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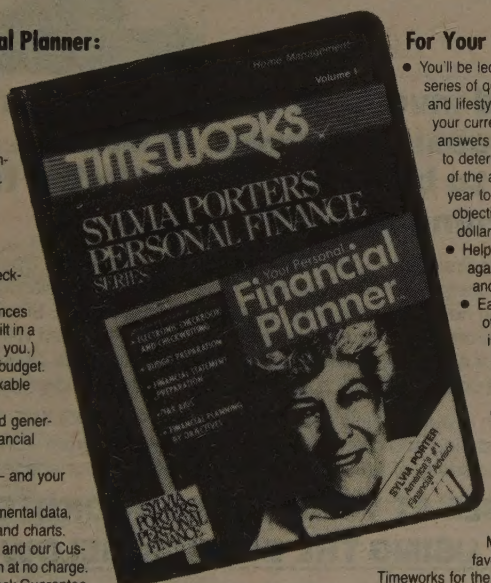

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Editorial

COLD FEET

Stanley Schmidt

Probably most of us have had the experience of looking forward to some big event and then being a little afraid to go through with it when the time finally came. It might be making a speech, asking for a date, going to the doctor or dentist to find out how bad a suspected problem really is, getting a challenging new job, or entering a competition. Whatever the details, the common thread is that we can talk eagerly, to ourselves and others, about what we're *going* to do—but when it's actually time to do it, and the outcome is uncertain, we wish we could put it off a little longer.

Elsewhere in this issue you'll find Richard C. Hoagland's article "The Curious Case of the Humanoid Face . . . on Mars." At first glance this might seem to have nothing to do with the preceding paragraph—but there's more to his story than he can tell in these pages. There's more than *I* can tell you, too; what I know about what went on behind the scenes is, from my point of view, hearsay. I'm not familiar with many of the details and I can't vouch personally for the truth of everything I've heard. Attempting to name names would be risky, serving no useful purpose and possibly even jeopardizing what progress has been made toward what some of us hope will happen in

the future. So I'm *not* going to give you a juicy exposé of who did what and what's wrong with it. I am not interested in making accusations or passing judgment on anyone's actions. The actions themselves are my concern, not who did them; and I know there are sides of the story I haven't heard.

But I do want to pass on to you the general features of some reactions I've heard about to the subject matter of Hoagland's article—and some speculations about *why* people have reacted as they allegedly have. If the allegations are true, they raise interesting and disturbing questions—not about specific individuals, but about how people in general react to certain kinds of information.

The details of the information itself you can get from the article. For present purposes, I'll summarize very briefly: there exist pictures, transmitted to Earth by one of the Viking Orbiters in 1976, showing a large surface feature on Mars bearing an easily visible resemblance to a human (or humanoid) face. When this was first noticed, it was quickly dismissed as "a trick of light and shadow" —but subsequent examination using sophisticated image processing techniques showed that the resemblance did *not* go away when the lighting angle changed, or even when the "face" was viewed from different directions. Furthermore, there was a whole complex of features *near* the face that seemed to be geometrically related to each other in too many ways to be easily explained as "mere coincidence."

Or so, at least, it seemed to many observers—but not all. Quite a few scientists have now examined the Viking pictures. Those who have looked most closely have come to suspect more and more strongly that the unusual forms in the Cydonia region of Mars could be of artificial origin—artifacts, in other words, of some civilization which occupied that area at some time in the past. If proved true, this conclusion would be of profound, far-reaching importance: it would be the first proof that we are not the only intelligence of our general type and level in the universe.

Since there are people who have devoted large parts of their careers to searching for such evidence, it was an obvious step for the Cydonia investigators to share their findings with some of these people and invite them to join the investigation. When they did, the results were surprising. Individuals who had spent years searching for evidence of other intelligence, confronted with something concrete that might be such evidence, shrugged it off with reactions ranging from indifference to dismissal of the evidence as meaningless. At least one such dismissal that I saw seemed to me little more than hand-waving, relying on vague analogies with things like rock "profiles" at earthly tourist attractions rather than directly addressing the Mars Investigation Group's quite specific observations on the Viking pictures.

Please note that the M.I.G. did not claim that its observations *proved* the Cydonia features are artificial. It did not ask other SETI experts to accept or support such a claim on its say-so. All it

claimed was that its data made such a hypothesis seem plausible enough to warrant serious consideration and testing. For now, that would mean additional people making their own evaluations of the data, offering their own interpretations, and exchanging criticisms and ideas with those already involved. Eventually, it would probably mean another trip to Mars, to collect better data than those already in hand.

All of which would seem to be a perfectly normal, reasonable, orthodox approach to provocative but incomplete scientific data. And one might reasonably expect that anyone already professionally committed to the search for extraterrestrial intelligence (SETI) would be very interested in following up any data that looked as if they might contribute to that search.

So what happened? Why the apparent

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reluctance of established "SETI-ologists" to take an interest in—or even admit the possible validity of—the Martian artifact hypothesis? Could it be a case of "big night cold feet"? Might it be that after a person has spent years thinking and writing and experimenting on the question, "Is there other intelligent life?" he or she can't quite face the prospect of actually finding out? Surely it can't be fear that the answer will close the question and throw the long-time searcher out of work. If there *are* ruins on Mars, finding out who put them there will keep plenty of researchers busy for a long time to come.

Could it be fear that their own reputations will be tarnished—tarred with the "von Däniken" brush—if their names are associated with any consideration of such data? An understandable caution, perhaps, but if the data are real, ignoring them won't help reputations much, either. Any scientist has the right to pick which problems interest him enough to work on—but disregarding data pertinent to a problem he's *already* working on is another matter.

Or could it be something even more disturbing? Some of the most interesting of the reports I've heard (but can neither confirm nor refute) allege that certain scientists privately showed considerable interest in the Viking photos, but refused to admit publicly that they had even seen them—and that others refused even to look. If these things really happened, why? Why would a scientist literally close his eyes to data, or deny having seen them after recognizing their potential significance? Could it be fear of being upstaged—for example, of having the first confirmation of ETI come from somebody else's data rather than his own, or of having a Mars expedition mounted for reasons other than his?

It may be, of course, that those scientists who refuse to be associated with the "face" honestly believe that it can't have anything to do with ETI. But if that's the case, is there a real basis for such a belief?—or have they so convinced themselves *a priori* that other intelligences *can't* resemble us that they are unable to consider any evidence that they do?

I say yet again that I raise all these questions not to cast any personal aspersions, but to point out the ways in which scientific searches can be marred by personal aims and politics. It can happen quite insidiously. I don't believe that anyone who does things like those I have suggested, in this or any other investigation, does so because he *wants* to suppress truth or ignore findings that are inconvenient to his own established or emerging hypotheses. He does them simply because he is human and his own experiences and feelings come, by imperceptible steps, to color how he *sees* truth.

That explains, but does not excuse. It's an effect that can happen to anyone—and for precisely that reason, anyone working in science needs to be constantly on guard against it. My principal hope in writing this is that anyone reading it who is associated in any way with the search for other intelligences will look for himself in my words. If they help even one such person to see something in himself that he didn't re-

alize was there, he may then be more watchful for it in his future thinking about such observations.

As far as the Cydonian face is concerned, I don't consider it by any means established that these structures are artifacts. But I can see a reasonable chance that they *may* be—and if they are, the implications are too important to ignore. Therefore I would like to see many good minds brought to focus on the question, to wring as much insight as possible out of the data already in hand. If *you*—whoever you may be—would like to get involved, those who already are would like to hear from you. There's an address you can write to at the end of Hoagland's article.

In the long run, of course, we're going to need more data—and getting good enough data to settle the question is almost certainly going to take another trip to Mars (preferably, in my opinion, a *manned* expedition). Some would consider this question alone worth the trip. For those who don't, perhaps because this one seems too long a shot, there are plenty of other reasons for going—and such an expedition should not limit itself to one project, anyway. Such a trip will happen, eventually, if enough people want it.

And it's none too early to start working on it. When you've been wanting the answer to a big, hard question for a long time, and the answer may at last be (literally!) in sight—that is *not* the time to get cold feet. ■

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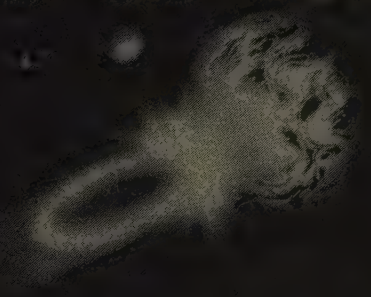

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by PAUL COOK

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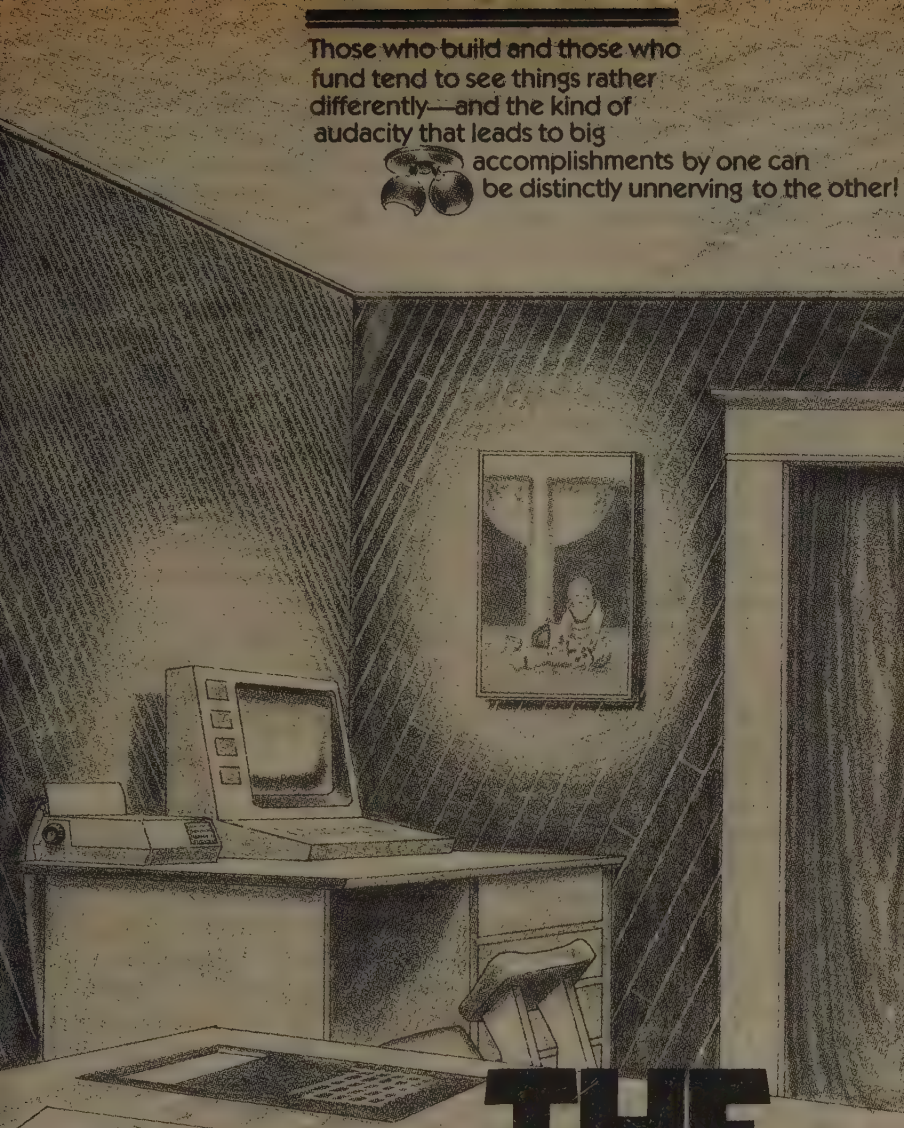
Those who build and those who fund tend to see things rather differently—and the kind of audacity that leads to big accomplishments by one can be distinctly unnerving to the other!



John Berryman

THE BIG DISH

I

My Grandpa said, "Never take 'no' for an answer." But it looked like I might have to.

"I can't see that Rettig Construction is asking so much, Pepper," I told the guy from NASA. "All we want is a chance to bid on your job. If our bid turns you off, tell us 'no.' "

Pepper shook his head with his chin stuck out at me, ready for a fight. "No, Rettig," he said. "We don't need Rettig Construction. We hire thousands of contractors for work Earthside. But not out in space. We don't want your bid. NASA builds its own constructs in space. I repeat, the answer is 'no.' "

I let him see me simmer for a few seconds, then reached over for his phone and asked the switchboard to call me a taxi.

"I'll be back, Pepper," I told the NASA hatchet-man. "But not to talk to any pip-squeak like you."

Gene and Jerry had stuck close to the pilots' lounge at Langley's airstrip. "Back to the barn," I growled at my pilots as soon as I had paid off the cab.

Gene let Jerry handle the take-off check list. "You look like you got shit at Langley," Gene said, looking back to where I sat in the cabin.

I moved forward so that I could kneel on the spar and stick my head in the "office." "That's what I got, Gene," I told my number one fly-boy. "Those idiots at NASA aren't scared by the size of the space telescope Congress gave them all that dough to build. They really think they can hack it."

"How big *is* the damned scope, Phil?" Jerry asked from the right seat.

"A hundred meters in diameter, with a tube three hundred meters long," I said as Gene gave the mills full-bore for takeoff. "They'll use articulated mirrors about a square meter each. It's the biggest thing ever scheduled to be set up in space."

"You've got it," Gene told Jerry about midway on the climb-out. He turned from his left seat to face me. "Rettig Construction builds the biggest things in the world, Phil," he said. "Is NASA any good at that stuff?"

"Who knows, Gene? They've put space labs and zero-g processing plants together, but nothing as big as the space scope. They think they can make the very large jump in scale."

"Too bad Congress didn't call for something twice as big," Gene mused. "Then maybe NASA—"

"Hm," I said, and wiggled back down the aisle between the seats to lie on the couch.

II

Back in my San Diego office the next morning, I had time to think about my pratfall at NASA. Rettig Construction is the biggest builder in the world. My name is Phillips E. Rettig III, and I own the whole damned thing. We work on all continents. Our billings lately have run between twenty and forty billion dollars a year.

That was what I had brought to NASA at Langley, our old fight song: "Rettig is the biggest. We build things on time, under budget, and they work." It hadn't been enough.

The idea I had taken to Langley was too simple-minded. Gene had sparked a thought in the jet on the way home. I'd need to quantify it, and that would

call for experts. I knew who could find them.

About the time our billings passed the five-billion dollar mark, I hired some fancy head-hunters in New York to make a search for a high-powered secretary for me. They were used to finding Executive V.P.'s, and balked a little at searching for a mere woman.

"Hell," I said to Clovis, their frontman. "You surely know some big companies where the boss uses a lot of frank four-letter words and likes to kick ass. See if he hasn't got a secretary who spends some of her time keeping his foot out of his mouth and the rest exuding professional perfection. Then steal her."

It took Clovis a few weeks, but there I was in his New York office looking over their candidate's resume. Her name was Wilhelmina Jewel Hodges, although her maiden name was Sauerbraten or something. "What a handle!" I told Clovis.

"I think she prefers to be called Jewel," he said. "Jewel Hodges."

"This is Phil Rettig, Jewel," Clovis said, when she was shown in.

She was a strikingly poised young grandmother, my own age and widowed, who was a great fit to the specs I had given the headhunters. Clovis warned me that Jewel had worked for some really sweet guys during her career. "Which," he said dryly. "I doubt they ever called you."

