jeffer, how sure are you that spinning a tree will make burl?"

Jeffer laughed. "I never tried it myself."

"Yeah. Are you all right?"

"It isn't too bad. Something like being young again, just old enough to hunt alone. I've got the cassettes when I get bored. I miss Lawri."

"Well, I'm going to move the silver suit. We can't leave it here."

"Where, then?"

"My house. I'll set it up so you can see the commons room. We can talk any

time, and when I have guests you'll see them too."

"That's good," said Jeffer.

Very good. Losing contact.

Chapter Seventeen: Serjent House

From the Citizens Tree cassettes, year 6 SM:

Sharon Levoy speaks of the archetypal rebellious computer, HAL 9000, from Gillespie's opera *2001*. Carol Burnes claims *Frankenstein* and *Faust* to be older and more appropriate images. One-upmanship is alive and well in the Smoke Ring. One and all, they expect me to tell them *how* it happened.

For the record: I don't know what's wrong with Kendy.

—Capability Jasper Gray
Cyberneticist, *Discipline*

Debby was in a hurry the next morning. It seemed she'd arranged something at Half Hand's: she was to meet Grag Maglicco for flying lessons. Booce drilled her to make sure she shouldn't get lost in the sky, then sent her on her way.

The rest shared out the meal from Half Hand's for their breakfast, then got to work. They fueled and fired *Logbearer* and set it steaming along the trunk. A half-turn brought the rocket to a halt opposite the Wart.

Clave, Carlot, and Rather swarmed out and attacked the termite nest with machets. When *Logbearer* blocked the Market, and floating chaff and chips of bark and wood blocked most of the sky, Clave and Rather ducked into the nest. Clave retrieved the body of the silver suit, Rather the helmet. Booce had kept the rocket hot. He jetted water into it, and away they went.

Secrets. Rather was starting to get the knack of it.

Half the termite nest had been scraped away, not by a hired team but by amateurs. What would the Market think? *Booce must be hurting for money. His crew has exposed damage to the log: a gaping, ugly hole behind the termite nest. They've quit in disgust.* Unlikely that anyone else would pry into that bug-infested darkness.

The house had drifted about the sky since its completion a year and a half since. Debby had relayed Grag's message: it was fifteen klomters skyward and some degrees to spin from the Market. The house was closer than it had been when Grag spotted it, but it was still a three day trip.

The house was five cubes arrayed around a concrete core. A small puff jungle grew on the roof. The main door was a huge slab of wood five meters long by four wide, half a meter thick. Booce set massive triangular braces to lock it vertical to the doorway. Mountings covered the inner surface: tethers for wings and cloaks, and coils of line, and big knobs to serve as moorings for winches and pulleys.

They tethered *Logbearer* to the door. In its shadow they moved the silver suit and helmet inside.

Secrets. What had been seen? *Logbearer flies to Serjent House. The crew stays for some hours while Booce inspects his new home and shows it off to visitors. Presently Booce will be spending money.*

Navy: Booce has retrieved funds from

some hiding place. He can outwait the Navy to sell his metal.

Belmy House: *Booce came as misdirection.*

The Market: *Any hiding place in Booce's house must be empty now.*

"Where do we put it?" Rather held the helmet like a severed head.

"Look around," Booce said. "Something will occur to you."

The citizens smiled at each other. They began to tour the house.

Doorways led from one section to another through the star-shaped concrete core. There were only two ways to move. Rather had to squeeze past Clave circling the other way.

The house was roomy: as big as a Citizens Tree hut, though much harder to build. The public room was lined with handholds and with hooks for outer garments and weapons, and a rack for a teapot.

The outer wall of the kitchen had long slots in it for ventilation, a concrete fireplace with a bellows attached, and racks for wood and cookware. Rather found Carlot making tea. He asked, "You already know?"

She nodded brightly.

The sleeproom: tethers and some wiry foliage padding four of the walls.

What was this next room? Curtains fixed across both interior doors, handholds and tethers mounted next to small windows with hatches over them . . .

Ah. This was the treemouth. And the fifth was a storage room, with another oversized door and moorings for tethers, but nothing stored yet.

Rather returned to the public room.

Debby was moving slowly around the perimeter. She seemed more cheerful than she had been lately. "Hi, Rather. Grag brought me back. I gather we're looking for some secret hiding place. Any luck?"

"Not yet. Booce, how do you get rid of the treefodder after you feed the tree?"

Booce stared. "*What?*—Oh. The wind floats it away and fisher-jungles gather it in. Now you know why everyone doesn't just tether his house to the Market. Find anything?"

"I didn't see any hiding places. I've never seen a house before."

"You were all somewhere else, so I searched here," Debby said. "Nothing. Booce, are there holes in the concrete?"

Booce laughed. "I could have done that. Access through the walls? Well, any burglar could tear the core apart and all he'd find is concrete and two chunks of sporing fringe buried along the hub. Meanwhile, what do you think of my door?"

"Thick. Like you're afraid someone might kick his way through."

"We tend to make them massive. Not just for burglars. It has to stand up to rough treatment when you're moving heavy stuff."

Clave shook his head in disgust. "We'd know who our thief is. We'd kick him into the sky. Booce, your trouble is, you've got too many people in the Clump."

Booce was taken aback. "I never thought of it that way. Anyway, let me show you what I did—"

When the door was fully open, one could slide aside a panel in the edge that faced the hinges. The half-meter thickness of the wood had been hollowed out. The silver suit went in easily. The

helmet was barely small enough.

"Now we need a hole," Booce said.

"Kendy for the State. Jeffer, would you rather sleep?"

"Mpf? No. Hello, Kendy." Jeffer stretched. "If I didn't want you waking me up I'd sleep outside." He looked at the view in the bow window. "Oho!"

It was dark, but Jeffer could make out Clave's anxious face. His voice sounded faint, distant. "Jeffer?" Talk to me, Jeffer."

"Prikazyvat relay to pressure suit. Scientist here."

"What do you see?"

"You. And a ragged border. What did you do?"

"You're looking through a hole in a door. Booce ripped a hook out. From here it looks like he just put too much tension on it."

"Good enough. I take it we can talk. Rather, you there?"

Rather floated into view, smiled and waved. Others joined, until five citizens floated in a star with their heads inward.

Booce said, "I've made a deal with the Belmys. Jeffer, would you like to learn something about the Dark?"

"You mean the Clump interior? Sure."

"That's good, because I've agreed to bring back some mud for Belmy's burl tree."

"You're going? All of you? *Logbearer?*"

"Ah . . . no. I think I'd better stay here. I've been weaving financial threads into one very complicated net. Carlot, you can handle *Logbearer* alone, stet? And I gather Raym Wilby is at liberty. He can guide you." Carlot was nodding eagerly. "Oh, and Hilar hadn't thought of spinning the burl log, but he's going to try it."

"Sounds good. Carlot, will you take the helmet so I can see these marvels?"

Carlot looked to her father, who said, "Why not?"

"Good. Rather, tell me about the Navy. Take your time."

Rather talked. Kendy guessed that the boy wasn't hiding anything, but he kept jumping back and forth. Kendy printed questions across the bow window; Jeffer solicited descriptions of Petty Wheeler, Bosun Murphy, Navy armor, the Navy ship, Murphy's description of Navy life, Wheeler's offer . . .

"Is this standard, Booce? Anyone can join the Navy?"

"Not just anyone. They wouldn't have Carlot because of her legs. Otherwise . . . well, any savage could join, but he might not get beyond Spacer First until they've watched him for years. The Navy wants loyalty. They take more men than women, and they won't take you if you're too old to be trained."

"Loyalty?"

"If you're loyal to your tribe, you're not loyal to the Navy. Navy above all, even family."

"The question is, if Rather goes in, can he get out? Booce?"

Booce mulled it. "Up to a point. It would be . . . convenient if Rather let Petty Wheeler make his pitch. Rather, the Navy could put certains kinds of pressure on me until I talk you into doing that. They want the Wart, but they can slow things down for me, and we don't want the Navy taking a *hard* look at us."

"No," Clave said.

"But when Wheeler interviews you, he might learn that you're simply not suited to Navy life. I can help you to help him reach that conclusion."

Carlot said, "He could get out later than that. Rather, my cousin Grag says they treat you like a copsik in Basic, but after that you're supposed to think you're better than the citizens. They do think they're better than us, and they don't take just anyone. When you're ready to leave, just do something wrong. Or get sick and stay sick. Tree dwellers do get sick in the Clump. They'll bounce you out."

"You think I should do this?"

She shrugged unhappily. "Whatever you want."

Jeffer said, "I'd really like to get him into the Library."

Booce shook his head. "No dwarf gets beyond Guardian unless he was born an officer, and even then . . . well, Wayne Mickl is officer and dwarf. They need him as a Guardian, so he'll never *use* his higher rank. Guardian is the lowest rank that can reach the Library, but they can't use it because they aren't taught to read. And you wouldn't be a Guardian for years, Rather."

Jeffer jumped on it. "But he *could* reach the Library. And Rather *can* read, and I can teach him how to use a carm keyboard!"

Rather was feeling trapped. He knew how to talk to Jeffer the Scientist, but how could you argue with a door?

"I hate to pass up the chance," Clave said. "Rather, you're reluctant. How do the rest of you feel? Debby?"