Jewel didn't seem to think I was so sweet, either, when we finally got her on the payroll, especially when I called her "Julie." Sweet or not, she had already stuck with me for five years.

Her office is just outside mine. When I want her, I get up, open our connecting door, and ask her to come in. That's what I did as the first step in finding some experts to booby-trap NASA.

When she had settled her classy fanny serenely in "her" chair, she drew a white sweater around her shoulders. Jewel works at 23° Celsius. I work at 20°. Thus the sweater when she comes in. I got used to it.

She seldom speaks first. I said: "Julie, in the last fifty years or so they have built a dozen astronomic observatories on the top of that volcano in Hawaii. Pretty good chance somebody who works here in the General Office was in on one of those jobs. Would the computer know how to find him or her?"

She paused for one delicate breath. "Tuan Foo worked on some of those installations," Jewel said.

"An Oriental," I grumped. "What does he do for us?"

"He's a mathematician, Phil. Have you met him?"

"How would I know?" I said irritably. "They all look alike to me."

"Now you be nice, Round Eyes," Jewel said, quietly pulling my foot out of my mouth.

"I'll try," I said sulkily. "Where's he working right now?"

"Here, in the General Office." She stood up. "I suppose you want him right away?"

"What else?"

She left with the same silent grace with which she had entered. Some day she would smile.

III

Tuan Foo put his slight frame in the same chair Jewel had vacated a few

minutes earlier. Considering how well we paid him, Tuan looked undernourished. Frankly, he looked close to the poverty line in general.

"Tuan," I said to this poor coolie, "Congress finally gave NASA sixteen billion dollars to build a telescope in space. It'll be the biggest thing ever assembled out there. Just because it's so big, I figured it was down our alley. So I hustled down to Langley to tell them how lucky they were to have Rettig Construction anxious to bid on their job. They don't want any part of us."

Tuan was politely and silently sympathetic.

"I've got an idea how to euchre NASA out of their own job," I said. "But I need to be sure I'm not a technological idiot first. Julie says you worked on some of those articulated scopes in Hawaii."

He nodded. "I worked on two of them, Phil."

"Run it down for me, Tuan," I said, interested. "Remember, clue me in on the technology."

"The first really modern astronomic telescope was the five-meter job at Mount Palomar. That was the limit for materials a century or so ago. That big a mirror tended to sag," Tuan said. "So back in the '80s somebody said, let's build a telescope with a number of articulated mirrors whose individual weight will not deform them regardless where in the celestial sphere they are aimed."

"I heard," I said. "Tied together, but so they can wiggle a little?" He agreed. "Does it work?"

"Oh, yes. Electronics even then had gotten to the point where they could put a laser at the Prime Focus and scan the mirrors about a hundred times a second, much like television guns. Each mirror reflected the laser beam into a specialized target that converted any sensed deviation from focus, into signals, to servomotors that moved the mirror the tiny bit to get it back working with the other mirrors."

"And the space scope, Tuan?"

"NASA has the same idea," Tuan said. "A lot bigger, many more mirrors, which can be thinner since they are not in a gravitational field."

"Okay, Tuan," I said. "Now let's get to technology. The way I got it, that NASA dish will have an articulated mirror of a hundred meters, and a tube three hundred meters long, right? A focal ratio of f/3."

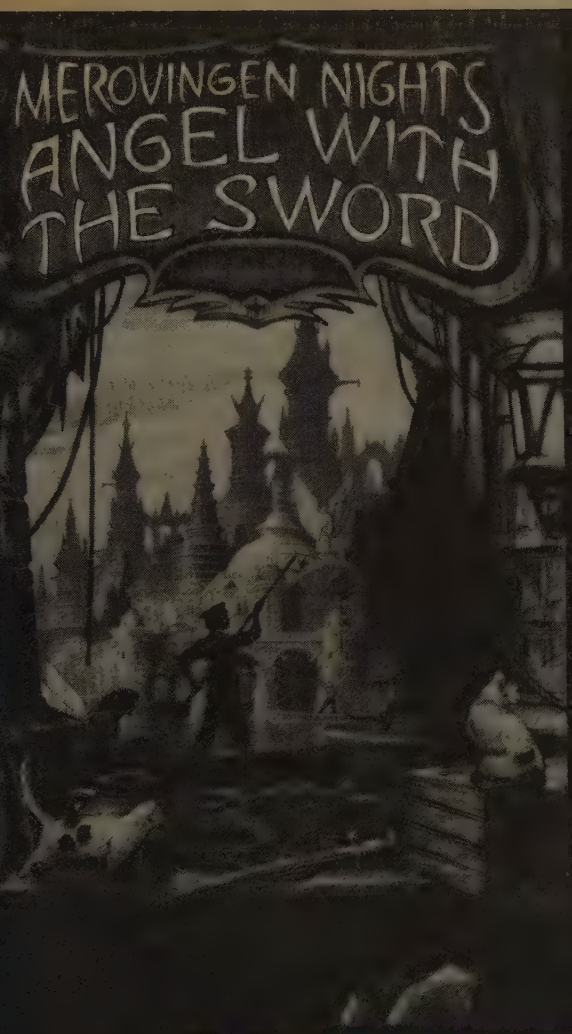
"That's right, Phil," he said.

"Well, why did they go so 'fast?' " I asked him. "I thought telescopes were long, skinny things."

Tuan shrugged. "Cost and convenience, I guess. A more conventional f-stop, if you want to look at it that way, say f/6 to f/20, would have involved a longer truss or tube to support the Prime Focus. Three hundred meters is a pretty big thing to erect in space. I suppose the difficulty would have increased with the square of the dimensions, perhaps the cube."

I thought that one over. "Doubt it. Big ain't harder. It's just bigger. They must have seen some problem that didn't relate to size as such. What was it, Tuan?" I asked him.

"Maybe NASA didn't see it, Phil," Tuan smiled. "But I would think all practical telescope designers have seen it."



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"What?"

"Earthside telescopes are heavy for rigidity, stiffness, solidity. But you pay a tremendous price to move a kilogram of stuff out to Lagrange Point L-4, where they plan to station it. So the design of NASA's space scope is thistledown light. After all, it is under virtually no stresses." Tuan held out his palms.

I frowned at my Oriental wizard. "Are you saying that beyond the parameters of a hundred meter diameter and a three hundred meter length, there's no way to keep it rigid, stiff, and solid enough, even out in space? Is that it?" I demanded.

He gave me another economical smile. "A good many telescope engineers say that NASA's present parameters are past the point of reasonable control of the articulated mirrors." He leaned back in "her" chair. "They think the construct will vibrate."

"So that if NASA saw a way to build an even *bigger* 'scope for the same dough, they would hesitate to build it themselves?"

Tuan shrugged. "Who knows what a Government agency will do? They don't have a profit and loss statement."

"Anything else that I should know about what NASA figures to build in space?" I chased him.

"They plan that the NASA construct will have its own power plant and the ability to change and hold its attitude in space. The living quarters, lab, power plant, and so on will be behind the mirrors."

"Tuan, this is great stuff. How sharp are you about telescope design?"

"Sharp enough," he said, squinting, if you looked for it.

"Am I right that the mirror is the big deal, and the major cost?"

"Yes, Phil."

"And its accuracy is everything, Tuan?"

"Pretty much."

"And," I pursued, "what is the standard or criterion of mirror accuracy?"

"Hasn't changed much in two hundred years, Phil," he said. "Mirrors can be made accurate to half a wavelength of light."

I shook my head. "How far is that? I mean, is that a very big distance, or whatever I am trying to say?"

"It's usually defined as 3,000 Angstroms, or three times one to the minus seven meters."

"Elementary math considerations hint to me," I observed, "that a flat mirror does not depart from the theoretical parabolic mirror by more than 3,000 Angstroms at some distance between the mirror and what I guess you call the Prime Focus of a scope."

He sucked air through his teeth. "As you say, Phil. Elementary. Dependant really only on two parameters."

"And they are?"

"The diameter of the mirror and the focal length of the optical system." His eyes were tiny slits, and he looked irritated, if not angry.

"Okay. Suppose the mirror is one meter in diameter. What would the focal length have to be for a flat to depart from the ideal parabola by no more than 3,000 Angstroms?"

"Hah!" Tuan Foo said, now clearly

sore at me. "From here to Tibet, for a starter!"

"That's a guess?"

"But close."

"Work it out for me, Tuan."

He looked over at my computer console. I won't have one on my desk. Mine is stuck over in one corner of the office.

"Sure," I said. "Make yourself at home."

Tuan spent only a few minutes at my console. It was, after all, simple trigonometry. The printer burped back the result. He tore the sheet off the platen and came back to "her" chair.

Tuan read it and looked at me. "Lucky Rettig Construction," he said. "Only two hundred fifty-two kilometers focal length!"

I scowled. "Not even in space," I grumbled. "Too big." I got up and walked to the window and looked at Coronado. "Tuan," I said at last. "Suppose I wanted to build a space scope with a mirror five miles in diameter—say eight klicks. And suppose I thought that a focal ratio of f/10 was about right. That would be an eighty kilometer 'scope. *Then* what would mirror diameter be where an optical flat would not depart from the theoretical parabola by more than 3,000 Angstroms?"

Tuan stood up while I went back to my swivel chair. "Rettig," he said with no Oriental blandness, "you're thinking in these ridiculous dimensions just to fake NASA into letting you build that thing in space. Eighty kilometers focal length! It's too big!"

I shrugged. "In space? Not impossible. It would—"

Tuan interrupted me for the first time I could recall. "Phil," he said. "I'm sure you have the greatest design instincts, the way you have the world's greatest everything else. You are being ridiculous."

"I guess that's possible, Tuan. Julie says that every so often. But work out what I asked. What would the mirror size be?"

Tuan walked stiff-legged back to my console and spent a little more time than before. Tearing the tape from the platen at the conclusion of the calculation, he went back to "her" chair and said:

"If your focal length is that ridiculous eighty klicks, a circular flat 57 centimeters in diameter will depart from a parabola of the same dimensions and focal length by no more than 3,000 Angstroms." He took a deep breath. "May I urge caution—"

"Don't cross any bridges, Tuan," I said, standing up. "I haven't made any bids, signed any contracts."

My rising was a dismissal signal for Tuan Foo. He rose sort of limply, hinted at a bow and took two slow steps backwards away from me before he turned to the door and left. A very comforting sort of employee.

IV

How much do you have to know about astronomy to figure costs on a telescope? My one-volume encyclopedia told me in a couple columns of type how to figure the angular size of any object in space in radians, and thus compute image size at the telescope in any scale I chose.

I had already felt an emotional urge to go for a "five mile" mirror. It was a place to start. With the eight by eighty

kilometer truss in mind, I could go to work on costs.

These fell in three big parts, really. Materials, erection, and transportation to the site in space. I could figure costs on all materials except the mirrors. Hauling the stuff to the site would be NASA's problem, for they had separate appropriation acts for that. Design and erection I could guess at by using a Finagle Factor to convert Earthside construction costs to deep-space costs. I doubted I was wrong on erection costs by more than a factor of two.

The mirror called for some scheming, and maybe a little front-money. I would have to talk with Rettig's chief beancounter. When I had the drill figured out, I stuck my head through the door to Jewel's office, said "Hi," and added: "Send for Cash and have Gene and Jerry set up for a flight back East this evening. We'll need rooms for me and the crew near the airport that serves Corning, NY. Binghamton, maybe. Tell Cash to bring the check book on the Zebra account."

Just a nod said it would all happen.

Cash Banas, our Executive V.P. for Finance, walked in a few minutes later, a big check book in his hand and worry on his face. He was wearing a vest, but no suit jacket. I held out my hand for the check book and took a quick look at its balance.

"Not Zebra, Phil," Cash said, standing across my desk to face me. "I haven't had to live through a Zebra caper for a couple years. And I'm getting older."

"Zebra, Cash," I said. "And countersign one check for me. I won't put my sig on it until I need it, okay?" He just winced. Believe me, Corporate Treasurers love blank checks. "And drop another ten million in the account for a week, Cash."

"Payee?" he tried weakly.

I shrugged. "Could be legit, could be a bribe, so I don't know."

He had no more to say, just went to "her" chair, sat down, and lowered his head over the big check book. He wrote "Casimir Banishevsky" in the space under where mine would go to make it a valid Corporate check, ruefully tore it out along the perforations, and handed it to me.

He looked up. "We would all like it better if it were legit," he said, trotting out his subjunctive for me to admire.

"Well, Cash, it might be ten million legitimate," I told him. "But maybe only one million if it's a lousy old bribe. Which would you prefer?"

"Pay the ten mil, Phil," he said. He knew we were loaded.

"Sold," I said, following him out through Jewel's office. I sat down in her visitor's chair and said "Hi," again.

She closed the Minute Book of one of the Rettig corporations that she had been studying and gave me her unflustered attention. She doesn't speak first, so:

"Julie," I said. "I want to talk, early tomorrow, to the guy at Corning Glass Works who is the highest level hot-shot they have who still knows the technical side of telescope mirrors."

"Technical?" she asked. "The 'know-how' side of it?"

"Yeah. But not just some damned engineer. I want some kind of vice-president, some clown who can speak for the Glass Works without a three-week

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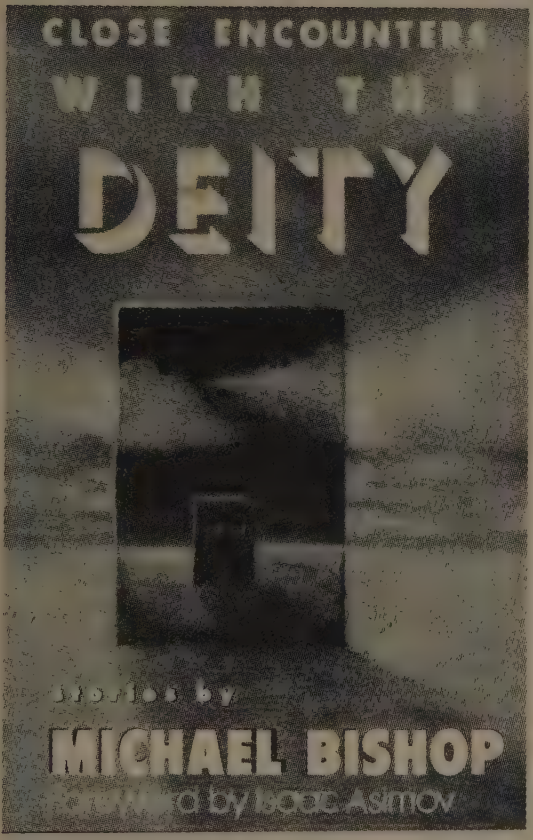

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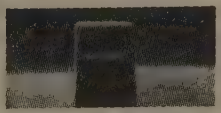

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period of percolating the problem up to the level of decision." This was a typical assignment for her.

"Tomorrow?" Jewel asked.

"Don't we have the clout, Julie?"

A little shrug. "If anybody in the private sector does," she said. "But he has to be in town for the clout to work."

"Fine. Tell him to hurry back to Corning."

V

Jewel's choice for me at Corning Glass Works was Don Nobles. Nobles was one of those big muscular guys with a cheerful puss that so often winds up in sales.

"I'm a builder, Don," I told him once I was seated across from him at his desk. "As I'm sure you know."

He nodded, keeping his words for later.

"I've got a chance to build an articulated telescope on a bid basis. I've got most of my costs in line, but I don't know a thing about mirrors."

"You don't know anything about politics, either," Don Nobles said. "Aren't you the guy who barged in on NASA the minute they got their appropriation for the space scope and got his ass kicked out of town?"

"That's me, Don," I said.