"It feels like we're selling him as a copsik. I'm against it."

Thank you, Debby!

Clave stared at her. Then, "Rather, does it feel like that? I wouldn't *do* that. We're just talking now—"

"They want his loyalty, stet, Booce? They've been doing this for almost four hundred years," Debby said. "Maybe they can *get* his loyalty—"

Clave snapped, "Treefodder, Debby. London Tree was keeping copsiks for about that long. When the chance came to bust loose, they did it!"

"Not all of them, Clave!"

". . . Uh huh. Booce?"

Booce said, "We're talking about power, Navy power, and it cuts two ways. If Rather was Navy, the Serjents would see a certain friendliness emerge. I'd love to put a son in the Navy."

"Carlot?"

She spoke to Rather, not Clave. "If you can stand it. Remember what I said about Basic. They worked Grag's tail off . . . hey. You're stronger than Grag. You lived in a tree. You just might give them a shock."

"We know you can fit a silver suit," Booce added. "Even Bosun Murphy doesn't know that."

"I'm scared."

Clave just nodded, but Jeffer snarled like static. "Oh, Rather! We're *here* already! Back in Citizens Tree, that was the time to be scared." Pause. "What are you scared of?"

"It's all too strange." Rather was suddenly, unbearably homesick. This wooden house, all angles—

"It'll keep being strange. Nobody fooled you on that."

"Scientist, I came here *looking* for strange. I wouldn't *be* here if it was

going to be just like Citizens Tree—''

''Then—''

But Rather had the words straight in his mind now. ''I followed you here, but the idea was to face the Admiralty in the company of my friends and my elders! And my father. Are we all going to join the Navy now? Is that what we're talking about?''

Clave said, ''Jeffer?''

The door said, ''I'm for it, of course, but the boy's got a point. It's his risk, not ours.''

Rather wasn't finished. ''You're asking me to swear to something that isn't true. I am *not* loyal to the Navy. If you thought I was, you wouldn't like it.''

Nobody wanted to answer.

''You can feed your secrets to the tree. I will not join the Navy. But I can go talk to Wheeler, if you think it'll help. I'll do that.''

''I go with him,'' Debby said firmly.

''And Booce, you tell me how to look unsuitable.'' A black depression was settling over him. He felt rejected by all of his companions save Debby; but Carlot wanted him out of the way. For Raff Belmy.

Chapter Eighteen: Headquarters

From the Citizens Tree cassettes, year 384 day 2050

Jeffer the Scientist speaking. Candidates are considered unsuitable for the Navy if they are sickly, or undependable, or easily lost or distracted, or loyal to some entity other than the Navy. They may have unacceptable motives for joining. If a family member accompanies, candidate may be reluctant or may need supervision.

Acceptable candidates would presumably have opposite traits. Data are as acquired from Booce and Carlot Serjent.

Headquarters was a pillbox: a short, wide cylinder, blurred to Rather's weeping eyes. The rim was dark wood. The nearer flat face was concrete covered with a variety of doors, platforms, winches, coils of line . . . and a broad strip of glittering stuff very like the hull of the carm. Two rockets were moored near the hub. A third, larger, was being winched in nozzle-foremost.

Debby looked back. Rather was far behind. When she stopped flapping, a gust of wind caught her wings and turned her on a random axis. She sighed and flapped back to rejoin him. ''I wish I could help,'' she said.

Rather made himself laugh. ''I did it to myself. Debby, you fly better than me.''

''I watched the crew when we went to Market. Keep up a steady kick. Don't try too hard, If you kick with all your might the wings just bend and don't take you anywhere.''

''What I need is longer legs.''

''Longer *wings* might do it. Try the Navy wings, too. Now, what door did Carlot say?''

''I can't tell. Pick one.''

''No, I—''

''Debby, *pick one at random*. I don't *mind* if Wheeler thinks I got lost.''

''Oh. The one in the middle, with the guards. We'll ask them.''

It was big and round and rimmed in

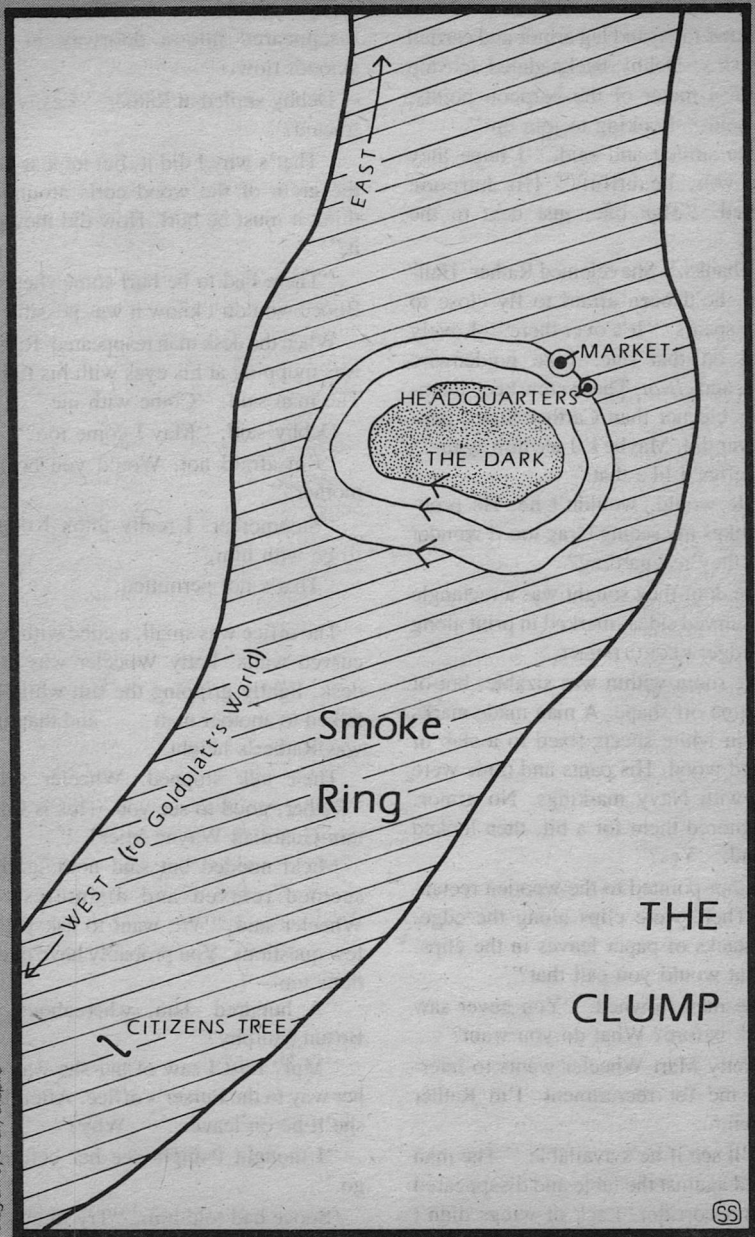


Diagram by Shelly Shapiro

scarlet paint. The four guards wore helmets and torso and leg armor and carried harpoons. Debby backpedaled to stop within a meter of the harpoon points. She said, "Looking to join up."

One smiled and said, "I hope they take you, beautiful." His harpoon pointed. "That one, just next to the rim."

"Thanks." She rejoined Rather. Half-blind, he'd been afraid to fly close to sharp spears. "It's over there.—Lovely beard on that one. Like goldenwire plant, and *clean*. These crew keep themselves cleaner than Carther States people ever did. Maybe I'll see him again."

"Jeffer'd like that."

"He would, wouldn't he. He probably likes my seeing Grag too. I wonder what they're guarding?"

The door they sought was a rectangle with curved sides, marked in print along one edge: RECRUITMENT.

The room within was sizable, but of the same off shape. A man made marks on thin white sheets fixed to a slab of sanded wood. His pants and tunic were blue with Navy markings. No armor. He ignored them for a bit, then looked around. "Yes?"

Rather pointed to the wooden rectangle. There were clips along the edge, and stacks of paper leaves in the clips. "What would you call that?"

The man frowned. "You never saw a desk before? What do you want?"

"Petty Mart Wheeler wants to interview me for recruitment. I'm Rather Citizen."

"I'll see if he's available." The man kicked against the table and disappeared down a corridor. Lack of wings didn't hamper him: he touched the wall and disappeared into a doorway in one smooth flow.

Debby smiled at Rather. "Easily distracted?"

"That's why I did it, but look at how the grain of the wood curls around! I think it must be burl. How did they get it?"

"There had to be burl somewhere or Booce wouldn't know it was possible."

When the desk man reappeared, Rather was mopping at his eyes with his tunic. The man said, "Come with me."

Debby said, "May I come too?"

"I'm afraid not. Would you be his mother?"

"Stepmother. I really think I ought to be with him."

"That's not permitted."

The office was small, a cube with two curved walls. Petty Wheeler was at a desk, lightly gripping the rim while he talked to another man . . . and that one was Rather's height.

Their talk stopped. Wheeler said, "Rather, good to see you. This is Captain-Guardian Wayne Mickl."

Mickl nodded but said nothing. He seemed relaxed and disinterested. Wheeler said, "We want to ask you a few questions. You probably have questions too—"

"A hundred. Um, whereabouts is Bosun Murphy?"

"Mpf? Last I saw of her she was on her way to the Purser's office. After that she'll be on leave. . . . Why?"

"I thought I might see her before I go."

(Booce had told him, "Try to talk to

Bosun Murphy. Your interest in the Navy comes straight from your seeds. If you see her, make a pass."

("What's a pass? Do you mean propose marriage?"

("No . . . yes. That's got just the right touch. All seeds and no judgment.")

Wheeler asked, "Rather, is there something wrong with your eyes?"

"Lack of sleep. Dry air." His eyes were clearing up now, but they still hurt. To Wheeler they must appear pink and weeping. He was sniffling too.

Wheeler took writing implement in hand. "Where were you born?"

"Citizens Tree, year 370. It's a tree sixty klomters long, six or seven hundred klomters west of the Clump."

"What's your height and mass?"

"One point nine meters. I don't know my mass."

"We'll weigh you on the centrifuge. How did you know the year?"

"The Scientist keeps track. Was I off? This is 384, isn't it?"

"That's right. Put your arms straight forward, fingertips touching. Now your legs, big toes touching." Wheeler made a note. "Symmetrical. How much do you know about the Admiralty?"

"Not much. We tasted some of the food you grow, and had a wild dinner at Half Hand's Steak House." Wheeler laughed at that. Rather went on, "The Serjents told us a lot. I've seen houses and the Market. The ride on the steam rocket was—well, I've never been through anything like it."

"Scary?"

"No, not that." He knew instantly that he should have said *yes*.

"Why do you want to join the Navy?"

"I came to find out if that was true, Petty. And you asked if I had questions."

Petty Wheeler stiffened a little. "Well?"

"I've seen the ships. They're all over the sky. I think I ought to ask, if I become a Navy man, will I in fact be riding one of those ships?"

"More than one, I expect. Over the years you'll fly every style."

"Will I be flying them, or just riding them?"

"You've given this a lot of thought."

"Yes sir. Once I thought I'd be a hunter for Citizens Tree." No need to mention the silver suit. "When I joined Booce and went logging, that was a big jump. I didn't know what I'd find here. The Market, it's frightening to think such a thing could be *built*. So many people!"

Wheeler was smiling, nodding. (In the corner of Rather's eyes, Wayne Mickl was clinging to a wall tether, merely observing.) "Daunting, is it?"

Rather nodded.

"The ships, the Market, Headquarters, we built them all. And more. We built a civilization," Wheeler said gently. "Now that you've seen it, how can you not be a part of it? Yes, you'll fly a ship before you're much older."

"I want to know whether I'll be able to visit Citizens Tree."

"Mph. The answer's yes, but I don't know how often. We'll want to contact Citizens Tree at once. Set up some form of trade. There'll be visits, and you'll be useful as an intermediate."

It was the right answer, Rather thought,

except for two things. The tree was in the wrong place; and if the Navy did find it, the citizens would have to hide the carm every time the Navy came visiting.

So Rather only said, "That's good. I'd hate to be cut off from my family." (Booce had said, "They want your loyalty. They won't like it if you're loyal to your family, your tribe, *me*—")

"How often do you get these allergy attacks?"

"Usually just when the air's too thin. I had them while we were moving the log; we were too far in. It's like knives in my eyes. I haven't been getting enough sleep lately. It happens then too."

"Would you describe yourself as sickly?"

Rather told himself that nobody would come to a recruitment office if he considered himself sickly, and said, "No. It's just something that happens. A day later I'm fine. It's almost over now."

"I see. All right, Rather. Go ask Able Jacks to put you on the centrifuge. We'll get in touch with you through Booce Serjent."

Debby and the desk man were ignoring each other. Debby seemed nervous.

"Rather! How'd it go?"

"Fine. Are you Able Jacks?"

"That's right."

"You're to take me to the centrifuge. What's a centrifuge?"

"I'll show you."

The wicker structure resembled the treadmill that ran the elevator in Citizens Tree. It was wider: twenty meters across. Rather was instructed to cling to the rim and wait. Two ratings spun it up, timing it with a hand-held device. The wheel rolled eccentrically with his mass to throw it off. A rating measured the divergence of the hub. "Your mass is eighty-one kilgrams," he said.

They locked the centrifuge in place and made him run.

Pushing himself round the rim gave him the sensation of tide. They had him run as fast as he could. It made him dizzy; the tide became fiercely strong. Then they made him slow down and run at a measured rate, until his legs burned and his eyes blurred. He would have stopped then if he had not noticed Bosun Murphy watching him.

He waved. The motion almost sent him tumbling. She didn't respond. But she watched, and he ran.

. . . It came to him that he was *rolling* around the centrifuge. He'd blacked out.

A rating snatched at his ankle and pulled him out. "Take a rest. Here." He handed Rather a towel, and Rather, gasping for air, mopped a sheath of water from his body.

Murphy said, "That was quite a performance. I could win bets on you."

"I grew up in a tree."

"I know."

There was no animation in her voice, her face, her body language. *Navy think they're superior,* Carlot had said; but that wasn't it. "Bosun, are you all right?"

"I'm a little down," she said. "Call me Sectry, Rather. I'm not on duty."

"Does *down* mean something like *miserable?*"

"Yeah. Guys, are you finished with

him?''

''He's all yours, Bosun. No need to be careful, he ain't fragile.''

Sectry Murphy flashed them a fleeting smile. To Rather she said, ''I can't picture the Petty rejecting you after he hears about that performance.''

Treefodder. Booce hadn't thought to tell him to hold back on a stamina test. ''What's got you down?''

''Not here, stet? I need someone to talk to, not Navy. I just came from the Purser's and I'm ready to tie one on. Want to join me?''

''I'm with Debby. My stepmother.''

''Stet. Let's go get her. How does Half Hand's sound?''

Rather was coming down the corridor. There was a woman with him.

Once upon a time Debby had seen Rather and Mark talking in the Citizens Tree commons. Both dwarves, but they hadn't looked at all alike: Mark's face nearly square, Rather's nearly triangular . . . She remembered it now, because Rather and the dwarf woman looked *right* together, though they were clearly from different branches of humankind.

And both, in different fashions, looked worn out. Debby asked, ''What happened to you?''

Rather said, ''Centrifuge. They ran me to death. I could have lifted an elevator all the way to *Discipline*. Debby, you remember Sectry Murphy—''

Clasping toes felt odd: Sectry's reach was so short, her toes so stubby and *strong*. ''Hello, Sectry. I take it you're off duty.''

''Right. On our way to Half Hand's. Join us?''

''Sure.''

Sectry led them in. ''The place is nearly empty,'' she said.

It wasn't. There were a good dozen people scattered around Half Hand's. But windows were clear, and Sectry led them to one. ''It's nice to have a view,'' she said over her shoulder.

Rather flinched. Debby grinned; she'd seen Rather watching Sectry's kicking legs.

''Grab a pole, someone will come. You hungry?'' When one of the women from the kitchen appeared, Sectry said, ''Fringe tea and sausages for three, Belind. You two should try the sausage.''

''Stet,'' Rather said. ''What's got you down?''

The false gaiety ran out of her, and Debby saw pain. ''I've been trying on pressure suits. I don't fit.''

Debby said nothing. Rather said nothing.

''They don't let you try the suit till you qualify for Guardian in all other respects. So they got me into the small one and I couldn't breathe.'' Murphy wasn't wearing armor now. Her breasts stretched her tunic tight. Debby had never had trouble feeding her children, but her own breasts didn't have that *vulnerable* look. ''I could have faked it, but the suits aren't all quite the same size. So I tried the bigger suit. My feet wouldn't reach the toes. There are controls in the boots. My fingers don't quite reach either.''

''That leaves one,'' Debby said.

''The large? It's in use. It won't fit. If my damn toes were longer! I'm out.

I can't be a Guardian."

Belind was back.

Sausage was a tube seared around the outside, delicious inside: ground meat with bits of plants added. Fringe tea Debby knew from last night. She still had a trace of the morning headache.

The situation felt uncomfortable, and Debby was rehearsing excuses to leave. She asked, "Are you going to stay in the Navy?"

"I think so. I'll never get further than Bosun, though."

"You'll be flying. More exciting than guarding the Library."

"As a Guardian I could spend some time making a home! Get married, carry some guests!"

"Don't they mind Navy people making babies?"

"You go to half pay when you're showing, but you've got a mate working . . . and even if you don't, Navy pay is good." Sectry drank deep. She hadn't touched her sausage.

Rather asked, "Sectry? Why would someone like the Captain-Guardian be interested in a recruit?"

"Wayne? That's easy. If he can get enough dwarfs at Guardian rank, he can move up to Captain. He's got the rank but not the duties. Him, he'd be better off if he *couldn't* fit a pressure suit."

Debby took the rest of her tea in two gulps. "I've got to be going. Thanks, Sectry. I shouldn't have come in. I'm supposed to be buying stuff at the Vivarium, now that we've got money."

"Well, remember you're on fringe," the redhead said. "Watch the prices."

"I'll be careful."

Outside, Debby let herself smile.

How would Rather handle it? Let Sectry believe that he'd come to the Navy only to get close to a lovely dwarf woman?

It might even be true.

A sheet of rainwater clung to the window. A blurred puff jungle drifted past.