He stood up behind his desk. "NASA is our best mirror customer. After the space scope, who will build a significant astronomic scope on Earth? And only NASA will build them in space. What have you and I got to talk about, Rettig?" he demanded.

I nodded. "We have to talk about what you will do when NASA *does* take my bid, and all of a sudden Rettig Construction is the big customer for mirrors."

"Hmph!" he snorted, sitting back down. "You have't got a prayer of being allowed to bid on the NASA dish. May we concede all around that we are both panting for our hunk of the sixteen billion dollars Congress gave to NASA for the space scope?"

"Sure. So I need to know what mirrors cost. How about quoting me on one-meter hexes ground and polished to the three hundred meter focus, and accurate to half a wavelength of light, say three thousand Angstroms. Either aluminized or silvered, as you prefer."

"Some economy in mass production," Don conceded, thinking hard about it. "For one such mirror, ready to mount, Corning would bill you around $800,000. For a big quantity, say seven or eight thousand, we'd want about $750,000 each."

I picked a pad off his desk and scribbled on it: "$Pi \cdot r^2$ is 2500 meters times 3.1416, or about 8,000 mirrors, Don."

"Seventy-eight fifty-four," he corrected me wearily. "What about it?"

"At the price you gave me, worth about six billion dollars. Too much for me. Well," I said. "I don't want to bid on mirrors like the ones NASA is going to use. What I want to buy is blanks. You do sell them?"

Don grimaced. "To amateurs. Maybe you qualify."

"Good," I said. "Quote me on a hexagonal blank with a diagonal of 57 centimeters, thirty millimeters thick, and optically flat."

"A worthless piece of junk like that would cost peanuts," Don said irritably. "We have never made anything like that

because it doesn't make any sense. But there would be nothing to it. Say a hundred bucks, tops. In any quantity, less.''

''You an engineer?'' I asked him, knowing from Jewel's instant dossier that he was.

''Started out that way.''

''Me, too. So neither of us can forget his calculus, right?''

He smiled a little. ''I hope not.''

''Then figure out and write down for me the function that describes your price when you make those 57 cm. flats in quantity, so that I can figure what you would charge me for any sized order I give you.''

Oh, that was not fair! *''Any* quantity?''

''Why not? If you give me the function, you're not giving away your profit, just showing how you would adjust your price to me with volume.''

''Give me a couple of days with the computer,'' Don said. ''I wouldn't do this if Rettig weren't such a big outfit and if you didn't have a reputation for doing the incredible.''

''That's nice,'' I said. ''A secret quote, you understand that?''

His eyes narrowed. The smooth salesman's visage gave way to something much more calculating. He shook his head slowly. ''NASA is a big customer of Corning. I wouldn't want to—''

''Sure,'' I cut in on him. ''So let me purchase the consulting services of Corning Glass Works for an absolutely secret project of Rettig Construction Co. Name your Corporation's price to keep this between us, both as a quote and, if we do business, as a confidential delivered price. Am I making myself clear?''

''Clear enough,'' he frowned. ''Give me ten minutes. I'll be back.''

Nobles came back in less time than he had said.

''We are going to take Rettig Construction absolutely seriously in your request for secret consulting services, Phil,'' he said, remembering that he was selling again as he slowly lowered himself into his chair. ''As well as all possible secrecy in any production for Rettig, we will make you a firm bid based on all available technology, logistics, and management skill. We will give you our bid in ten days. Our consulting fee, to be paid in advance, is one million dollars.''

''Hm.'' I got my wallet out of my suit jacket and plucked the blank check that Cash had given me from the junk that's in everybody's wallet, and made it out. I wound up signing the check on our Zebra account ''Phillips E. Rettig III, President,'' right over ''Casimir Banishevesky, Treasurer.'' I passed it across to Don.

''Phillips?'' he asked, I guess for lack of anything else to say. ''I always thought your name was 'Phillip.' How come?''

''My Grandfather left his mark on everything,'' I said. ''Ten days. That's the seventeenth.''

He moved his head slowly from side to side. ''We didn't think you'd take us up on it,'' he said. ''We thought the million would stop you.''

I was a good kid. I didn't tell him I was ready to go to ten million.

* * *

VI

Corning's bid reached my office on the sixteenth. It was in the form of a letter, the important parts of which read like this:

"We quote the glass hexagons as per the above specifications in quantity as follows:

20 flats	*$151.91 ea.*
100 flats	*120.08 ea.*
1,000 flats	*76.51 ea.*
10,000 flats	*55.85 ea.*

"You may figure other quantities beyond ten thousand by use of the following algebraic function, where Q is quantity, T is the desired delivery interval in days, and P is our price to you F.O.B. Corning, NY."

Hm. This was more like it. I stuck my head into Jewel's office.

"Let's go over and see Tuan Foo, Julie," I said. "Call ahead so that he knows we're coming."

Tuan Foo stood in his office doorway to greet us. "Most flattering," he said to my serene right hand. He has a way of curving his spine about six microns that suggests he would bow if he were in China. It's kind of nice. Jewel gave him her courtly nod and preceded me to a chair. Tuan, as far as I could see, wore exactly the same baggy clothes he had worn ten days earlier when I called him to my office. I closed his door behind us and handed Corning's quote to Tuan.

"This is important, Tuan," I said.

"It must be," he slid in politely.

"What I have brought you," I said, "Is just arithmetic, I suppose, but it would really torpedo me if I got it mixed up." I pointed to Corning's function spelling out how to figure their selling price with volume.

"What I want to know, Tuan, is this: using this function, and giving them three years for delivery, at what quantity of optical flats will their quoted price times that quantity equal six billion dollars?"

He looked at the letter for some time. "Mmm, Phil," he said. "You must see that even at their lowest quoted price of $55.85 that would be an enormous quantity."

"Yes, Tuan. And if the price were lower still with volume, the quantity would be larger still. How does it figure?"

I could see Tuan try to keep his anger from Jewel. He tapped at his keyboard for a while. His printer hummed and clacked, and he ripped off the sheet as it fed from the platen.

"Rough and ready, Phil," he said. "It looks like six billion dollars would buy you about two hundred million blanks at a price of twenty-nine ninety-nine each." Tuan's eyes were the narrowest of slits.

"Fair enough. With a 57 centimeter diagonal, they'll be about .2513 square meters when finished," I said, using pen on a yellow Junior Legal Pad. "So what's the diameter of a circle that has an area of—" I paused to look at my scratch pad, "—fifty million two hundred and fifty thousand square meters?"

Tuan did the computer bit again. But this time he looked for a long time at the printout before he slowly tore it free at the perforation and turned to us.

"Rettig," he said. "No one with such a ramrod personality could possibly be psychic. You just have the luck

of the Devil! The diameter is 7,997 meters. Eight kilometers!" he almost squealed in fury. "Just what you wanted!"

"Shades of the Fenachrone," I grinned, and watched Jewel get that down phonetically. "That's my five miles!"

I should not have been so cool about it. Tuan advanced on me, a lightweight tiger. "Coincidence with Doc Smith, is that all you can see?" He fired a Kung Fu glare at me and then stopped to turn and wither Jewel.

"Do you want this lovely lady to stay here while I tell you what I think of you, Rettig?" he said.

I shrugged. "Why not? She knows all the bad things about me already."

"So? Then you *do* sleep together."

"Haven't got around to it," I said with annoyance, not looking at Jewel. "Go on. Lambaste me."

He stood very close to me, looking up into my face. "You asked what I knew about telescope design. This much:

"Each articulated mirror is mounted atop three small servomotors. That tripod mounting permits any attitude desired, within the limits of travel of the servos. And they travel in response to a program initiated by the degree to which a reflected laser beam misses a special target. You understand that?" he said, seizing my shirt front.

"Sure. What else?"

"So two hundred million mirrors will have six hundred million servomotors mounted out in space and wired to a computer eighty klicks away. At any one moment, what does the present state of the art say about the number of servos that will be malfunctioning? Just a wild-ass guess, Rettig."

Another shrug. "Depends on how much dough you put into them. I guess you could engineer them for virtually indefinite life."

Tuan nodded. "For a virtually indefinite cost! Don't be an idiot, Phil! Nothing mechanical runs that long in hard vacuum, and at close to zero Kelvin. Nothing!"

He turned back to Jewel. "He can't see it. With six hundred million little electric motors, each with its wear-prone potentiometer, not to speak of a tricky million-to-one gear train, he cannot picture the number of repair men in space-suits clambering around the dark side of that mirror, replacing those damned little snivvies as they pack up and quit!"

And back to me: "Phil, you can't afford to have *any* of them fail to focus. And you surely realize that with six hundred million of those ridiculous devices exposed to such an environment, you will have a constant succession of failures."

"Sit down, Tuan," I said quietly, and waited until he did. "You are right in what you say. I accept your criticism, and I thank you for it. But all it means is that you and I have to find a way to tilt the tripod mounts of the mirrors in Angstrom distances, a something millions of times as reliable in that environment as a servomotor."

I took my own advice and sat down in the only other chair in Tuan's office. I looked at my Oriental mathematician. "Well?" I said.

Tuan said nothing for a bit. "Everything we know," he said slowly, almost

musingly, "says that only a solid-state device has that kind of inherent reliability. Nothing with rotary or linear motion would be any good."

He looked back at me. "Solid state?" he said. "Piezoelectric crystals, Phil?"

I shook my head. "Sort of like a transistor, either on or off. Those cyrstals have two states, only two physical dimensions. We need a solid state device that has a physical motion that is proportionate, even if it is not a linear relationship."

We both looked at Jewel. She shook her head. "Don't ask me," she told us. "You think of it."

"Okay," I said. "Tuan, what about a bimetallic strip? It doesn't have any moving parts in the usual sense of the word. But if sensed deviation from the laser target is programmed right, we can heat or cool the strips under the tripod mounting so that differential expansion of the two metals bonded together induces a curving of the composite. By simple leverage, we can set parameters for motion at each leg of the tripod. And all the feedback devices could be solid-state, too. I'll bet that would be cheaper than servos, anyway."

Tuan's mouth slowly dropped open. "Miss Jewel," he said. "Please lead him away. No stimulants. Whiskey might help him."

Jewel stood up when I did. "Don't take it to heart, Tuan. We haven't crossed any bridges yet. Nag Horthy and those dreamers in Research will have to tell us if this makes the slightest bit of sense."

Tuan shook his head. "Too bad you own it all, Phil," he said. "If we were a public company, with our stock on the market, I could make a fortune selling short."

VII

Rettig's attorney for the caper with NASA was the firm of Levine, Shapiro, & Alvarez. Don't let that "Alvarez" fool you: he was Sephardic.

It took a lot of phone calls, help from our Senator, and six trips by Morrie Levine to Foggy Bottom to set up a full dress meeting so that Rettig Construction could make a formal bid on the telescope NASA planned to erect out in space.

Generally meetings of this kind start out with the guy who intends to have his way establishing the pecking order. This NASA sultan was named E. Clarence Putney ("Call me Clare"). He had half a dozen of his own people at a conference table with him.

He started things out like this:

"I want you people from Rettig to know that I have always been, and still am, opposed to having outsiders do work for NASA in space. You would not be here making this bid, and I want you to know that I am vengefully aware of it, without the political pressure you brought to bear on this Agency from the Senate."

He stopped, and that made it my turn. "Sure, Clare," I told him. "Your protest is on tape. Since I'm both a taxpayer and a guy who helps elect Senators, I would like this line of bullshit to stop right now. Let's do a little business. You can throw me out for good and sufficient reasons when the facts show them to be true. Okay, Clare?"

Zero-g never made him feel that bad.

"Say your piece," he gritted between teeth set in an astronaut's firm jaw.

"You have an appropriation of sixteen billion dollars to pay for construction of a telescope in space. The sixteen billion does not include any costs involved in lugging material to the site. Those are handled by other appropriation acts. Right?" I demanded.

"That's right," he said.

"Okay. Rettig Construction is making a *performance* bid to build that scope for NASA. Our bid is sixteen billion dollars, the amount of your appropriation."

"Well that's some saving!" one of Clare's yes-men cried out.

"I didn't say I would save you any money," I told them all. "I said this was a performance bid. For the same money that you plan to use to build a dish a hundred meters in diameter, by making use of the economies of scale, I'll build a dish of articulated mirrors eight kilometers in diameter. Its performance will be proportionate to its size."

"For the love of Pete," Clare snapped, unable to keep silent. "Eight *kilometers!* What could it see?"

"Take Alpha Centauri, our nearest star," I said. "About four light-years away. That's thirty-eight trillion, four hundred billion kilometers. If that star has the same diameter as our own Sol, the scope we plan gives an image size of 4.64 millimeters. Doesn't sound very big, does it? But ocular magnifications of 1,000X are routine with Earthside scopes. With the stability of a scope in space, magnifications right up to the theoretical resolving power of that space scope should be practical.

"With only 1,000X at the ocular, you'd get an image disk of Alpha Centuri of 4.6 meters, too large for a normal photographic plate. But by a series of pix, you could actually *see* its shape, perhaps find and count its planets. My tame astronomers tell me there are about twelve thousand stars within a distance from Earth that should permit this big dish to define their images as more than a point on a plate, using the 1,000X ocular. And let us not forget that at eight klicks, the big dish has sixteen hundred times the resolving power of the two hundred inch at Mt. Palomar. What do you think of them apples?"

You can imagine the hollering that started then. It went on for most of a week. In the end I promised several things:

- An eight-kilometer dish of articulated hexagonal mirrors each about 57 centimeters across at one end of an eighty-kilometer tubular truss, with the Prime Focus at the other end.
- A laser or equivalent focusing system that would scan each mirror at least once each fifty seconds.
- An option at all times of a Cassegrain or Newtonian Focus.
- Mirrors parabolically perfect to within 3,000 Angstroms, and silvered as opposed to the usual aluminum coating (no corrosion in space).
- A power plant, photographic station, controls, and living quarters behind the mirror.
- Attitude jets and/or gyroscopes capable of turning the eighty-kilometer construct 360° in twenty-four hours.

On the other hand, NASA agreed to carry to the site in space the material

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needed for construction. There was a lot of other crap about who paid for spacesuits, for training of groundlings, and equally thrilling matters. And of course, a gigantic performance bond.

A silence finally settled around the six-sided table that had seen so much blood spilled. "I gather this means that NASA has accepted Rettig's bid," I said. Clare started to stand up, I guess unable to stay there any longer than necessary after giving us the bid. But I waved him back down.

"Is it yes?" I asked.

"Yes," he gritted, turning to the rest of his mob. "Clear out!" he snapped. He sounded like a colonel then. When the two of us were alone at the table, he turned to me:

"I've had the run-down on you, Rettig. I know exactly why you made this monstrous proposal—to force us into taking a bid from you. Now I will tell you what is going to happen!"

"Gee," I said. "Even I don't know that."

"You'll fall on your face, that's what will happen. Eighty kilometers, you idiot. That's too big! But you're bonded. So when you fall on your ass, we'll pick up the bond money and do it the way we planned from the beginning. Do me a favor: Take your pratfall quick."

What could I say? After one gloomy stare at his grim face, I pulled a phone over to me. I had Don Nobles of Corning Glass Works on the blower in less than five minutes and placed our order for two hundred million hexagonal flats.

VIII

The media had a field day with our performance quote to NASA. Don Nobles stood it for about a week. Jewel stuck her head through the door between our offices: "Nobles from Corning wants you on the phone, Phil."

I nodded and pressed a few buttons to make sure of what classes of recording would be, in Sam Goldwyn's deathless phrase, "included out."

"Hi, Don," I said.