Rather had finished his sausage. Sectry passed him half of hers. When Belind came past she ordered more fringe tea. She asked, "How do you like the Clump?"

"It's mostly strange. Too wet, for one thing. I think I could get tired of boxes. Huts in a tree aren't like that. Sectry, why did they build Headquarters round?"

"It was built to spin."

"Spin?"

"The early officers, they thought we'd need tide to stay healthy. They gave that up early. They couldn't dock a ship while Headquarters was spinning, and it tended to wobble. So they stopped the spin and they built the exercise room, centrifuge included. Those early Navy men must have been *monstrously* strong. But it turns out we don't get sick. We still use the exercise room, though."

The fringe tea was fizzing in his blood. Sectry Murphy seemed to glow. His mind was trying to follow a dozen paths at once. It suddenly seemed very natural that the early men would move a tree into the Clump, spin it, try to settle the tufts, get the benefit of tide *and* the clustered resources of the Clump . . . and produce the burl that later generations hadn't been able to

duplicate.

At the same time there was a strangeness in what Sectry had said . . . and then he had it. "How do you know all that? Booce told us about the Library. He said only officers' children are taught there."

"Wayne told me."

"Oh."

"We were together for awhile. I never thought he'd marry me, I'm not an officer, but when he. . . . What I was saying, he told me a lot of history. The Library used to be part of a starstuff rocket. We've never built anything like it."

"What does it look like? Where—"

She shook her head; her hair spread around her like a flaming halo. "I never saw it myself. I'd like to. I wonder if I could talk my way past the guards—"

Guards. *That* door.

Voices and vision were turning strange. Sectry glowed; she was the Smoke Ring's most beautiful living thing. Rather took a firm grip on his equilibrium. Offering to make babies with a high-ranking Navy officer now seemed presumptuous beyond insanity. Carlot had warned him: she might be badly offended. Yet he'd never seen a woman like her.

"Then he married a woman three meters tall and thin as a feathersnake. She's got a face that would scare away a drillbit, and when she carries a guest she looks like a line with a knot in it. But she's an officer."

"Money."

"Mmm? No. Rank."

"Money," Rather said distinctly, "is why Carlot is going to marry Raff Belmy." He was losing control of his mouth.

"Oh. The dark girl, Serjent's daughter?" A smile flickered and vanished, but Rather caught it. "That's rank too."

"You saw us."

"Yeah." The smile was back.

"Do you have rank?"

"I'm a Bosun. Crew."

"Do I have rank?"

"No. What's this all about? If you want rank you join the Navy. Then you're crew."

"Would you marry me then?" His mouth was running away with him. Fringe.

She laughed. She was trying to stop, and ultimately she succeeded. "We just met. How old are you?"

"Fifteen."

"I'm twenty-eight. Where do you want to live?"

"Citizens Tree. Any tree."

"Carlot probably wants to live in the Admiralty."

"To the treemouth with Carlot."

"I do too."

"Make babies with me," his mouth said.

She thought it over, while Rather tried to think himself invisible. She said, "Right."

A score or so of puff jungles were in view. Some bore logos. They chose one that didn't, and circled it to be sure. "Quietly now," Sectry said.

"Nobody here but us flashers."

"If we scare flashers out, some meat eater might come after them."

He wiggled through the foliage in her wake. Nice to have a view. The puff

jungle was hollow in the middle. A thousand flashers edged warily away, flashing blue and yellow wings at them.

They balled their clothes and threw them at the flashers, causing great excitement.

The birds perched in a shell around the hollow, watching them. She was just his size. She knew more than Carlot: delightful things. There were moments in which Rather resented that knowledge. Others in which he was shocked. His body knew things his mind hadn't dreamed.

They rested . . . running hands and toes across the sweat-slick contours of stranger's flesh, learning each other. *Smooth muscle. Hair red everywhere. Fingers and toes stubby like his own. Either of Sectry's breasts fit nicely into his two hands.*

"We could go back and forth," she said. "Live some in the Clump, some in your tree."

"Do you mean that?" As the fringe died out of his brain he began to wonder what he had committed himself to.

"Who knows? Don't ever make decisions when you're on fringe." Suddenly Sectry wriggled out of his arms. She snatched up her wings and eeled through the foliage and out. Rather followed, curious and horny.

Only her head poked into the sky. Flashers wheeled there, and something much larger circled thirty meters away. Sectry asked, "Want to see something funny?"

A wedge with teeth. "Get back." He pulled at her ankle. She had donned her wings. "That's a Dark shark. Carlot showed me."

"We try to keep them out of the Market region." She thrust herself into the sky, naked; waved her arms and yelled. The Dark shark froze. A window came open in a nearby cluster of cubes. The beast charged.

Rather didn't have his wings. He called, "Sectry! Dark sharks aren't funny!"

The long limber torso whipped back and forth too fast to see. The narrow triangular wing was a rippling blur. Sectry turned and kicked hard. She dived into the foliage, whooping, pulling Rather after her.

They were in the hollow center.

"Are you nuts?" he bellowed, and she laughed. Then the Dark shark burst through in a shower of leaves and splintered wood.

All Rather could see was teeth. His own wings were out of reach. He set his feet against a branch, and watched the predator. Which way to jump? Flattened head and the forepart of a thrashing torso, three big crescent eyes, a thousand pointed teeth . . . the eyes beginning to show panic. Sectry couldn't stop laughing.

The beast was stuck.

Rather asked, "You do this a lot?"

"Sure. We don't like Dark sharks." She wrapped her arms and legs around him and laughed into his face.

The predator snapped its teeth at them, raging and impotent. Sectry murmured in his ear. "Gives it a kick, doesn't it?"

Debby was tired. She was flying blind, pushing bags of about her own mass, with no more than the strength

of her legs. From time to time she stopped to look past her burden. The Serjent log grew larger.

Logbearer had dropped Debby and Rather near Navy Headquarters on its way to the Serjent log. Now Debby found the rocket moored near what had been the out tuft.

Two days' time had wrought wonderful changes.

A skeletal cylinder perched atop the fuel pod. Men were all over it, placing planks, driving pegs into wood. Booce floated nearby, watching contentedly. When he saw Debby coming he donned wings and kicked to join her.

"No problems?"

"No problems," she said. "Zakry wanted money. I just went down the list and paid him what I had. Here, there's some left. I don't think I got cheated. I've only got half the seeds here. We're supposed to get the rest within five days. Where do we store all this?"

"Not in *Logbearer*. There'll be paint fumes."

They lined the seed bags along the crack in the bark and ran tethers across them.

More men approached, pushing a cylinder of wooden beams. Debby watched as they maneuvered the lumber toward *Logbearer*. She called, "Ho, Clave! Learning a new trade?"

Clave joined them. He smelled of hard work. "I'm learning it, but I don't like it. Too nitpicking. Every board has to be just the right size, just the same thickness."

"I got the seeds."

"Good. Booce, isn't this a bit of a luxury? Don't we have other concerns?"

"Like selling my wood? This'll show off its quality! I'll paint my logo, but I'll leave most of the wood bare. I'll cruise past the Market and anyone can see I've got a good tree."

The hired crew were fixing panels on the long cylinder. Clave, rested, resumed work. Some of the panels were on swivels: windows. The sun swung behind the Dark; the day turned gloomy. When the sun reappeared, passing within a degree of Voy, one whole flank of *Logbearer* was finished.

A shadow flapped out of the sun and became Carlot with her arms full of gear. Debby flew to help her. She was pushing cooking utensils and a slab of smoke-blackened moby meat. She asked, "Where's Rather?"

"I left him in Half Hand's with Sectry Murphy."

"Mmm."

They stored the gear near the bags of seeds. "We'd better do our cooking here tonight," Carlot told her father. "That paint's awful stuff." Booce agreed.

Carlot asked, "How did Rather do? I keep forgetting we want him to *fail*."

"Yeah. The way Sectry Murphy was acting, he made some kind of endurance record on a big wheel. *Somebody* should have thought of that."

"Me," Booce muttered.

"Might not matter. They seem to want him bad."

The cabin formed with remarkable speed. Now men were pegging crossbars across the bow . . . for pushing against a log? Two men produced gourds; wind brought a noxious chemical reek.

Booce excused himself and went to supervise while they painted the finished flank of *Logbearer*.

Carlot asked, "What was he doing with Murphy?"

"You remember your father said—"

"Yes, and I said she might be seriously offended. He didn't actually make a pass, did he?"

"Not while I was there. She's in a rotten mood. They put her in a pressure suit and she didn't fit."

"That's bad."

"She wanted to blow her mind out on fringe tea, and she wanted company. I left them alone. Treefodder, Carlot, if he does get Murphy mad at him, what'll she do? Keep him out of the Navy!"

". . . Yeah." Carlot began setting her gear up for cooking. She worked with furious energy.

Debby watched. Presently she asked, "Carlot, are you going to marry Raff Belmy?"

"I don't know. I just spent a couple of days with Raff aboard *Woodsman*. He seems—he takes it for granted we'll be married. He's so sure, he hardly mentioned it."

"So? It's what you told Rather?"

"I know. Where *is* he?"

There were beams left over from the making of *Logbearer*. Clave brought them an armload. Carlot arrayed them and started a fire.