"I'm comming to see you tomorrow. We have some things to talk about, Rettig!" He was red hot.

"Come ahead," I said, shrugging with the tone of my voice.

"Not to that damned office building of yours," Don said. "That place is famous as the most thoroughly bugged piece of real estate in the world. This is going to be a private talk."

"How about out at the Beach House, where I live, Don? No business ever transacted out there."

There was a pause. "Okay. About six P.M.," he said.

Our chopper pilot Alexis Cloates dropped Don at the Beach House right on time the following evening. I stood just outside the rotors' swath with a double Beefeaters Martini in my hand. Sales types drink Martinis.

"You greet a weary traveler well, Rettig," Don said, sipping as we strolled toward the verandah.

"Gin was right, Don?" I grinned.

"For an immediate hit," he nodded. "But I started out as an engineer. When we get down to business, I hope you've tucked away some single-malt Scotch for an emergency."

"You'll have to make do on Laphroaig," I said.

Olga, my sometimes cook, served us promptly and oh so well. "I'll remind

you again that I started as an engineer, Phil," Don said as he finished the brandy that Olga had poured. I raised a finger to Olga, and she was there with the Laphroaig, which she served in a snifter, as it deserved. He nodded his thanks and kept with his train of thought. "Astronomy isn't so tough for an engineer, not the mechanical parts of telescopes and all that junk," he said.

"Suppose not," I agreed.

"Your quantity of two hundred million flats shook me. I should have known that instant what you were up to."

He pointed a finger of his left hand at me (he had the single-malt in his right). "I know why Rettig ordered flats and not parabolic mirrors," he said.

"I think you know why the tube is eighty klicks long, too," I said. "How can I argue with you?"

"You can't," he said sipping. "Any idea what your wise-ass contract cost Corning Glass Works, Phil?"

I made sure I didn't smile. "A couple billion bucks, I guess," I told him. "Two hundred million flats at twenty-nine ninety-nine each is the same gross sales as about eight thousand NASA mirrors at seven-hundred fifty thousand each. My wizards say that nobody builds things in these quantities by hand. They said they could turn out those NASA parabolas for about seventy-five hundred thousand each, so you were planning a ninety-nine percent profit of about five billion, nine hundred forty million dollars. They figured our unsilvered flats cost you something like ten dollars each in these wild quantities, which left you a profit of about twenty dollars each on those babies. That was, say, four billion. Yeah, about two billion in net profit down the drain."

Now his voice went to its full bitterness: "How do you think our buddy E. Clare Putney will react when he finds out that you are installing flats and not parabolas?"

"With an injunction, Don, if I understand the government mind. But how can he find out? Corning can't tell him—your contract with me forbids it."

He huffed at that. "Well," he demanded, "how long before NASA figures it out the way I did?"

I grinned. "First, they have to be sure that we are *not* grinding those hexes into parabolas. I promise that the smoke screen over that will be impenetrable."

He mumbled something that might have been "bastard," but I gave him the benefit of the doubt. "Corning won't forget what you cost us, Rettig," he said, putting down his glass with a firm hand.

"Not until my next order, Don," I agreed.

"You'd never order mirrors from us again!" Don scoffed.

"Sure I would, Don. You can't *want* me to go into competition with you. Whenever you build any eight thousand identical things, you mechanize. And two hundred million you mass-produce. I know how to do both. No, I'll buy from Corning to simplify my life.

"Obviously," I went on, raising another finger to Olga and the Laphroaig, "Our Big Dish out there at L-4 will be the end of astronomic telescopes based on Earth. We're about to show the world how to build a really big one in space. So who else except Rettig will know how to build one? No, Rettig will be

stuck with building scopes in space for the whole world, and thus we choose to be stuck with Corning. We should both get filthy rich. What's the matter with that?''

Don couldn't think of anything.

''All we need now, the both of us, Don, is a little injunction-prevention. That means that Clare Putney has to stay in the dark about the flats until we install enough of them to prove that they work just fine. Think you can hold your tongue?'' I kidded him.

''How long will I have to keep my lip buttoned?'' Don asked thoughtfully.

I showed him a palm as we rose from the table. ''Well, if my guys are as good out in space as they have been in the bush all over the world, I'd say a couple years.''

IX

The next morning we stood on the pad at the beach house, waiting for the chopper to take us to our different destinations.

''I'm glad I came to see you, Phil,'' Don said. ''You're different at home.''

''Who isn't?''

He shrugged. ''Yesterday I didn't give a damn what happened to you. But this morning, I know I would sense a loss if what you are trying to do out in space fell apart on you.''

I gave him a look of surprise. ''You think it might, Don?''

He held my elbow. ''You are probably the world's greatest engineer, the way you are the world's greatest everything else. But until now, the largest scope ever built is about ten meters in diameter. And you propose to jump the size to eight thousand meters. You are sure to run into problems that have never been possible to perceive before, because nothing was big enough to display them in recognizable form. Phil, it's just too damned big!''

I had to shake my head. ''You told me yourself it had to be eighty klicks long. And a focal ratio of worse than f/10 would make a lousy scope. Nope, that's the *smallest* I dare to build it.''

The whap-whap of our chopper stopped further talk on the pad. Gene and Jerry (they fly *me*) picked us up. They dropped me on the roof of the general offices and lugged Don farther down the coast to where Corning's jet had squatted all night.

It isn't exactly a ritual, but I usually stick my head in Jewel's office first thing. She nodded a greeting.

''Anything?'' I asked, because she looked so grave.

''I'll bring it in,'' Jewel said. I went back to sit behind my desk. Her present to me was a videocassette. ''You and Nobles at the Beach House,'' she told me.

This was a first. The Beach House had been off-limits to bugging.

''You have seen it, Julie?''

''Yes, Phil. I've seen it.'' She stood still and straight before me.

''I hadn't thought about it before, Julie,'' I said. ''But I realize now that I have no secrets from you.''

''You had me worried,'' she confessed. ''I've worked for you for five years, Phil. In that time I've decided on several occasions that you were out of your mind, and at other times that you were in over your head. I've always been wrong.''

''And this time?'' I prodded.

"You were too far out. It's simply too impossibly big! You had to have an angle. I had to *know*, if I was going to protect you."

This was a moment of truth. If I blew the handling of the next sixty seconds, I knew that all that Jewel and I had built as a working team would fall apart.

"Well," I gambled. "That sure settles one problem, Julie."

Her naturally curved eyebrows raised in a question. "And what is that, Phil?"

I tried for a relaxed tone: "You'll have to give up your apartment here in town and move in with me out at the Beach," I said. "You know too much, or guess too much, for me to have you running around loose."

There had never been an intimate word or touch between us in the five years. What would she say?

She thought about it for a moment, practically her trademark. "That is absolutely the most crudely formed and unflattering proposition anyone has ever made to me," she said in her version of an angry tone. "Is that the best you can do?"

I could do better. All it took was a small and dignified laying on of hands. Anyway, we made the deal. She'd move into the Beach House with me, "just to make you feel better about security on our NASA contract."

"Before we get out of here today, Julie," I suggested. "Let's pick the crew to generate the smoke-screen for Clare, and maybe pick the erection crew. Then we should talk things over at the Beach House."

She gave me a hint of a smile. I knew she would some day. "Will I be on overtime?"

"Something or other," I said. "It'll have its compensations."

X

The more I thought about it, picking a crew for the projected mirror plant we were building at Blythe called for picking one deft obscurantist. We had to hide from E. (Call me Clare) Putney what we *weren't* doing at the mirror plant. So who is the best obscurantist on the payroll? Your financial guy, of course. He hides your profits. So I picked our Executive V.P. for Finance, Casimir Banishevsky, to run the smoke-screen at Blythe.

Sticking my head in Jewel's office, I asked for Cash and Tuan Foo, post haste, Air Mail, and Special Delivery. They had never met, so I did the introductions when Jewel brought them in. Tuan *still* hadn't changed those baggy pants. Cash still hadn't found his suit jacket.

"We have a contract to build a telescope eighty kilometers long, with two hundred million articulated mirrors," I started out. "We have bought two hundred million flats from Corning to be delivered to a plant some of the gang are building at Blythe. There, in conditions of great secrecy, we will turn those flats into the mirrors called for in our contract with NASA."

I looked over at my poor coolie. "Tuan, you and Cash share the fact that you are bean-counters. Please tell Cash how we will make the optical flats into parabolic mirrors at virtually no cost."

"We won't," Tuan told Cash. "A parabola 57 centimeters in diameter with a focal length of eighty kilometers is so nearly flat that you can't tell the

difference. Mathematically, the difference is less than three thousand Angstroms, and that is the tolerance to which Phil said Rettig would hold our work. There is no need to figure the flats."

Cash is no figure dummy. "Ah," he said. "So that's why it had to be eighty klicks long."

"Just that simple," I agreed. "But let NASA, and particularly Putney, find out too soon, and we'll spend the next five years in Federal courtrooms We'd win, I suppose. But I want to build the damned thing."

Cash said: "And you want me to keep it secret?"

"Just add the new plant at Blythe to your present duties, Cash," I said. "All I want you to do is make smoke. As soon as we get the tube erected in space and a few mirrors installed, and show that they work just fine, it doesn't matter what Putney thinks about it. We can laugh him out of any court where he is after an injuntion."

"May I quibble?" Tuan asked.

I pressed my lips together. "I'd rather you didn't," I said, feeling a little weary. "My thirty years of engineering says you spend more time fiddling around to cure quibbles than you do with the original design. What burr do you have to put under my saddle, Tuan?"

"Just that you build Blythe big enough," he said. "It will be an assembly line before you are done."

He doesn't say anything dumb: "Assembling what, Tuan?"

"You have more than two hundred million mirrors to mount, and in some way to permit adjustments to their attitude. Surely you want to hitch all that gadgetry to the hexes Earthside—and not at incredible cost out in space."

"Sold," I said. "Since you got the first insight, get to know Nag Horthy over in Research. Just mounting the completed gadget will be pretty labor-intensive. What can you cook up in the way of automation?"

Tuan gave me an economical smile. I guess it was the first time we had ever had sense enough to get him out the narrow niche of mathematics. Like almost all the staff at Rettig, he had the compulsion to *build* something.

Jewel had suggested names for the gang who would design and erect the "construct" (as NASA liked to call it). She picked five of our top engineers, Tuan Foo (to his obvious delight) for the optics, and for an added starter a new hand named C. Fessenden Morris. Fez (they called him) was a sure enough Ph.D. from Stanford. His dissertation, I recalled from signing the pink sheet, was in some rare field I couldn't place that was so remote from what Rettig does for a living that I had wondered why we ever hired him. He broke up the first Erection Task Force meeting before it started.

"You really blew this, Phil," he said. I called that pretty good for a pup under thirty years of age whom I had never met before.

"I'll bet," I said. "How?"

He stuck his hands in the back pockets of his Levi's. Sure enough intellectual. "You forgot fuel for our prime movers in space, tugs, or whatever," he said, looking me right in the eye. "We'll need space-tugs to move members and sub-assemblies."

"All right," I agreed.

"Tugs need fuel," Fez told the meeting. "NASA didn't say anything about bringing fuel up to us. They'll make us pay a pretty penny, when you think how red-hot mad they are at Rettig."

He'd have handled Clare Putney better, he was saying. No doubt. "Say you're right, Fez. What's our right move?"

He looked at me with what might have been pity. "Phil, first we all close our eyes to the fact that this thing is too damned big, and that its size, not to mention its being out in space, will pose problems nobody ever heard of before."

"That's first," I said. "What's next?"

"We hire as many experienced erectors from NASA as they will let us have. They have built things in space and know how to do it."

"I don't want those bastards around, Fez," I said.

"Easier for us to invent the wheel, eh?"

That hurt. "No. Go ahead and hire them. And next?"

"We should start sending up fuel right this moment," he said. "Right up to your Lagrange Point L-4. We can get to use NASA's linear catapult as soon as we can get in on the schedule. I know they charge for that, but those are published fares, and reasonable because Congress only let them build the 'pult to help the private sector get into space. That should make up for a few of the oversights."

"Tell me, Mr. Morris," I asked quietly. "Did anyone ever tell you that you were bumptious?" There was a long moment of silence while the half-dozen old hands in the room got ready for the boss to cut a pup down to size.

"You don't sound like much of a Chief Executive to me," Fez answered just as calmly. "Hate me because I'm right? You should be damned glad I'm bumptious. *Somebody* has to speak up when you've gotten so far out in left field!"

That settled one thing. He thought he had the balls for it. "Okay," I said. "I've done enough damage today. I'll straighten it out like this:

"Fez Morris is boss of erection. If that bends noses for any of you senior guys, come see me privately." I went back to my office.

So at the end of that very long day, Jewel and I talked on the chopper as Gene and Jerry took us out to my place on the beach for the first time.

"Hey, Julie," I said above the chopper clatter. "How come you know Fez? Where did we get him, and why?"

She gave me an owlish look. "A resumé came across my desk, Phil, in from out of the cold about a year ago," she said. "Somehow I liked the look of it and sent it to Personnel with a note, 'Phil says check this one out.' I think he fills a certain need, Phil," she concluded, looking away. She was ducking me. Rare.

Grandpa built the place on the Beach. While it's dated, he sure did pick the best site on the whole Coast for scenic charm.

Jewel looked around and said it was nice in her quiet way. "But don't get any big ideas, Phil Rettig," she told me.

"Like what, Julie?"

"Like you are going to sweep me off my feet and marry me. Just looking around here, I think we could wind up with a completely satisfactory love af-

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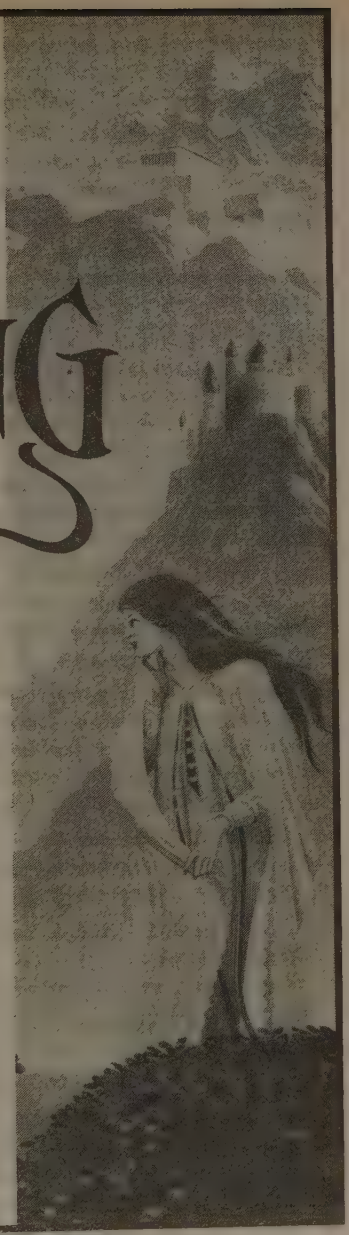

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fair. And that's enough," she finished with a nod.

"Enough?"

"Yes, If we get all mixed up and get married, everybody will feel I should quit working for you. And I'm not *about* to do that!"

XI

For a few weeks there you would think that all Rettig Construction did for a living was build telescopes in space. But we did get organized again and I started to pay attention to our other hundred big projects around the world. I did my best to get our two task forces to do the work on the big dish with little of my time involved in the job. But the scope was so special, and I guess so scary, that it kept intruding.

Surveyors' tapes and chains are made of a steel called "Invar," that is alloyed to yield a low thermal coefficient of expansion. Fez suggested it for the main construction material and successfully backed down my objection to its relatively high cost. He said something that had a long look to it:

"Invar will give the *operators* of that scope a lot less trouble than any other construction metal I can think of."