Booce paid off the hired crew and they departed. His own crew went to inspect the altered rocket. Booce was exuberant. Clave was proud. Debby made appropriate noises. *Logbearer* had been repaired in just four days.

The paint was well done, she thought. She wasn't qualified to judge woodwork. The cabin was as big as the pod, roomy for half a dozen. Booce and Clave began the finishing touches: setting knobs and moorings into the hull, outside and in. Booce wanted particular patterns . . .

The fire was going well: a dim globe of heat, nearly invisible while both Voy and the sun bathed this side of the log. Carlot sliced the moby meat into two slabs. She set sliced vegetables between the slabs, locked them together with wooden pegs, and tethered it all within the fringe of the flame.

A distorted blue-fringed black manshape swam across Voy.

"Rather! Where have you *been?*" Carlot shouted.

He reached the bark. "I'm in deep trouble," he said. "Where's the chairman?"

"Working on the rocket. What kind of trouble?"

"Carlot, maybe you can tell me." Rather looked bewildered, a little frightened. "I'm afraid I've gotten myself in deeper than I wanted." ■

CONCLUDED IN NEXT ISSUE

the reference library

By Tom Easton

Quester's Endgame, Jo Clayton, DAW, $3.50, 372 pp.
Reign of Fire, M. Bradley Kellogg with William Rossow, Signet, $3.50, 352 pp.
Winter in Eden, Harry Harrison, Bantam, $18.95, 416 pp.
Phaid the Gambler, Mick Farren, Ace, $3.50, 296 pp.
The Tail of the Arabian, Knight, Geoffrey Marsh, Doubleday, $12.95, 181 pp.
Sea of Glass, Barry B. Longyear, Bluejay, $17.95, 352 pp.
Pindharee, Joel Richards, TOR., $2.95, 216 pp.
Double Nocturne, Cynthia Felice, Bluejay, $16.95, 330 pp.
Best Science Fiction of the Year #15, Terry Carr, Ed., TOR, $3.50, 379 pp.

It's been a while since Spider Robinson last asked for the loan of my soapbox, and the poor thing is getting dry rot. Therefore, I welcome the opportunity to loan it out again, this time to writer Bill Forstchen (the *Ice Prophet* series).

Bill recently wrote to inform me that in 1985 Senator Spark Matsunaga (D-HI) proposed on the Senate floor an international manned mission to Mars. Since then, support for the idea has been building—even William Proxmire has come out in favor of it—and Bill has been beating the drums. Among other things, he got the Maine legislature to pass a resolution calling for a joint Soviet/American Mars mission and gained the support of Maine's Senator George Mitchell. This spring, he led sixty high-schoolers on a tour of the USSR, where he presented the resolution to Soviet space program heads, including Alexei Leonov, the Soviet commander of the Apollo-Soyuz mission.

Now, Senatorial aides Bob Corolla and Harvey Meyerson have asked Bill to organize the SF writers' community, which they believe has considerable influence with readers and may be able to help the space program escape the

budget cutters and its ideological opponents. Bill is therefore trying to organize "The Mars Project," a coalition that can push for the joint mission. If you agree with me that a joint, species-wide reach for the future is saner than a grab-bag of selfish, nationalistic efforts, and more likely to fulfill the dreams of SF, write to:

William R. Forstchen
RD 1, Box 3774
Oakland, ME 04963

Bill did not ask for this column space. I volunteered it, in response to his remark that "Together we could reach tens of thousands of readers, who could demonstrate the support our space program has." And I am sure he will welcome your advice, comments, expressions of support, and offers of assistance.

And now to business—namely, book reviews:

Let's begin at the end, with Jo Clayton's **Quester's Endgame,** last in the nine-volume tale of Aleytys and her Diadem. The title is a bit of poetic license, reflected less in the nature of the plot (or game) than in the chapter headings (such as "Vrithian: On the Oblique File [1]"), and a device that allows somewhat greater complexity of story organization. It doesn't really add much, but it doesn't intrude either, and the novel is well worth reading.

Aleytys, you may recall, is the bastard offspring of an enslaved superwoman and a savage. When Mama could, she escaped the world of her degradation and left her child behind to grow up an outcast. In due time, Aleytys acquired the Diadem, an alien device that binds itself irrevocably to its wearer, at whose death it absorbs and preserves the personality. It already holds three, and their various viewpoints and skills are an immense help to Aleytys as she escapes her world in pursuit of her mother and her people, the immortal Vrya.

There are sidetracks on the way, of course. Aleytys has a son and loses him, regains him, and loses him again. She encounters the most vicious representative of her people, Kell, who denies her both the name of sister and the right to live in the same universe as he. She joins Hunters, a group of bounty hunters for hire, and quickly becomes one of their best agents. She finds friends and lovers and has several volumes' worth of adventures. And eventually her mother comes to get her.

Aleytys is on the Hunter world, Wolf, at the time, and she is looking forward to meeting Shareem and taking up her heritage. Unfortunately, her lover, Grey, has disappeared on what should have been a routine mission. She wants to go save him, but she allows herself to be convinced that his absence represents a Kell-set trap for her. Shadith, one of the Diadem's trapped personalities whom Aleytys has been able to give a body, will go instead. Aleytys will go with Shareem to Vrithian.

Quester's Endgame thus quickly becomes two novels, running side by side and destined to unite again at the end. On the way, Shadith shows us the world of Avosing, a religious dictatorship with a strange intelligence at large in the forest. Aleytys reveals the world and ways of the Vrya, bored and callous manipulators of the natives around them, resented, feared, immune. Kell is the worst of the lot, and when he declares formal war on Aleytys she must find a way not only to survive but to destroy him.

Of the tale's two worlds, I liked better Avosing. Its people are more appealing, their problems more on a human scale.

Vrithian's people face the whims of gods, and their only hope appears to lie in divine boredom or divine revolution. They can do nothing except keep their heads down.

We meet again a people rather like Vrithian's natives in **Reign of Fire,** by M. Bradley Kellogg with William Rossow. The Sawls inhabit caverns in one small part of a distant world subject to violent, apparently random extremes of weather. They say their world is ruled by two goddesses, one of heat and dryness, one of wet and cold, and their constant battles are what make their weather swing so wildly, from desert heat to glacial cold, the transitions marked by vast floods and absurdly brief growing seasons. And they too must keep their heads down, doing the best they can to survive.

I reviewed the first volume in the "Lear's Daughters" series, *The Wave and the Flame*, in the mid-December issue. I called it a fine job and recommended, at least implicitly, the entire series. That series seems complete with volume two, for here the intrepid Terran explorers find all the answers to the world's mysteries: The Sawls' technological anomalies do indeed reflect a mightier past, and the goddesses are quite real, if not quite divine.

Is *Fire* as good as *Wave*? Does the series fulfill its promise? Alas, no. The purpose of this volume seems largely to develop the conversion of Stavros Ibia, the explorers' linguist, into a mystic who can speak with the goddesses and save the Sawls. The rest of the tale is fairly pedestrian, dealing with a long trek to a neighboring cave-city and the impact of the latest climatic disaster. The conflicts of the explorers with Emil Clausen, the designated prospector for the corporate world-raper behind the mission, are just more of the same thing we saw in *Wave*.

I wish Kellogg and Rossow had boiled their tale down to a single volume. The result would have stepped to a much livelier pace, held the reader's interest much more effectively, and made its point more clearly. Sadly, this is a common problem. To my cynical mind, it seems that when many writers find their tale growing beyond the bounds of a single book, neither they nor the editors have the integrity to cut. They see more and easier money in padding it out a little more and selling it for twice the price to the unsuspecting readers. And that, they say, is business.

Seriesitis also afflicts Harry Harrison. In *West of Eden*, he gave us a well imagined, thought-provoking, adventurous tale of "What if . . . ?" What if the dinosaurs had never gone extinct? What if they had given rise to a sentient species, with a technology based on biology rather than physics? What if, somehow, mammals had still managed to flower, humans had appeared, and the two sentient species had come into conflict? I criticized him for the way he had to stretch the science to make it all fit (he defended himself in "Brass Tacks," but I stand by my cavils), but I applauded the story. So, apparently, did many of you, for it sold well.

Now Harrison gives us **Winter in Eden,** and he promises us a third volume. And he bids fair to lessen our memory of the first. After *West of Eden*, *Winter* is a weak book indeed. Kerrick and his allies are cleaning up the city from which they had driven the saurian Yilané. Kerrick finds two surviving males and encourages them toward independence and self-sufficiency. One of the human factions leaves. Kerrick busies himself, forgetting his wife in the

north until she has begun the trek south to him, been intercepted by the furry, tailed, Eskimo-like Paramutan, and wound up still further north. In due time, Kerrick tracks her down, nearly dies, is rescued, and goes with the Paramutan to explore the fringes of the Yilané home continent (Africa). Meanwhile, Vaintè, the Yilané villain, is mounting a return expedition to the Americas, determined to wipe out the beastly humans and reclaim a new homeland for her people, threatened by the encroachments of a new ice age.

At the same time, the pacifist Daughters of Life have escaped from what seem to be the Canary Islands and voyaged to the Amazon basin to establish a city of their own; there they meet wild Yilané whose males are not sequestered for breeding purposes. Their tale has nothing at all to do with the other plot lines, but presumably the lines will intersect in volume III.