"So?" I asked at the task force meeting on materials.

"Who knows?" Fez said. "If NASA doesn't know how to *build* a big one, maybe they won't know how to *operate* a big one. We might bid on the job."

So we used Invar, prefabricating as much as possible Earthside to save costly labor in space, shooting as much as possible up on the 'pult and dragging some of it up in NASA's shuttle rockets when the pieces were small enough. Those rides were free.

The mirror task force was different: quiet, orderly, and hard to read. Cash was doing a nice job as obscurantist. He'd also laid out the best part of an automated assembly line to put the focus-adjusting tripod mounting on the mirrors, "untouched by human hands." It was only partly laid out, because Nag Horthy and Fez on the construct hadn't put the final seal of operating success on our fix.

XII

Rettig Construction's world was more quiet for the next two years. In that time Fez Morris and his gang had the scope tube and the dish completed as to framework, and the power-plant slung, in the time that I had told Don Nobles would be Rettig's normal pace.

The mildly curved dish, an eight-klick section of a sphere one hundred sixty klicks in diameter, had a most carefully aligned grid in place to receive the 57-centimeter hexes. We have some real weirdos on the payroll, and one of them came up with the idea of a "corn-planter" for the mirrors. It was just a big robot designed to crawl tenderly over the grid to which the mirrors would be fastened. In its belly it could carry nearly a million of the hexes and drop their attachments accurately into the three holes in each grid. Nothing fancy, just a high-grade Dzus fastener, of a zero-Kelvin viable material, and enough tension to hold things permanently tight.

They built ten of them, a good part of each having to be assembled in space. But Fez figured, once we got on line and really went to work, that we could

mount the two hundred million mirrors in just short of four years. We'd need that much time for the fine work on the controls, the focusing array, and the spinning living quarters. Without a simulated gravitational field for the scientists, they would be subject to being ferried back and forth to Earth every couple months for rehabilitation required from extended time at zero-g.

And by the end of the first two years, Fez had his spacesuit-clad erectors hang a few of our flat hex mirrors at different spots in the eight-klick dish. That gave them a setup where they could test what Nag Horthy's gang in Research had done with my first wild-ass suggestion of bimetallic strips to regulate mirror attitude. Of course it wasn't that simple, but Nag came up with something that was all solid state and that we could hope would run for centuries without attention.

The two-year period of relative quiet, insofar as NASA was concerned, could not last forever. Back from a meeting somewhere in the bowels of the general office, I stuck my head in Jewel's door late in the day. "Anything, Julie?"

She gave me her short pause and said: "That crazy Hungarian from Research needs a quick five minutes, Phil." Jewel would never call a person "crazy" unless it implied her approval. I nodded okay and went to sit at my desk.

Our genius from Research has a wild name: Nagybanya Horthy. He bustled in, still in his white laboratory coat. He was too jittery to sit down. He has a small, spiky moustache which I think he waxes. It quivered.

"Hot off the griddle, Phil," he said, tense. "Our mirror targeting system is not working out."

I had to frown at that one. "They don't stay in focus, Nag?"

He glared at me. Hungarians are good at that. "No," he said.

"But your tests—"

Nag shook his head. "Murphy," he said. "First Law."

Hm. "Nothing is as simple as it looks, eh?"

"Right."

"Tell me, Father, where did I go wrong?" I asked him.

"Material," he said, getting tense again.

That stopped me. "Like what, Nag?"

"You let that pup Fez Morris talk you into using Invar instead of structural steel or structural aluminum alloy."

"So?"

"Invar is just another alloy at Earthside temperatures. But at the low temperature in space, it exhibits a really low internal damping or hysteresis loss. Start a vibration with a blow, even a loud accoustic shock, and it runs up and down that eighty-klick telescope longer than you would believe. And the shock wave transfers to the eight-klick dish where the mirrors are mounted. The mirrors jiggle. Constantly."

"Oh, I can't see *constantly*, Nag," I started to protest.

"Talk to Fez," he interrupted. "He won't radio you. NASA monitors our communications."

"How come you know this?" I wanted to know.

"George Heebner, one of my gang, came back from the construct on the shuttle this morning. Fez clued George in," Nag told me.

"Can you keep this scary stuff bottled up with George?"

He bristled. His *moustache* bristled. "Research people don't talk!" he snapped.

"Not even to wives?"

"Not even to *mistresses!*" he said

Jewel came in, sweater over her arm, the moment Nag Horthy left.

"Were you listening to us, Julie?" I asked.

She nodded.

"Getting it on tape?"

"No. Too hot. I've been worried sick about those flat parabolas for two years, but this sounds worse."

I started to speak, but her finger motion stopped me. "And that's enough talk for now. This place really *is* bugged. I've already sent for the chopper. Let's kick it around at the beach house."

After Gene and Jerry had dropped us at the Beach, we sent Olga home, made some *huevos rancheros* and guacamole ourselves, and took it to bed. Sometimes we talk business there, if Jewel doesn't get distracted.

She drew close to me and almost whispered. "You've kept those flat hexes secret for two years, Phil. How long can you get Nag Horthy and George Heebner to keep that vibration problem out of circulation?"

"Not long," I said. "After all, Clare Putney has known all about the flat mirrors for a couple years."

Jewel sat straight up in bed. "What!" she said, a sort of soft exclamation.

I grinned and chucked her under the chin. "Don Nobles had the news on those flats leaked to 'Call me Clare' within a couple days of his visit here. He had to. If we flop out in space, and Don is afraid we will, NASA will again be his only mirror customer. He'd be crazy not to protect himself."

"Lordie!" Jewel breathed. "Then how long before Clare knows about the focusing problem?"

I looked over at the lighted alarm clock on the bedside table and started to bring all this serious talk to a halt. Jewel let me draw her to my side. "George Heebner has already whispered all this to his wife, or will later tonight. I suppose the news will be in the Rettig grapevine by noon tomorrow. Clare won't know for a couple weeks, I would judge. I think we have that many friends."

"Oh, Phil," she sighed, tickling my ear with the tip of her tongue. "Is it really too big?"

"Maybe, Julie. But I think Scarlett O'Hara was right. We should worry about that tomorrow."

XIII

First thing the next morning, I called Fez Morris on the radio. I knew Jewel was monitoring the call.

The distance between San Diego and our "Construction Shack" at L-4 was, of course, a little under 400,000 klicks, which meant a delay of a second and a third from the time each of us spoke until the other heard.

"You sound good, Fez," I told him, Company code for "We are being monitored by NASA."

Pause.

"Feel good, Phil." He acknowledged the coded message.

"Talked with Nag yesterday," I told Fez. "He says I better come out to see the construct for myself. The way you

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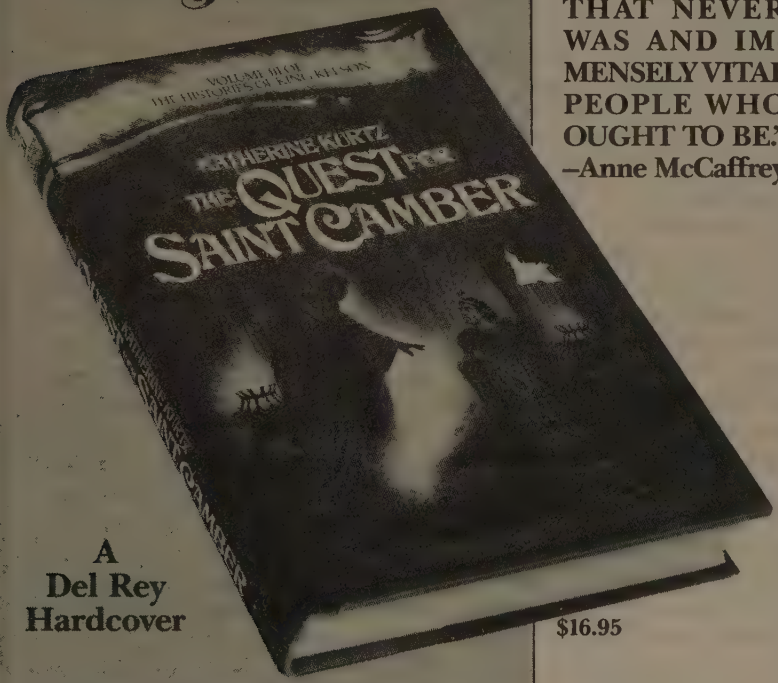

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guys are racing through this job, he says it'll be done before I get there."

Pause.

"How soon, Phil?" Fez's impatience for me to get out to the site sounded as though he felt he was in over his head.

"Day or two, Fez."

Pause.

"Good. How about bringing Tuan Foo along?" He *was* in over his head, and he needed a mathematician.

"Okay, Fez," I said. "I'll see if his old lady will let him out in space."

Pause.

"He hasn't got an old lady, Phil."

"Everybody has an old lady," I told him. "Over and out."

I was just reaching for the phone when Jewel came in. For once she had forgotten her sweater.

"No!" she said, for a rarity speaking first. "I won't hear of your going out into space!"

With a finger on my lips, I picked up the phone again, pressing buttons to establish the nearest thing to a bug-free environment in my office.

"You heard Nag Horthy, Julie. You just heard Fez. The kid up there admits in some oblique way that he's in over his head. We know from George Heebner what the problem may be. Sometimes the boss really leads the troops. This is one of those times."

While she thought that over, she slid smoothly into "her" chair. "I hate to say this, Roomie," Jewel said, "but you're too old to make your first trip into space."

"Probably," I agreed. "But Fez's safety drills have been effective. We have yet to have a space-related fatality on this project."

"And you want to be the first?" she said, as close to anger, and perhaps tears, as I could recall.

"Make you a deal, Julie," I grinned. "You can come along."

She topped me: "This place couldn't run ten minutes without me, Rettig. Go on—put on your dog and pony show. The whole world is watching and waiting."

XIV

We had a deal with NASA. Our people could go to L-4 on the Shuttle any time they wanted. Tuan Foo and I wriggled into "one size fits all" spacesuits two days later.

In spite of all we knew, Tuan and I were unprepared for the God-awful *size* of the "construct," as NASA had gotten all of us used to calling it.

Fez Morris had made sure that any visitor from Earth could tell just how huge his scope was. As quickly as the construction crew welded Invar into place, Fez strung yellowish halogen lights around the perimeter of the thing. Nearly two years of building had gone by when I made my only trip during construction. The dish and tube were complete as far as framework went. So my first view when the tug carried us from the NASA Shuttle rocket to our construction shack was of strings of yellow lights fading away into the distance as a framework eight klicks in diameter and eighty klicks long, nearly invisible in the dark of space, tapered in visual perspective.

Fez was in the shack when I led Tuan Foo in a crawling struggle through the flexible tube connecting it to the tug. "Get those suits off," he said.

Free of the suit's constraint and hanging on to a handhold (they were everywhere) you could possibly say I was back on my feet.

I took a deep breath and turned to face our problems. Jewel was right. I was too old for this stuff. Fez Morris frowned a little at both of us, clinging like bats to a cave wall.

"You really do look good, Fez," I told him, aware that he had left the Construct only once in two years for a medical check-up on which NASA insisted.

"Older," he admitted with a healthier looking grin than mine. "And I hope wiser." All of a sudden I got it. I might be Phillips E. Rettig III, but there was no Phil the IV, nor would there be. I was looking at my possible successor. Maybe Fez hadn't caught on yet, but Jewel must have thought he might go all the way.

I rolled my eyes at the mob of engineers and such working in our construction shack and said: "How do Tuan and I get a ride to your test station at the Newtonian Focus, Fez?"

"With me, Phil," he said. "It's only about twenty klicks up to that end of the tube from where we have our shack falling free. Let's go."

We both nodded and dragged our bodies after him, back into our low-powered jitney, which rolled out of its cradle and started up the length of the tube. You could see our movement only in terms of Fez's halogen lights swimming past our view-ports.

"Looks like a dirigible framework, Fez," I said.

He agreed. "Nearest thing ever built to this in terms of need for longitudinal stiffness and lightness. We took a lot of lessons from Count Zeppelin."

I started a superior smile as I heard the "test pilot" monotones of our pilots. They were, after all, borrowed from NASA. My flicker of amusement came from the way our crew treated our little jaunt through space, which I suppose somebody made twenty times a day, like the launch of the giant shuttle from the Cape.

But as I watched the halogen lights on the huge construct get closer and could see the Newtonian Focus end of the tube take shape as an eight-klick ring of lights, I could realize that to count on depth perception, or almost any other human sense to bring us home, would have been a bummer. It took radar, radio, and forty kinds of gyros and accelerometers to get us lined up just right. I could hear the tug's computer's synthetic voice do the final countdown as we oozed closer to the docking cradle.

"Seven meters, six meters, six meters, six meters." I felt a tiny thrust. "Four meters, two meters," and another different thrust. "One meter, one meter." And then a brief shock as the grapples pulled us against the air-bag and hooked up the crawl tube.

We followed Fez through, wriggling as best we could.

His test station had all the native charm of an outdoor privy: space-worthy, but without a right angle in it. Fez had wrapped it around main girder number 63 on the scope tube.

He stood on no ceremony, but pushed off from his handhold where the three of us had clung near the airlock to the crawl tube. He seemed to swim over to the big girder, and braked on another

handhold. I got some snickers from the two technicians working in the station for my try at handling zero-g the way Fez did. With some mild caroms, I wound up close to where Fez Morris clung to girder 63 in the middle of the test station. I waved to Tuan Foo.

"Watch that first step, Tuan. It's a killer."

But he floated over to join us with a kind of Oriental calm and detachment that I envied.

The big girder had started out as a super-colossal "I" beam. But its web and its flanges had been pierced and cut away to the point where it was more holes, ovals, rounds, triangles or what have you, than original material. I complained to Fez:

"Can this collection of holes actually support anything? I swear it's more holes than beam."

"Right," Fez said happily. "It weighs about forty percent of its original weight. But in the position we have it installed, it is about ninety-six percent as strong as the original member. In some other attitudes, under different stresses, it would fold up pretty quick."

"Yes, *Mein Graf*," I said.

The part of girder 63 inside Fez's test station sprouted a sort of growth of dials, clamps, mikes, recorders, and the like.

"Our riggers have spotted about a dozen of the mirrors at scattered points in the dish so that we can make tests. We built this scope knowing that we would have to focus the mirrors at the outset, and perhaps some or all of them at intervals later. After all, nothing is perfectly rigid, and squatting as we are in the Moon's orbit, Earth will eclipse the Sun every twenty-nine days," Fez observed. "That means we must expect some departure from rigidity as the construct cools while in the umbra. Even Invar has *some* thermal response."

He looked at both of us, one after the other, for a moment. "All this we are prepared to do, Phil. But we have run into a second set of problems that I don't think any of us contemplated. The first member of that set is the speed of sound in Invar," he concluded.

"More than atmospheric Mach One, of course," I said.

Fez smiled a little bitterly. "Yes, something more than three-hundred thirty-five meters a second. Sonic speed in Invar at this ambient temperature is about twenty thousand meters a second. It really carries energy."

I nodded.