Harrison developed his novel idea—a saurian Earth—very well in *West of Eden* and developed the conflict in potent terms indeed. Here he throws in tidbits to broaden the picture—the developing self-sufficiency of the city's surviving males; the independence of the wild males; the incompetence of the intellectual Daughters of Life; the Paramutan's tails, which demonstrate that his "humans" are not really human; and so on—but he is marking time, running his characters through essentially futile paces that get neither them nor his idea anywhere. He is filling in details and, presumably—as when he frustrates Vaintè so thoroughly—setting the stage and the motivations for volume III. Sadly, this is not a sufficient excuse for a book, except from the commercial point of view. The book will surely sell. It will also surely disappoint.

I hope Harrison has a blockbuster in mind for volume III. If so, then like Brian Aldiss with his Helliconia trilogy, he may be able to save the whole.

We see a much worse sign of seriesitis in Mick Farren's **Phaid the Gambler.** Farren has not, to my knowledge, written any earlier books. He thus begins his career with volume I of an open-ended series, which is nice work if you can get it. Unfortunately, *Phaid* has very little to recommend it.

The title character lives in a far-future Earth whose legacies from the past include robots, odd sentients, and broken weather machines that have blessed the planet with alternating stripes of desert, ice, and tolerable climes. As the tale begins, Phaid is fleecing some hicks in the back of beyond, to which he has fled to escape the consequences of a "misunderstanding" back in the wealthy Republic. When his bumpkins get bumptious, he flees once more, but this time he heads homeward, His foes, he thinks, have vanished by now, and he can return safely.

To cross the desert, he boards a vehicle like a giant tank, where he meets the barbarian warrior Makartur, who soon takes a dislike to Phaid. Coincidentally, both have the fare only to a desolate waystop, where they must continue as herders of "veebes," at least until their fellow herders decide to massacre a party of the elaihim, aliens or mutants smarter and more effete than mere humans. Under the elaihim's telepathic influence, Phaid and Makartur foil the attack. As a reward, they get a smart-alec robot hitchhiker and a lift to the Republic, where they part company.

Once home, Phaid quickly slips into the high society life, but he as quickly discovers political chaos, apparently stage-managed by an elaihi *eminence grise,* and becomes involved in a nas-

cent revolution. After an assortment of scampish adventures, he leaves town again, all set for volume II, *Citizen Phaid*.

It might have been a decent tale, and the series a promising one, if only Farren had succeeded in making Phaid the scamp he apparently intended. But Phaid spends too many pages marking time, and when the action starts, it soon proves tepid. At the same time, the characters are cartoons and anyone with a faint knowledge of what drives the winds must choke on Farren's weird climate stripes. Farren might benefit by following Kellogg's example and taking on an expert as a partner.

Just as light and much more successful is Geoffrey Marsh's **The Tail of the Arabian, Knight,** his second mystery/fantasy starring tailor Lincoln Blackthorne and his bizarre friends. When fat horse-breeder Farren Upshire learns that he must lose weight if he hopes to live out the year, he engages Blackthorne to find a mystic talisman reputed to have great healing powers, the severed tail of Knight, an Arabian stallion of the Spanish colonial era. Unfortunately, others want the tail as well, and from the beginning Blackthorne is shot at, bombed, crashed, and otherwise persecuted. He is even threatened by rattlesnakes, scorpions, giant centipedes, and half-Indian maidens.

The tale is thus something of a compendium of cliches. But every word is irreverent and jolly, and the tale is great fun. I commend it to you.

Barry B. Longyear began his writing career with a long and successful series of circus yarns and made a considerable splash with *Enemy Mine*. Now he's aiming for another splash with **Sea of Glass,** an ambitious effort and a book that is long past its time. Barry has been picking up the same message I give my biology students—if they could arrange today to wipe out nine tenths, 4.5 billion, of the Earth's human population, they would save more people than they would kill, thanks to the foreseeable consequences of worldwide population growth. Perhaps we need an international Jim Jones, with cyanide-laced Kool-Aid for the billions.

In Barry's vision of the early 21st century, the U.S. is but one part of the Compact of Nations, an alliance unified by MAC III, an immense computer that both tracks every variable that affects population stability and resources and manipulates people to make desired outcomes appear. MAC III even manipulates the Otherworld, non-Compact, nations, aiming the world toward the Wardate, August 9, 2033, when a war must purge the Earth of its excess people, or else civilization will be doomed. After the Wardate, corrective action will be too late.

One of the Compact's tactics has been to restrict births. Excess children, such as hero Tommy Windom, are refused citizenship. Regarded as no better than animals, they are shipped off to concentration camps where they are brutalized by sadistic guards. Their parents are executed by slow electrocution, on live TV.

Tommy's parents try to keep him secret. They have blacked out their windows. They keep him indoors. They teach him with books and movies. But at age seven, he opens an attic window

and is seen by a neighbor, who calls the blackshit (cops). Tommy is taken away, never to see his parents again, and in the camp he soon learns to kill. He also learns something of the principles on which MAC III works, and when he eventually has a chance to escape, he does. He finds a niche in a small New England town, where there are people he can love, almost replacements for his lost family. He also learns that he had not escaped MAC III. The machine has plans for him, as a part of its manipulatory apparatus, and it will steer him in the appropriate direction.

The book's early scenes of pain and death are quite moving. So are the warmer days in West Ellen, Vermont. The transitions from one to the next, and then to Tommy's place in MAC III's plan, have a remarkably arbitrary odor, even to Tommy, who at one point asks, "Fighting, struggling against the unknowable toward goals without meaning within a universe that takes no notice of the contest. It makes no difference what we do?"

As Tommy begins to realize how thoroughly MAC III can track and steer the world's individuals, we see the arbitrariness not as an authorial shortcoming, but as deliberate intent. In a sense, Barry has become an existentialist ecofreak. MAC III is God, and an interventionist God at that; Tommy and all those around him do God's will at every step of their lives, no matter whether their actions seem good or bad. The machine sets up the killing of a child, so that Tommy, at seven, will hammer a wooden stake up a guard's ass, so that Tommy's mind will be bent in a way that lets him, much later, execute a friend. The target at the end is the Wardate, the nonnuclear purging of the world. Kill a child, and save billions. Murder, and do good.

World War II taught us something: The end does not justify the means. But MAC III is able to show that any other steps to save humanity must cause more deaths in the long run, or fail to save the species and cause still more. The means it chooses are the least among evils. Are they therefore good? Barry recognizes the pain of those who must act, and he suggests that "good" is not really the point. Necessity is.

The book is not perfect. Barry's concentration camp is but a weak shadow of the Nazi camps it emulates. His children are noble martyrs. His adults he sketches in too-bold relief, coloring them more in black and white than shades of gray. The tale's ending is weak. But the book is an effective sermon nevertheless, and if it is widely read, it will surely prove controversial. And the controversy may do a great deal of good. The Wardate is not fiction, and we do, for just a few more decades, have the chance to stave it off by finding more humane final solutions.

Joel Richards's **Pindharee** is a satisfying short novel. Earth, desiring colonies and mineral resources and not too concerned about the rights of natives, is exploring the galaxy, and one of its ships has found an enigma: Lydia, a lush world with a single high-tech city and no apparent inhabitants. But then contact officer Damon Hart meets a very human-looking fellow who explains that

he is one of the 30,000 natives in human form. The rest have moved into animal bodies, such as that of his wolf companion, Kira, or into the city's computers. Some live as disembodied essences, and some have actually developed beyond human awareness. Lydia is theirs, and they want no colonists or miners; they *will* accept scholars and trainees in their peculiar psi-based powers.

Damon chooses to stay for the training when his ship leaves. When the next ship arrives years later, bearing scholars, he is ready to serve as Lydia's ambassador to the human species. But among the scholars lies a snake, a disguised exploiter who will stop at nothing to gain the aliens' riches of resources and knowledge. Damon's life is at stake, and so is his love for the human scholar Kerry.

At the story's end Richards seems to wave his arms and, in effect, leave the question of how Damon uses his newfound powers to save Lydia as an exercise for the reader. Yet this is only an apparent weakness. The tale moves well, with warmth and vigor and a keen sense of what telepathy might do for love and of what an ecological utopia, achieved by high-tech transmigration of souls, might be like. And despite the inevitable temptation to move the story onto a cosmic plane and resolve the grand conflicts that provide its context, Richards has kept it on a very human level. The tale's resolution settles only the minor, temporary conflicts, and it leaves the reader content.

Cynthia Felice's **Double Nocturne** begins poorly, moving slowly and murkily into an ideological swamp, but the pace picks up in time and the tale turns into an interesting feminist adventure.

The world of Islands was settled by groups of female religious fanatics seeking an isolated place to do "penance" for all humanity; also by convicts, and the convicts's guards. The Penitents reproduced with the aid of artificial insemination, using semen treated to destroy male-producing sperm. The other groups preferred the old-fashioned method. Now Islands is a female-dominated world in which many of the men born are "purified" by vasectomies. It is also an isolated world, having lost contact when war distracted the Homeworlds, and a primitive, autocratic one, for the Artificial Intelligence that was to have guided its development was destroyed in a volcanic eruption.

The story begins with the arrival of a mission from the Homeworlds to replace the missing AI. Unfortunately, the first lander, carrying the crew's two female members, is shot down, and the male pilot, Tom Hark, must do the best he can to save his crewmates and the mission. Alas, the scene is the most extreme of Islands's three states, and he is captured by people who refuse to see him as more than a clumsy, brutish, irresponsible "Sweetchucks."

Felice here draws a bold contrast between men and women, claiming that women are far better suited to rule and dominate. However, she does not claim that women are more fair-minded than men, for her gynocrats are as fat-headed and blind as the men she has dealt with all her life. Unfortunately, she spends far too many pages developing the gyn-

ocracy and Hark's fix, and any reader who is not obsessed with grinding the same axe soon grows bored. It does not help that a top-ranking woman is called "Top" and her male aide, if any, is her "bottom man." The role reversals go ridiculously far.

The boredom ends only when Felice stops lecturing and gets on with the story. Then, with the aid of two local men, Hark escapes to a neighboring state in search of a radio with which to contact his orbiter. The political set-up remains the same, but the new group is somewhat more open-minded. Despite misunderstandings and imprisonment, Hark finds true love and eventually succeeds in rescuing his crewmates.

Felice's points, that women can be as unfairly and unreasonably sexist as men and that love, while it remains inevitable even with the tables turned, cannot conquer all, are worth making. But I wish she had made the first more deftly.

Do you want to know which of the 840 short and medium-length science fiction stories published in 1985 were really the best? You can look to the various awards, but they honor very few tales. You can also look to the three "Best" anthologies from Gardner Dozois, DAW, and Terry Carr. They generally catch the award-winners, plus many of the stories that made the awards's final ballots, plus a few more. The best of the best may be those very few stories that show up everywhere. Happily, you don't have to buy all three of the "Bests." Gardner is still the most inclusive of them all.

Terry Carr's **Best SF of the Year #15** (a dozen stories) overlaps the DAW volume (reviewed in January) only with Silverberg's "Sailing to Byzantium." It overlaps Gardner's book (reviewed in December) with Tiptree's "The Only Neat Thing to Do," Shepard's "A Spanish Lesson," Waldrop's "Flying Saucer Rock & Roll," and more. If you buy this one, it will be for the relatively few good stories Carr alone calls "Best," plus the annual wrap-up by Charles N. Brown, editor of *Locus*. ■

●We are on the eve of man's final emancipation from rigid reasonableness, from the last trace of the trim clockwork thought of the seventeenth and eighteenth centuries.

Herbert George Wells

submitted by G. Harry Stine

brass tacks

Dear Stan,

Well, I have figured out who "Kelvin Throop III" is. Kelvin is an obvious reference to the British Lord, but Throop had stumped me for years until I saw an odd-looking steam pressure governor in the Arts and Industries building of the Smithsonian Institution that was patented by an American fellow named Throop. So our Kelvin Throop is the sociodynamic equivalent of a thermodynamic governor.

Analog has done a fine job of presenting exciting, often thought-provoking, stories with diverse viewpoints. Keep it up!

By the way, why the "III"?

PETER GRIFFITH

Athens, GA

Well, Kelvin Sr. is getting up in years, and Jr. was pretty quiet. . . .

Dear Stan:

I would like to express my compliments to your fine magazine and Elizabeth Moon for her fine story "ABC's in Zero-G" in the August issue.

As a practicing Advanced Emergency Medical Technician, I can appreciate the problems experienced by the medics in the story. Practicing emergency medicine in a constantly accelerating and decelerating vehicle that is also changing directions unexpectedly can be an extremely frustrating experience.

My only criticism is that in real life, the computer program which automatically started their "ambulance" after four minutes would have been dumped immediately after the first time it interfered with the proper treatment of the patient. You don't move the patient until he is ready to be moved. The story shows why.

Is Elizabeth Moon an EMT? She shows a good understanding of what is involved in the job.

JOE CLEMENT

Kenton, OH

Elizabeth Moon is an EMT, and she writes that, "even though the time-on-scene limit is stupid, it exists in real life, supported by angry physicians. It won't go away just because it kills people, if the people who make the rules don't believe *it kills people. There are, on Earth, ways around a time-on-scene limit, but that's not a science fiction story."*

Dear Stan,

Harry Stine usually talks a lot of sense. But one comment in his August "Alternate View" almost made me fall out of my tree. He asks, "have you ever competed in an international sporting event in a Warsaw Pact country where national prestige is far more important than our British-born sense of fairness, fair play, and sportsmanship?"

Whoo, boy. Have *you* (and Harry) any idea of the reaction provoked amongst we fair-minded British by the arrogant, chauvinistic TV presentation of the Los Angeles Olympics? From where I sit, *both* superpowers need to put their houses in order—along with such former superpowers as we British.

Incidentally, scientific colleagues recently back from Moscow report a new willingness of the establishment out there to listen, under the Gorbachev regime. The trouble is, if the US believes its own propaganda about the big bad bear, you'll never be able to start a real dialogue going.

JOHN GRIBBIN

Dear Mr. Schmidt,

I was delighted to find a story with so many musical references [L.A. Taylor: "Cultural Exchange," August 1986,p. 60].

However, I was horrified that the singer, Cora, was wont to "smile all the time, even when the music is sad." One shudders that such erroneous information, such embouchure restriction, would survive in Cora's century. One's mind is boggled to imagine Dame Kiri Te Kanawa, for instance, grinning through the poignant, heart-wrenching "Vissi d'arte, vissi d'amore" from Tosca, or any good basso, as Mozart's *Commendatore,* intoning the ominous "Don Giovanni" while smiling!

While sometimes the lifting of the corners of the mouth does induce a brighter sound, *constant* spread will detract from the tone color, vowel sound, pitch, and dramatic import.

But then, it is Cora, one supposes, not the author, who believes that. Perhaps that's why she's sent to back-water planets instead of major cultural centers!

L.E. CARROLL

712 High Avenue
Hatboro, PA 19040

Dear Dr. Schmidt:

In "Cultural Exchange" (August '86, p. 61) we find ". . . although in the red light of the auditorium the attentive faces looked more brown than green." (The light in the auditorium is red because ordinary daylight on the planet is red.)

That colors will look different under the light of different stars is an old cliche of science fiction. But Land's theory of color vision entails that so long as a star emits some nontrivial amount of light at each of red, green, and blue wavelengths, colors will look perfectly normal to the human eye/cortex.

This might be a good topic for a fast article, if you could get an astronomer and a perceptual psychologist to collaborate.

No reflection on the story. The pas-

sage in question was just building some local, er, um, ambience.

NOLLAIG MACKENZIE

Toronto, Ontario

John M. Campbell did such an article back in February 1960. The Land results included some most remarkable results, one consequence of which is, as you say, that humans will see full color under a surprisingly wide range of lighting conditions. However, human beings can learn to see even the relatively small differences that remain. Photographers, for example, get so they can see the difference in light quality between daylight, tungsten, and fluorescent light, even though most people don't notice it. It's also true that (a) the differences are most noticeable if you move from one kind of light into another, and (b) if the illumination spectrum is unusual enough, there will be color differences obvious to anybody. Take a look around a darkroom by safelight and you'll see what I mean.

Dear Mr. Schmidt,

I would like to add my voice to the probable pile you have received about publishing a story by your associate editor. Putting aside any discussion of the merits of the story (I'll get to that later) I wish you had been more sensitive to the obvious appearance of a conflict of interest. I would not like you or anyone else on your staff publishing a story in *Analog* while in its editorial employ. How can you honestly state, even subjectively, that knowing your editor wasn't a factor in your selection? How can potential new writers honestly feel they got a fair shake when their rejection slip comes from someone who puts her own story in the magazine. Even if you presented Ms. Frier's story with an anonymous pen name, was all bias truly excluded? Scientists have had to develop rigorous double-blind experiments for just such reasons. I think you should try to avoid even the *appearance* of a conflict of interest to give new writers confidence that the exception won't turn into a rule. If Ms. Frier's story has merits, surely she could get it published in any other SF magazine.

As for the story itself—I thought it was average for *Analog*. Neither particularly outstanding nor unreadable. However, I can't help but wonder—was there a really outstanding story turned down for Ms. Frier's?

RICHARD DASKIN

336 E 81 St.

New York, NY

It's been some months now, and that "probable pile" of letters has grown to two. I think most people realize that we are not running a contest, but a business whose purpose is to publish stories readers like. I'll take the best ones I can get, regardless of who wrote them—and I mean regardless. As for "surely she could get it published in any other SF magazine," I know several hundred writers (myself included) who would love *to live in a universe where they could get any publishable story published anywhere they like—but* this *universe sure isn't built that way! Every magazine has a strictly limited number of pages and an editor with highly individual tastes. Many published stories are perfect for one magazine and quite unsuitable for any other—and many are rejected simply because the editor doesn't have* room *for everything he likes.*

I don't know any *editor who would turn down a really outstanding story to make room for a mediocre one from a favored person—we can't afford to. As for convincing new writers they got "a fair shake," remember that Ms. Frier is a new writer, too. Your letter says I*

should discriminate against *her because she works here. Is* that *fair?*

Every week I reject stories from old friends and buy them from total strangers. Who wrote a story doesn't matter at all to me, one way or the other. It shouldn't to you, either. Criticize anything we print for its merits or lack thereof—but who wrote it is not a valid basis for criticism.