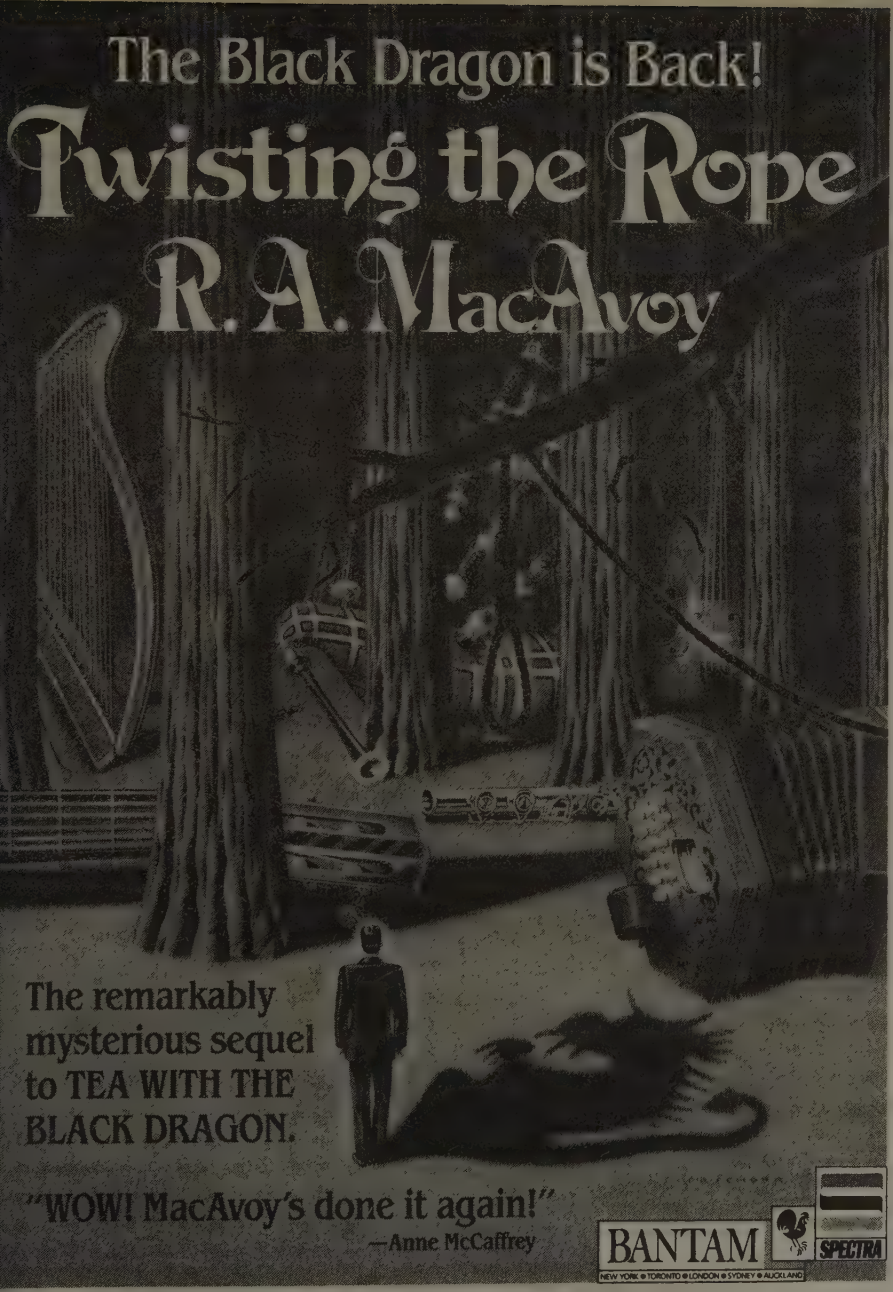
"Second problem of the set, Phil," Fez went on. "Invar has a remarkably low hysteresis loss at this temperature. Any impact imposed on a girder like this one here doesn't die off very quickly. The shock wave bounces back and forth between ends of the girder. An eighty-klick guitar string."

That sounded like a dumb remark to me, Fez's first one. "So?" I asked.

"Because any shock wave is renewed by new impacts, that sonic vibration can be counted as permanent. While hysteresis blunts it, the girder gets another blow before the vibration of the first is fully damped. It keeps bouncing from one end of the scope to the other."

"Is that all?"

"One more, Phil, although this may be for Tuan Foo to handle," Fez said. "The shock wave propagated down the girder has an enormous frequency, so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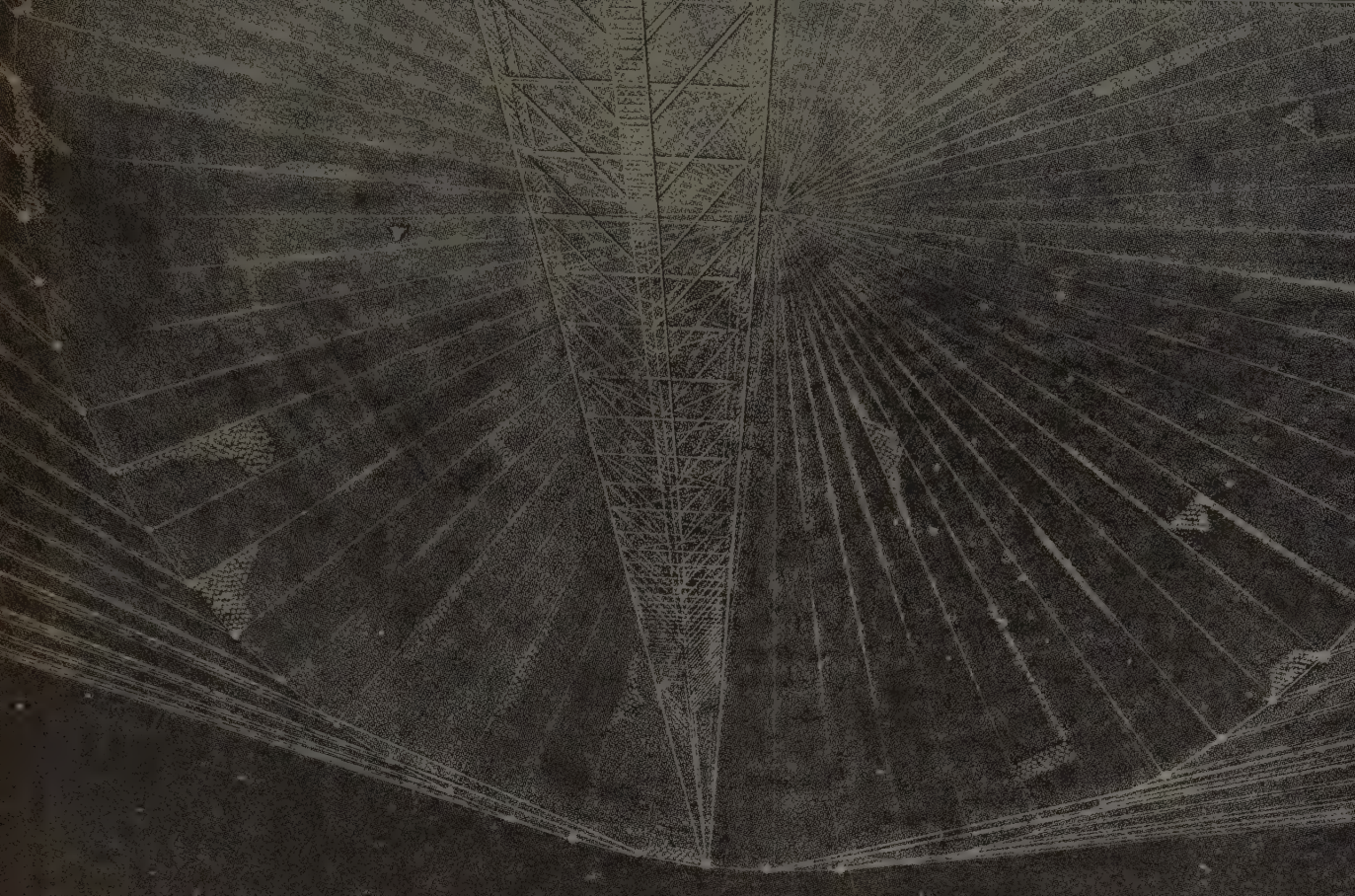

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that the lateral component of the wave also has a high velocity. When that wave hits the mirror dish at the bottom of the scope tube, it transfers some of the lateral component to the Invar frame of the dish. It makes the mirrors jiggle!"

"Now we know why Fez wanted a mathematician, Tuan," I told my Oriental bean-counter. He clung, white knuckled, to two handholds, feet drifting limply away from his trunk. "Fez can't figure out how that smack of energy is making the dish wiggle. Can you?"

Tuan Foo shrugged, gingerly let go with one hand, and pointed at the keyboard of the nearer of two big computers. Fez nodded, and Tuan did his "Flying Chinaman" imitation. Anchored at the console, he started programming cartoons of the problem.

Fez was right. Tuan's graphics showed that induced motion in the dish looked like concentric circles with the center at the point where the vibrating girder met the dish. Since all lines across the dish were rhumb lines, energy pumped in by vibration had to show as deflections in the sphericity of the frame of the dish.

Waving the two curious technicians away so that Fez, Tuan, and I could talk things over softly without being overheard, I tried some questions.

I pointed at the garden of instruments growing so fertilely on girder 63. "Fez, does one of those two dozen recorders keep track of the vibration in the main girders?" I asked him.

He pointed to one of the instruments, kin to a recording oscillograph, mounted on the beam. I looked at the long sawtooth squiggle streaming from the stylus as the paper tube sped from one spool to the other. I nodded and turned to Tuan Foo.

"Tuan, your cartoon graphics are exaggerated so that we can see relative motions. What is the absolute magnitude of one of those concentric ripples in the dish? In other words, how far *vertically* is each mirror displaced?"

Tuan swung almost as easily over to the computer keyboard again and entered my problem. "Have to make a few assumptions, Phil," he said. "Let's hope my errors are offsetting."

The printer hummed. Tuan took care to tear the hard copy from the platen. We were destroying the evidence.

"Well?" I said. "How much vertical displacement, Tuan?"

He shrugged. "Hardly any, really. Twenty Angstroms, perhaps."

"Angstroms?" I said, surprised.

"The speed of sound is so great in Invar that there is no time for the wave to generate much lateral displacement across the dish, which is the vertical component you are looking for. I say twenty Angstroms."

Fez shook his head angrily. "No way," he said. "The returning particles of the laser scan are displaced from the Prime Focus by a good millimeter, sometimes more, in their one hundred sixty klick round trip to the mirror, surely enough to ruin any celestial photograph. That displacement is a hundred thousand times as much as the vertical displacement of the mirrors that Tuan has computed."

I nodded and said: "I think that does it for now. Let's get back to the shack."

Fez's eyebrows started up his fore-

head. Even Tuan opened his Oriental eyes a bit.

XV

As the construction boss, Fez had a private office in the shack. There were enough seat-belted stools to hold a decent conference. Fez sat, if that's what you call it in free-fall, behind his desk; and Tuan Foo and I faced him.

"First," I started, "let's get rid of a nonsense issue." I did a little glowering at Fez, who should have known better than what he had suggested. "An eighty-klick telescope tube cannot be compared in any sense that affects our problem with a half-meter guitar string."

I just got frowns for that one. "Well," I pursued. "Any shock wave moving at twenty thousand meters a second makes a round trip in a main girder in eight seconds, for a frequency of .13 Hertz. Strings on a guitar probably average about 440 Hertz. That refers to their *sideways* motion, the source of the sound we hear when the string is plucked. So .13 Hertz is one *real* bass note. Slow as it is, both of you know that this eighty-klick construct is *not* vibrating side to side .13 times a second. That would take an incredible amount of energy, when you think what the whole construct weighs. So we throw out the analogy with the guitar string."

"What then?" asked Tuan. Fez was wrinkling his brow and trying to think along with me, or ahead of me.

"I can see vertical displacement on the order of a few Angstroms in the dish from energy transferred from a main girder. I would guess that if you looked into the total mass of the dish and the amount of deflection at any one instant, by subtracting troughs from waves, you'd come out with a reasonable figure for the number of dynes involved."

Fez protested: "But the big scattering of the focus," he said. "How do you account for that?"

"You are looking at a wave or ripple, as we saw in exaggerated form in Tuan's graphics, moving across the dish. Those waves *tip or tilt* each mirror for an extremely short period of time and through an incredibly small angle. After all, that tilt only displaced the returning particles of the laser scan by about a millimeter in a round trip distance of one hundred sixty thousand meters. If we weren't aiming at a degree of perfection that has never been achieved in anything ever built of this size before, we'd think nothing of all this.

"Notice, too, that because this is a true wave across a surface, the trough of the wave returns the energy used to tilt the mirror back to the dish. Thus any small increment keeps the ripples going."

"A great lecture on solid state physics," Fez said, angry now. "It leaves us with devastating focus problems no matter how you slice it!"

I nodded. "I'd agree with that, for the moment," I said. "But let's look ahead while we keep our tempers, eh, Fez? Does the construct now resonate with all the energy that will, over time, be imparted by blows and loud sounds and the like?"

"No," Fez said, cooling off a little. "Of course not."

I looked to Tuan for his answer. "Phil, there will be people working around this scope for the next thousand years. They can't avoid banging into things. No, there will be more and more

resonance added in time, from which hysteresis will continually subtract to an unknown degree."

"So the ripple and focus problems will get worse and worse?" I asked.

This time they both exhibited a cerebral pause, finally looking each other in the face. Tuan shook his head briefly. "No!" Fez said, showing surprise at Tuan's agreement.

"Why not?" I asked.

Fez spoke slowly. "It would seem to me that new vibrations will start to overlap older resonance, which we know in time will begin to die, for there is *some* hysteresis loss. I suppose that enough of these events will have the effect of leveling out the resonance, which will be the sum of many vibrations. One peak will fill in the other valley."

"And cancel each other out?" Tuan asked him doubtfully.

Fez shook his head. "No. The imparted energy is still there. At some rate it will be converted into heat as hysteresis kills off the waves. But the rest of it will be part of the energy content of the construct, much as thermal energy is part of it. This would be kinetic energy, I guess."

"So what happens?" Tuan demanded.

Fez smiled ruefully. "I suppose eventually, and it might be a *very* long time, this whole construct will sing its own song, a subdued hum of incredible quivers. I would think this high-frequency hum would have so little amplitude that it would not be perceptible. It would not make observable ripples in the dish or materially tilt the mirrors."

Tuan nodded. "Sounds about right," he agreed. "I wonder if we could calculate how long, in years, centuries or what, it will take the construct to reach that status?"

I'd been thinking while Tuan was talking. "Why bother, Tuan?" I asked him. "How about speeding up the process yourself? Why not set up some kind of hammer, or maybe a bunch of them, that bangs on a girder, or maybe all of the main girders, continuously—maybe at random intervals. I'll bet you could get to the status of 'subdued hum' pretty damned quick."

Fez's face showed pain. "They said you would—" he started, and then shut his mouth.

"You and Tuan can work this out," I said. "Just don't make any big thing out of it with the troops. Let's keep NASA thinking we knew what we were doing all the time."

"Hey! Hold it, Phil!" Fez said. "Work that out? There isn't a damned thing out here at L-4 that wasn't reviewed by about three committees to make sure it was essential. There's no spare nothin' here. What am I going to use to generate my 'subdued hum?' "

I had to agree. "I'll ride the Shuttle home now, Fez," I said. I looked over at Tuan. "Coming with me, Wun Long Hop, or do you think Fez could use you for a while?"

Fez answered that: "He stays, Phil. How many times do we have to beat on the main girders to get the vibrations to so high a frequency that we can ignore them? Only Tuan can figure that out."

My Oriental squinted his eyes in a smile. "I don't know, either, Fez," he confessed.

"Wait, Tuan," I said. "I have to have some idea, too. I'm going to be

rushing some kind of equipment up here to bang on your girders. How many bangs?''

Tuan Foo held out his palms. ''A million?'' he said. ''Is that even the right order of magnitude?''

''I'll set you up for a billion quick ones,'' I promised. ''Fez is right. Stay. Help him measure what you are getting. I know that test shack had a raft of recording instruments in it, but think about whether you want more sophisticated stuff, things that can measure much higher frequencies and show them in slow-motion. Whatever. Name it. You'll get it.''

I pointed a friendly finger at both of them: ''I repeat: let's keep NASA out of this as far as possible.''

I made a pretty good dive over to the hand-hold at the exit to Fez's office. ''Nag Horthy and I will fake up something for you. No communications. It'll be obvious and will be marked 'Research Instruments.' Think we got it right?''

I got two nods. Grudging from Fez. Respectful from Tuan. As I said, he was really a very comforting sort of employee.

XVI

Jewel was glad to see me back on Earth. At least she said so. ''It was nice to run it by myself,'' she told me. ''All the Executive V.P.'s were so kind.'' (We only have three.)

''Anything new, Julie?''

''I'm not sure,'' Jewel said. ''But it's possible that Clare has picked up the news on our vibration problems.''

''Shucks,'' I said. ''I need a couple days before I tangle with that—''

''Stop!'' Jewel said. ''You are through using words like that—''

''Like what?''

''Like what you were going to call Clare,'' she said.

''Well,'' I grumped. ''Maybe not in front of you. But that certainly doesn't change the sad facts.''

Clare Putney had me on the phone within an hour after I checked into the office from the jaunt to L-4. ''No,'' I told him. ''I'm not coming to Langley because you're afraid you'll wet your pants if I don't. That damned scope out there at L-4 is a mighty small part of what Rettig Construction does for a living. I got some things to take care of before we can meet.''

''Just what is more important?'' Clare said importantly.

''The public water supply system in Jakarta has packed up and quit. It's squirting typhoid all over a hundred mile radius.'' This was pure baloney, but not such a bad guess, maybe. They always have water supply problems in Indonesia.

''No one else is smart enough to go and handle it, Rettig?''

''They insist on me,'' I said modestly. ''Hurry right back, Clare.'' I hung up before he could protest.

Wondering just how long that hokum would hold Clare Putney, I looked in on Jewel. ''You heard, Julie?'' She nodded.

''Better get Nag Horthy over here. And send somebody on a milk run to Jakarta,'' I said.

''Somebody named P. Rettig?'' she said, reaching for her phone.

I grinned. ''And with convincing luggage and briefcase.''

She shrugged. "Might get you forty-eight hours, Phil."

"Time enough, if Nag is on the stick."

My crazy Hungarian (I'm quoting Jewel) came in only moments later. I told him just about verbatim what Fez, Tuan Foo, and I had said at the construct. "So, my boss of Research, I ask you to cobble up something that will bang on Fez's girders, OK?" I said.

Nag took his time to sit down, choosing as most of my visitors did, "her" chair. He unbuttoned his starched white lab coat—a first in my presence. "Sounds too simple, Phil. You think it will work?" he asked, delicately testing the waxed points of his spiky moustache with a cautious finger.

"Why not, Nag?"

"Well," he mused, "I don't know the actual hysteresis loss, but if it is negligible, and you add more impacts, maybe you'll wind up with a wave which is the superposition of all of them. Some peaks may fill in some valleys, but it's just as likely they will reinforce existing peaks. Wouldn't you wind up with a very complicated, random-looking waveform of ever-increasing amplitude? It might shake the whole construct apart. What do you say to that?"

"Three things, Nag," I answered. "First, hysteresis loss is low, but not negligible. Second, while the whole construct hasn't been in existence two whole years, at least half of it has been there for a full year. It isn't shaking apart. Certainly we bang it around harder during construction than will be the case in later times. That must be proof that there is enough hysteresis loss to prevent indefinite ganging up of peaks. And third, Fez had a meter recording the vibration frequencies of the construct on a long roll of oscillograph paper. He had the gain way up, so that the peaks and troughs were visible even at the high speed he had the paper moving under the recording stylus. The pattern was quite uniform, a classic 'saw-tooth' with no 'rogue waves' in it. The construct is humming its song already. We just need to increase the frequency enough to get amplitude down to where it won't tilt the mirrors."

"What I wish," Nag said, "is that you damned engineers would stop talking like physicists. You don't know a thing about it."

"Sure," I agreed. "So how will you go about it, Nag?"

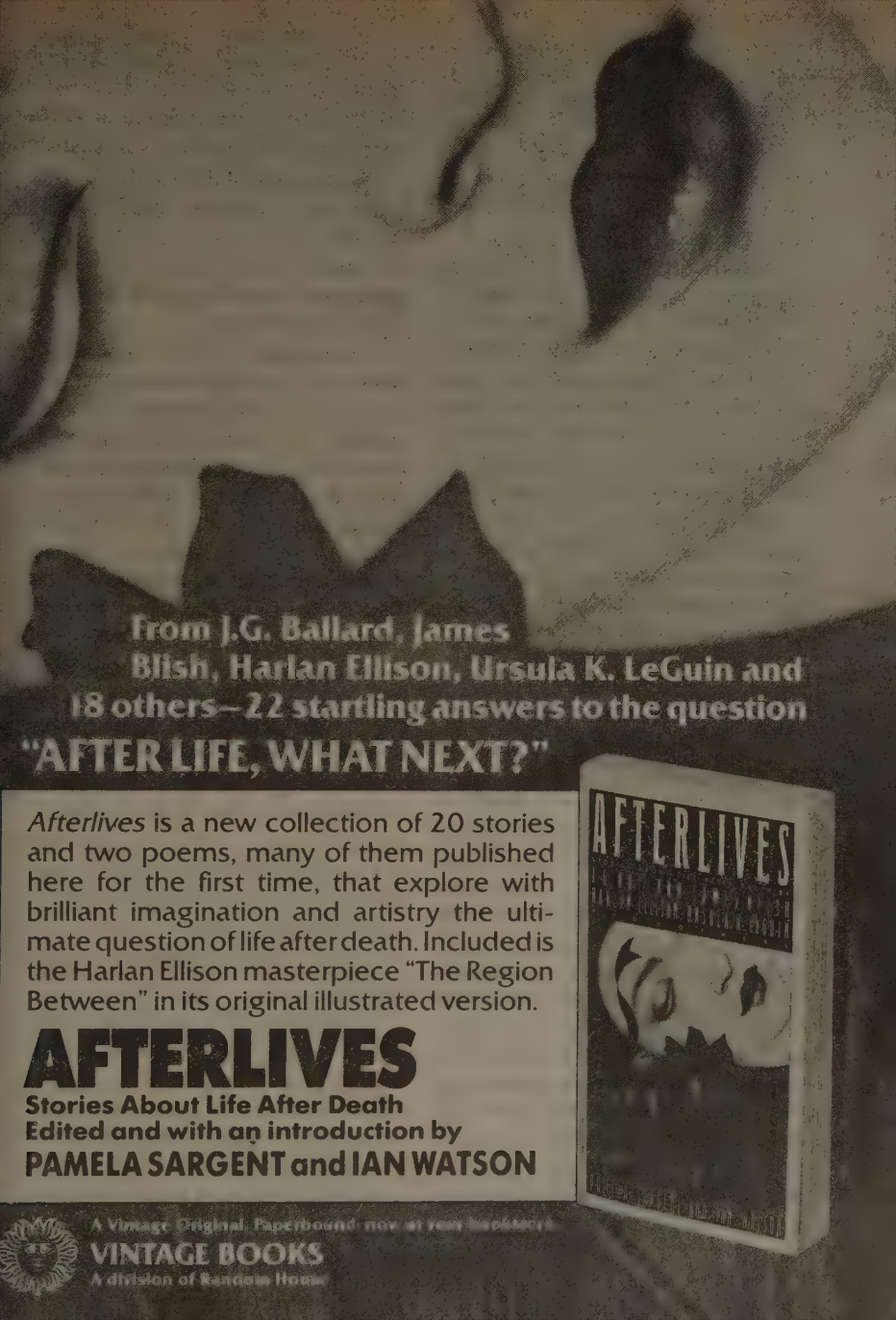
"Let's see: sixty-four main girders. I'll send him seventy-five half-horse electric motors with slightly oval flywheels of a material that can stand the gaff of a lot of thumps. Have to mount the motor on some kind of wiggly base, maybe rubber. That calls for a doghouse so that we can control temperature enough to keep the mounting pad flexible. Wonder how long they'll have to run?" Nag asked.

"Maybe forever, Nag," I said. "So get the heavy duty model. Just how fast do those motors turn, Nag?"

"Off the shelf, fourteen-fifty rpms," he replied.

"Okay, but build in a snivvy that gives Fez the capacity to control each motor's speed slightly, say a control range of one hundred to two hundred rpm. That will help assure that our impacts don't gang up on each other."

"Done," Nag said.



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"So, how long for a billion impacts?" I asked him.

"A *billion?*" Nag said. Like most scientists, he had respect for truly large numbers. "Take forever, Phil."

"Are you sure?" I asked, doodling on my yellow Jr. Legal Pad. "I get ninety-eight hours, Nag."

"Bearable," he agreed. "We'll fake up a simple dog-house in no time."

"Think that over," I suggested. "First, those motors may have to thump forever. And second, if you put a dog-house on each of the sixty-four main girders, those snoops from NASA will have a million questions that we don't want to answer for a while. Make them be and look permanent. Can you think of anything else we could put in the dog-house as a smoke-screen?"

Nag's spiky moustache quivered with his smile. " 'Never give a sucker an even break,' " he quoted. "Sure. Doesn't have to be useful, does it?"

"Got to sound useful," I argued.

"How about strain gauges, Phil?" he suggested.

I squinted at him while I thought it over. "Okay, Nag. In the seventy-five dog-houses that will have motors for banging on girders, put strain gauges and leads to some central recording facility. Fez can fancy that up as much as he thinks is needed to convince NASA that we are really monitoring strains in the construct. Then, Nag, build another thousand dog-houses in the next couple weeks that contain only strain gauges. Same solid quality of dog-house. Have Fez place them strategically all over the contruct, and wire them into the same strain recording center." I chewed on a lip.

"One more thing," I said. "Label the dog-houses plainly: 'Strain gauges. Vessel under pressure. Do not break pressure seal.' That just might keep Clare's snoops out of them for a while."

"Use the 'pult or the Shuttle, Phil?" Nag asked, standing and buttoning his lab jacket.

"Shuttle for the first seventy-five dog-houses. You'd have to stand in line too long for the 'pult."

A couple days went by. Jewel got tickets for a "Rettig, P." for Jakarta, and some stooge from Personnel carried an empty brief case halfway around the world while Nag and I sweated at getting material together for Fez and Tuan. We had barely got the report that the Shuttle had blasted off with our "Research Instruments" in its hold than Clare Putney was screaming at me over the phone.

After some pretty fair profanity, Clare yelled: "Rettig, we know you didn't go to Jakarta! There's nothing the matter with their public water supply! And we don't like the idea of your shipping some creep over there just to stall us."

"Suppose not, Clare," I said, trying to sound sheepish. "But it worked, and as Mayor Pragma of Rome said in 1879, 'If it works, it's good.' "

I got fresh orders: appear at Langley at once!

"Can we keep this simple at the start, Clare?" I asked him over the phone. "Do you need more than an astronomer and a lawyer to help you at this stage? We only need three to meet with you: me, Morrie Levine, and Jewel."

I hung up with some kind of grumbled assent, and looked over at Jewel. "I

guess he *was* the last to know," I said. "We've got an awful lot of friends."

XVII

Clare had two men with him whom we knew from the yelling matches with Morrie Levine when we hammered out the contract two years earlier. The astronomer was Pietro Fibonacci, a bright one, and the lawyer was Fred somebody.

Clare was at his desk. He had a table set "T" fashion to it so that we could sit on each side and glare at each other. Fibonacci could not look me in the eye. Fred was scribbling on some foolscap.

"Why are we here, Clare?" I asked.

He took his time, and got the full savor and relish out of his answer: "We are here to negotiate a termination of your contract with NASA for construction of that thing cluttering up L-4!" he said.

"Hardly necessary, Clare," I said mildly. "We may want to renegotiate a point or two, but terminate? No. We want to finish the job."

"Tell him, Pietro," Clare said to Fibonacci.

Pietro looked up, first to Morrie Levine, and then to me, and found he still didn't have the guts to look Jewel in the eye. "I have just come back from the construct," he said. "I have made a careful examination of the dozen mirrors you have in place. I found—"

"Yes, yes," I interrupted. "You found they were optical flats. Now, Pete, as an astronomer—"

"Oh, shut up, Rettig!" Clare hollered at me. "You and your damned flats! We've known about them for nearly two years. (I winked at Jewel on that one) And yes, Rettig, we know why they work and why they meet the specs of three thousand Angstrom conformity."

"I'll be switched," I marveled. "Two years? And to think of the trouble we've gone to—"

Nobody would let anybody finish a sentence. "What a pack of dumbbells you must have thought we were," Clare said.

I turned back to Pete Fibonacci. "So they're flat, Pete. Clare just said he knows why they work. What's the beef?"

"That isn't what I discovered, Mr. Rettig," he said. "You made a fundamental engineering error, and you know it yourself. You just can't make that big a jump in scale without running into problems never observed before. The thing is just too big to work at the present state of the art."

"What doesn't work, Pete?" I asked.

He took a deep breath. "I was at the construct the same day you were, Mr. Rettig. Within an hour of the time you left that test station on girder 63, I was in there, talking with the technicians and looking at the computer analysis your mathematician, Mr. Foo, had made. Your choice of Invar has backfired. Your eight-kilometer dish *ripples* when any major shock is transmitted down one of the girders. And keeps rippling because hysteresis loss is so small at temperatures in outer space." In other words, he had seen Tuan Foo's cartoons.

"Now what we propose," Clare said. "Is a statement from Rettig confirming our finding and accepting a mid-contract termination. We'll give you your direct

costs. We'll accept ownership of that pile of scrap iron and those two hundred million useless mirrors. When we finish building our construct as we planned, a hundred meter dish and a three hundred meter tube, we'll hit your bonding company for our shortfall in funds. Fair enough?"

"It would be," I agreed. "If Pete knew what he was talking about."

"Don't try that on me!" Clare snapped. "He brought the floppy disks with him. I've seen Tuan Foo's graphics!"

"Yeah. So we both have. Pete should have stuck around for another hour or so, Clare. I admit that rippling was something we hadn't counted on. But it was just an engineering problem. We handle those every day. So we doped out a fix for it inside an hour. Those mirrors stay in perfect focus," I said.

"That's a damned lie!" Clare yelled. Fred stopped scribbling and tried to think of what a lawyer should do at a time like that.

"We have our own radio network to the construct, Clare," I said. "If Jewel asks your switchboard, can she patch us into our office in San Diego? We'll ask Fez Morris how things are going out there at L-4."

He paused on that one. Figuring whether his bugging system would record a call that went out in that fashion. Decided he was covered, and threw a switch to put both Fez and my comments on a loudspeaker.

Jewel got me Fez on the horn. We had the same old one-and-a-third-second pause to contend with.

"Hi, Fez. This is Phil. I'm talking with you from Clare Putney's office in Langley. He's curious to know about how well the vibration fix we doped out when I was at the construct is working."

Pause.

"Just great, Phil," his voice sounded plainly in Clare's office.

"Vibration problems licked? Mirrors in sharp focus, Fez?"

Pause.

"Sharp as a tack, Phil," we all heard Fez say.

"Then that's all, Fez. Hey, one other thing: Nag sent up some Research Instruments for you. You get them?"