Dear Stan:

I have just finished reading your stimulating editorial "Trick Questions" in the October *Analog,* which just arrived today. I concur: viewpoint is all-important. In this connection, I have developed some insights on magic squares—those remarkable square arrays of integers, first discovered by the Chinese several thousand years ago, which sum to the same fixed value by row, by column and diagonal—insights which have not previously been elaborated by anyone. Viewpoint is crucial. With it, I hope soon to publish a comprehensive theory, catalog, and illustrative "applications." But, as you point out, it may be necessary to explore numerous unfruitful approaches to arrive at the fruitful one. I already have the approach, but need to demonstrate its application to 5×5 and larger squares. Can anybody "out there" lead me to a good catalog and/or enumeration of such squares? (Incidentally, did you really mean to leave out the 1 ohm resistor between points C and E in Figure 1 of your editorial? It makes for an enormously harder problem than if it were present, and, of course, does not match your text. Is this a challenge problem?)

ANGUS R. MCKAY
Vashon Island, WA

The omitted resistor in the diagram was just an oversight; fortunately most readers didn't notice it either, and got the right picture from the text description. Leaving it out does make it harder, but you can still do it if you have the patience (and preferably a computer!) to slog through Kirchhoff's equations!

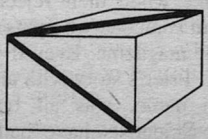
Dear Stan:

Liked your October editorial very much, but took particular note of your statement that you had a collection of problems like that running back many years. Have you considered a book? Admittedly, if you are working as hard as an editor as you probably are, you don't have that much time, but it might be a collaboration with one of the many authors you know. Now that Fixx has dropped dead running and Gardner has retired from the *Scientific American* there isn't much in the way of good problems running around. Gardner hasn't been putting his best stuff into *IAsfm* and Mensa will probably not authorize another puzzle book although an occasional good problem does crop up in the Mensa Journal.

The following might be of interest to you. . . .

Take any three digit number and duplicate it to make a six digit number, i.e. 192 yields 192192, and the resulting number is divisible evenly by thirteen. Why?

The following, I think was Gardner's. Take a cube and draw a couple of diagonals on two of the faces such that they meet like the following. What is the angle between the lines? That is truly an AHA as Gardner called it. If you see



it it is obvious, but if you don't you trot out the trig identities and sweat.

ROLAND L. PORTER

Santa Cruz, CA

P.S. Have you calculated the resistance between points A & B on your diagram?

I've thought about that book, but it's not very high on my priority list at the moment. Meanwhile, Martin Gardner has done one called Aha! Insight, *published by* Scientific American *in 1978.*

As for the resistance between points A and B, that's left as an exercise for the reader—and as far as I know, there aren't any sneaky shortcuts to that one!

Greetings:

I enjoyed Mr. Eric Vinicoff's "Windrider" story very much. Ever since reading *Orion Shall Rise* by Mr. Poul Anderson I have been wishing for some authors to use the aerostat as a story vehicle (no pun intended). Now, would it be possible for you to find some knowledgeble writers to weave readable stories around some of the following:

How do you launch an aerostat in the first place?

Could it be used for a power generation platform and send microwaves to receivers on earth?

How about a "low orbit" stationary communication transfer satellite?

What is the legal impact on current national/international law if a private firm puts an aerostat up for transmission, power generation, research, etc.? Is it like a ship on the high-seas?

The above less than exhaustive list is not an attempt for me to come back later and say, "they stole my story" if you print this letter and someone comes up with a good story. If I could write a sellable story, I would be sending the same to you instead of this letter.

C. HENRY DEPEW

Tallahassee, FL

Dear Mr. Schmidt:

I guess that I couldn't disagree more with parts of your Editorial in the August 1986 issue.

The child's problems *are* more "trivial" than an adult's because of the security represented by the parents. He/she has someone to run to. In contrast, an adult is on his own: for example, if the breadwinner loses his job, not too many people are there to help him. The child's problems become of equal (or greater) severity than an adult's mostly when the parents do *not* represent security (such as in child abuse).

Similarly, the "good old days" existed when we felt more secure with our government. This includes particularly police protection, and also protection against war and destruction.

This, plus the Future Shock syndrome, plus the disintegration of the family unit (perhaps one of the most profound changes in human culture in history), plus the growth of a middle class which is concerned with external events (vs. making ends meet), sure makes us feel less secure. *Actually,* our life expectancy is greater than ever, if survival is the main question (is it?).

LEONARD R. WEISBERG

Minneapolis, MN

Yes, our life expectancy is much *greater than it was through most of history. On the adult-child thing, I'll grant your point of difference, but attach a lot less significance to it than you do. No child feels that he can take* all *his problems to his parents—and even when he does, the parents aren't nearly as omnipotent as he might believe. On the other hand, adults often do have institutions they can take their problems to—and they're not omnipotent either. I'll stick to my original thesis, that a problem which* looks *as big to a child as a different one does to an adult really* is *as big, in ways that count.* ■

a calendar of analog upcoming events

6-8 March
CONCAVE 8 (Upper South Relaxacon) at Park Mammoth Resort, Park City, Ky. Guests of Honor—Jane and Scott Dennis. Registration—$9 until 14 February 1987, $13 thereafter. Info: Concave, PO Box 24, Franklin KY 42134.

13-15 March
KINGKON 7 (Colorado SF conference) at Embassy Suites, Colorado Springs, Colo. Guest of Honor—Robert E. Vardeman, Fan Guest of Honor—Don C. Thompson, TM—Somtow Sucharitkul. Registration—$15 until 1 January 1987, $17 until 28 February 1987, $20 at the door. Info: KingKon 7, PO Box 16597, Colorado Springs CO 80935 (enclose a S.A.S.E.). (303) 520-1241.

16-20 March
General meeting of the American Physical Society at New York, N.Y. Info: A.P.S., 335 East 45th Street, New York, NY 10017.

18-22 March
Eighth International Conference on the Fantastic in the Arts (Academic conference) at Hobby Hilton, Houston, Texas. Info: Thom Dunn, ICFA-8, Miami University, 1601 Peck Blvd., Hamilton OH 45011.

20-22 March
LUNACON '87 (NYC area SF conference) at Westchester Marriott Hotel, Tarrytown, N.Y. Guest of Honor—Jack Williamson, Artist Guest of Honor—Darrell K. Sweet, Fan Guest of Honor—Jack L. Chalker, TM—Mike Resnick. Registration—$16 until 27 February, $20 at the door. Info: Lunacon '87, Box 338, New York NY 10150-0338.

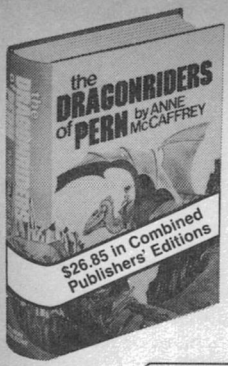
20-22 March
MILLENNICON minus 14 (SF conference) at Dayton Airport Hotel, Dayton, Ohio. Guest of Honor—Hal Clement, Fan Guest of Honor—Rusty Hevelin. Registration—$15 until 1 February 1987, $18 thereafter. Info: Millennicon, PO Box 636, Dayton OH 45405.

28-30 March
COASTCON X (Gulf Coast SF conference) at Coast Coliseum and Convention Center, Biloxi, Miss. Includes gaming, costume display, etc. Registration—$15 until 1 January, $20 at the door. Info: CoastCon, Box 1423, Biloxi MS 39533.

27 August-2 September 1987
CONSPIRACY '87 (45th World Science Fiction Convention) at Metropole Hotel & Conference Centre, Brighton, U.K. Guests of Honour—Alfred Bester, Doris Lessing, Arkady and Boris Strugatsky; Fan Guests of Honour—Joyce and Ken Slater; Artist Guest of Honour—Jim Burn; Special Fan Guest—David Langford; TM—Brian Aldiss. Registration—Attending (until 30 September 1986) L25, $40, $A50; Supporting L10, $15, $A20; 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. Join now and get to nominate and vote for the Hugo awards and the John W. Campbell Award for Best New Writer. Info: ConSpiracy '87, Box 43, Cambridge CB1 3JJ, England, U.K. OR Bill & Mary Burns, 23 Kensington Court, Hempstead NY 11550 OR Justin Ackroyd, GPO Box 2708X, Melbourne, Vic. 3001 Australia.

3-6 September 1987 CACTUSCON
(North American SF Conference) at Hilton, Hyatt Regency, Convention Center, Phoenix, Ariz. Guest of Honor—Hal Clement, Fan Guest of Honor—Marjii Ellers. Registration—$15 supporting; $30 attending until 15 September 1986. Info: CactusCon, Box 27201, Tempe AZ 85282. (602) 968-5673.

—Anthony Lewis



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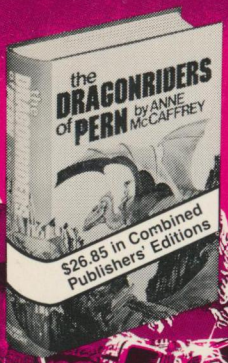

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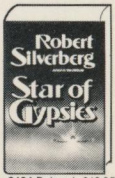

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