Pause.

"Being unloaded now, Phil. Tuan Foo is in a mathematician's heaven."

"Great. Over and out." I hung up and turned to Clare.

"Now if that was all that was on your mind, Clare, we'll be leaving. Work to do."

"Work to do?" he said hollowly.

"We've got over two hundred million mirrors to mount with those wild corn-planters the gang came up with, for openers. If I don't get one of these panic-button bleats from you tomorrow morning in San Diego, we'll put them in place as quickly as we can."

As I got up and walked toward the door, for once leading my little brood, Clare cried out:

"How did you fix it, Rettig? How did you make it work?"

Jewel walked through as I held Clare's door open, and then Morrie, who for once had never said a word. "Trade secret, Clare," I grinned at him. "If I tell you, then anybody can build scopes in space. Like it better this way."

Gene and Jerry had us at altitude in short order, aimed at San Diego. Jewel

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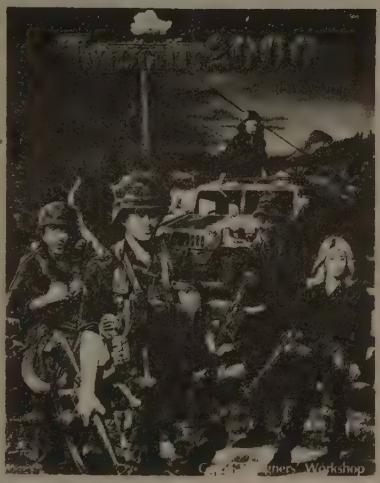

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fussed around with some canapes that the crew had gotten from the caterer at the fixed base. I nibbled, looked out the window at the usual featureless Earth you see from a high-flying jet, and thought about what lay ahead.

Jewel finally stopped acting domestic (after making sure that Gene and Jerry had their coffee in the office) and sat down across from Morrie Levine and me.

"Isn't it wonderful, Phil," Jewel said, "that Fez and Tuan Foo could fix those vibrations so quickly?"

"Seven years, Julie," I told her fondly. "And your first dumb remark."

"Dumb?"

"They need to run those girder-thumpers a long time, maybe four days, maybe longer, to get the effect they want on the construct's overall vibration. Hell, Fez says he's just unloading that stuff from the Shuttle now. They haven't got the first thumper in place yet."

Jewel was a "round eyes." "So you really don't know if it will work?" she gasped.

"Not exactly, Julie," I agreed. "But we know that Fez Morris may be just the guy you figured him for. He knew he had to fill Clare Putney so full of baloney that he and Tuan Foo would get their chance to try the thumpers. It's capers like this that change young pups into Chief Executives. That's where you have him figured, right?"

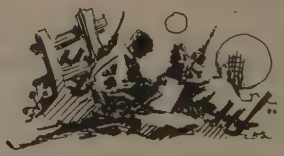
She didn't answer that. *"But what if it doesn't work?"* Jewel said in a deadly tone.

"Then he'll figure out something else. Hell, he's an engineer, isn't he?"

Jewel shook her head slightly. "Then you don't know the field of Fez's dissertation?"

"Not really. Just that he wasn't a run of the mill civil, mechanical, or electrical engineer. What is his field?"

"Ever so much more fitting," Jewel said. "Abnormal psychology." ■



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light-hours. That, and the fact that it is literally "talking" to its creators.

For the true flight controllers of this mission are a whole new breed of computers: the decades-refined product of research in artificial intelligence.

The spacecraft is—of necessity—completely under the control of the most sophisticated, completely autonomous example of this technology ever flown—the result of decades of development. It is the latest word (or was, forty years before) in "artificial intelligence masquerading as a spacecraft." The men and women gathered in the darkened control room are truly only here to watch.

The incoming images, their color hauntingly lifelike even after a journey of over 24 trillion *miles, show only a trace of interstellar noise. But they do visibly reveal the probe's immense velocity through the Alpha Centauri system; the motion of the target planet against the background star-field demonstrating not only the impressive sensitivity and latitude of the imaging system, but also a vivid reminder of the key trade-off of the entire mission:*

The decision, for reasons concerned mainly with time and fuel, not to kill the significant approach velocity from the acceleration phase.

Thus, the encounter will all take place within the next few hours, the computer's elegent programming almost totally directed toward being able to distinguish possible artificial *structures and associations from the natural contours of an alien world, then zoom in for essential, detailed close-ups.*

Such on-board screening in the few short hours when the spacecraft is in range is absolutely critical. There are simply no margins on power, fuel, on-board data storage, bandwidth for transmission, etc., to allow the luxury of high-resolution mosaics of the entire planet; the computer must make the appropriate decisions regarding the presence of intelligence the first time around, to target the required close-ups.

Everything depends on this—the ability of this on-board electronic wizard to recognize what intelligence on another planet looks like.

Question: how does the computer know what it's to look for? What are its criteria for "indications of intelligence"—all by itself, four years *from the nearest human input?*

The fact is, this is not some hypothetical scenario dreamed up to entertain you, the quintessential *Analog* reader. The truth is that precisely such a problem already exists—on a set of images returned to Earth in 1976 by a fairly simple (though expensive!) forerunner of the craft I've just described.

Because it looks, gang, like we may have finally done it:

Discovered the first bona-fide evidence of an extra-terrestrial civilization!

Surprise: the evidence *isn't* in the form of some noisy ultra-narrow band radio transmission originating a thousand light years distant. The good news is: it's in the form of ruins lying on a nearby world; the possibilities for in-depth exploration *with current technology!*—including a manned expedition—stagger the imagination.

The bad news: the ruins lie on Mars.

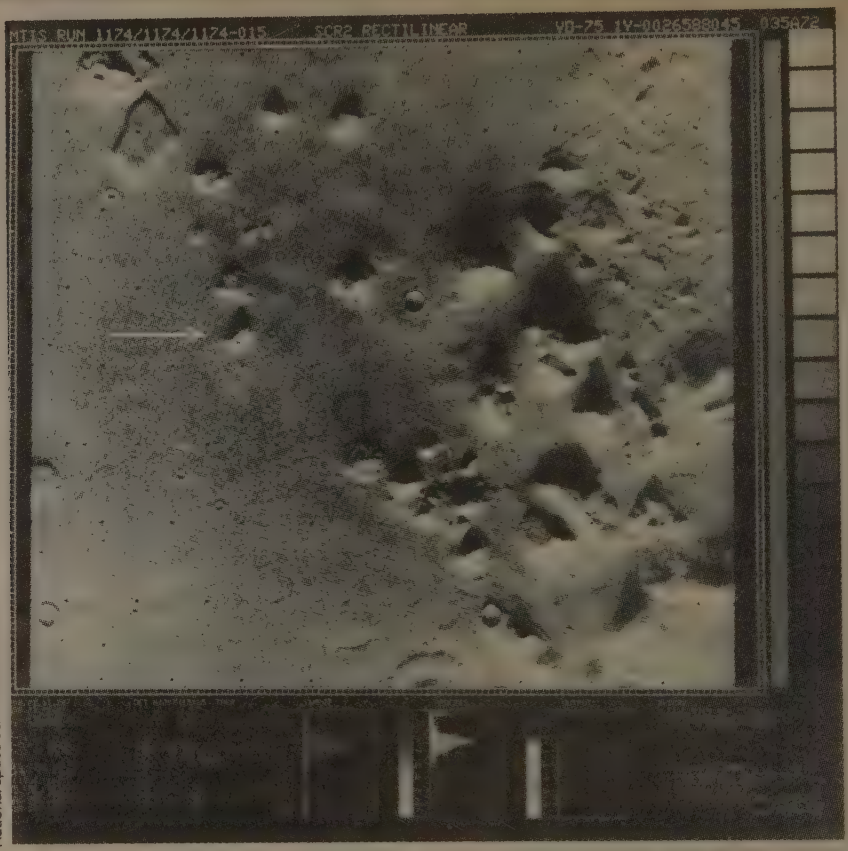

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Figure 1 NASA Viking frame 35A72. Arrow indicates the "face"

And they don't seem to conform to our prejudiced Earthbound impressions of what an extraterrestrial civilization is supposed to look like.

And therein lies the exquisite epistemological problem: how will we ever program an artificially intelligent *computer* to recognize what we cannot yet agree on how to recognize ourselves?

Now I know what you're going to say. "Ruins on Mars! Shades of Percival Lowell, has Stan Schmidt finally flipped his noodle, even to print such drivel!?".

Read on.

Frederik Pohl once told me that the true worth of science fiction wasn't its predictive value: it lay in its ability to construct alternative scenarios around important scientific discoveries and technological developments—to pose the "what if" questions.

Is the aforementioned evidence truly confirmation of our fondest dreams? Considering the nature of the problem which now confronts us—how to even recognize evidence of intelligence—it seems only appropriate that we consider both that evidence and its implications here. The long history of this magazine as a forum for constructing alternative scenarios, not just in its fiction but also in its fact articles, and the unique nature of its readership, seem tailor made for constructive dialogue on this most important—and highly provocative— unfolding tale.

This, then, is a process story—how a group of serious scientists are endeavoring to grapple with a set of at-the-moment inexplicable data, *one* interpretation of which *could be* that we have found It:

The first real evidence that We Are Not Alone.

The first Viking Orbiter had a dual mission: locate a safe touchdown site for the two Landers, *then* proceed with synoptic photography of Mars. It was during this initial, intensive reconnaissance that this Orbiter took what I call the "discovery frame" (35A72) of the ruins on July 25, 1976 (Figure 1)— located in the Cydonia region (41 N. 10 W.) of the planet. The image had been taken late in the Martian summer afternoon (about 6:00 P.M. "local" time), when the sun was low in the northwestern sky—only about 10 degrees above the horizon—and all the shadows long.

The most extraordinary feature on this image was a literally mile-long representation of a *human* face: "the Face on Mars."

However, according to Dr. Gerald Soffen, Viking Project Scientist, "when the Orbiter took a picture of the region a few hours later, the resemblance went away. It was merely a trick of light and shadow."

Thus began a curious pattern of denial which, for some, has extended to the present: the apparent inability—either on the part of the original Viking Imaging Team or of the press—to entertain even for a moment the possibility that the "humanoid Face on Mars" could be anything but a projection of a too-vivid human imagination.

As later events would show, Soffen's statement was somewhat premature.

In 1979, after discovering the quirky image in NASA's own picture files, two computer specialists working under a sub-contract to the Goddard Spaceflight Center—Vince DiPietro and Gregory Molenaar—would spend considerable time working with the image. Using first-generation data tapes from JPL (the Jet Propulsion Laboratory) they would apply several standard enhancement techniques to the original data—and discover that the Face was even more human-looking than originally thought. Their real contribution, however, was the discovery of a vital *second frame* of the face—70A13 (Figure 2)—taken *35 days* later and at a much higher sun angle (30 degrees). Not only did this frame dramatically belie Soffen's glib assertion that the whole thing was "merely a trick of light and shadow"; it provided new data on which to base measurable estimates of precisely how humanoid

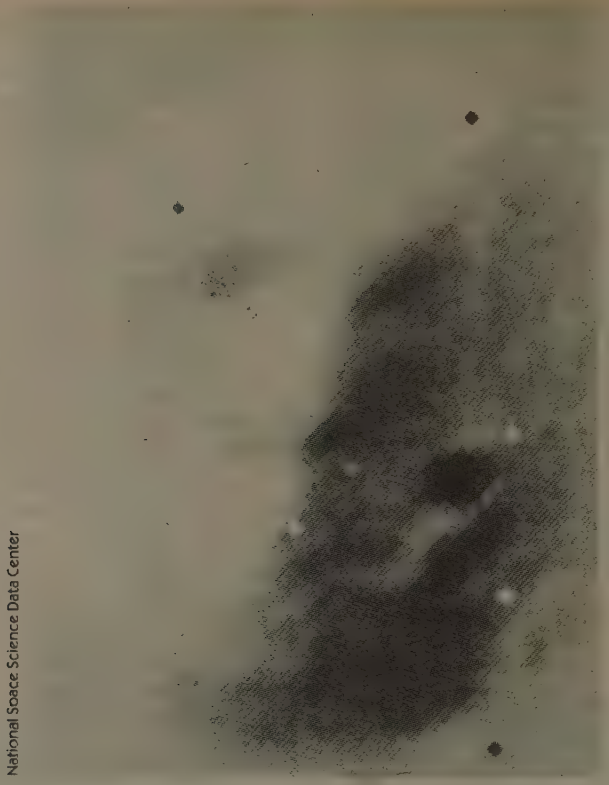

Figure 2 The "face," with sun at 30 degrees (frame 70A13).

the face truly was.

These developments would, in turn, be followed by exhaustive image-processing of the remarkable resemblance in *both frames*, confirming not only its true three-dimensionality, but also a remarkable amount of detail (two eye-sockets, a mouth extending evenly from left to right, etc.). In other words, something that no vaguely similar formations on Earth exhibit: true bisymmetry (Figure 2).

(Critics have dismissed the Face at Cydonia as merely another version of several natural formations here on Earth—such as New Hampshire's Great Stone Face. But it, and all other terrestrial examples usually cited are inevitably *profiles*, not bisymmetrical frontal shots. This alone sets the object at Cydonia apart.)

My own entry into this increasingly curious tale (not just as an observer—but as a participant!) would not come until

much later, in 1981, when I briefly examined DiPietro and Molenaar's work at the first Case for Mars Conference in Boulder, CO. This would mark my second introduction to the enigma of the Face, and would be followed (in the summer of 1983) by a set of circumstances resulting in a call to Vince DiPietro regarding his image processing techniques (for a completely different problem: computer-processing of data on a little anomaly at Saturn [see Hoagland, "The Blivit in the B-Ring, *Analog*, December 1982 and January 1983]). As a result of this one call, I would ultimately receive from him several glossy images that would directly catapault me into the very center of the controversy—including a full-frame, processed-version of 35A72.

Thus would begin my initiation into this nagging, eight-year-old unfinished tale.

It was in looking at these actual specially-processed images that the full impact of the implications of the Face's existence finally hit me.

The more I studied the actual glossies, comparing the two sun angles and the two orbits, minutely examining two sets of compelling features under a stereo viewer and marveling at the corresponding detail between the two versions, the more I felt that here was something profound. The degree of symmetry and bisymmetry—for a natural wind-carved mesa—was haunting. Could it possibly be . . .

What if it was?

It was that simple: if the Face on Mars wasn't natural, it had to be artificial. There was no middle ground (somewhat like the old joke about being a little bit pregnant). But proving such a hypothesis would present formidable problems, especially if one tried to do so using the existence of the face as proof. For one thing, accepting its presence as an indicator of intelligence apparently meant (in the minds of most of its many, many critics) tossing out several cherished scientific theories—all the way from our recent hard-won ideas regarding Martian geological history, to perhaps the origin and evolution of humans themselves.

Without a doubt: based on the record of the previous eight years, the single greatest impediment to treating this data seriously was the nature of the data itself—

The Face.

All right, if the Face by itself was literally beyond serious consideration, how else could one rationally approach the problem?

(This, of course, brings up the question, "Why even bother?"

(The answer to this larger question can best be couched in terms of a cost/benefit analysis: if the Face *is* an indicator of a possible extraterrestrial civilization, then determining the actual reality or falsity of that proposition seems to me to be at least as worthwhile as using valuable radio telescope time searching for *theoretical* radio signals of artificial origin. With the Face we have *real* [although highly controversial] data; with SETI, as presently presented, we have a controversial theory—and absolutely *zero* data.

(Perhaps the difference between the level of research support being given to

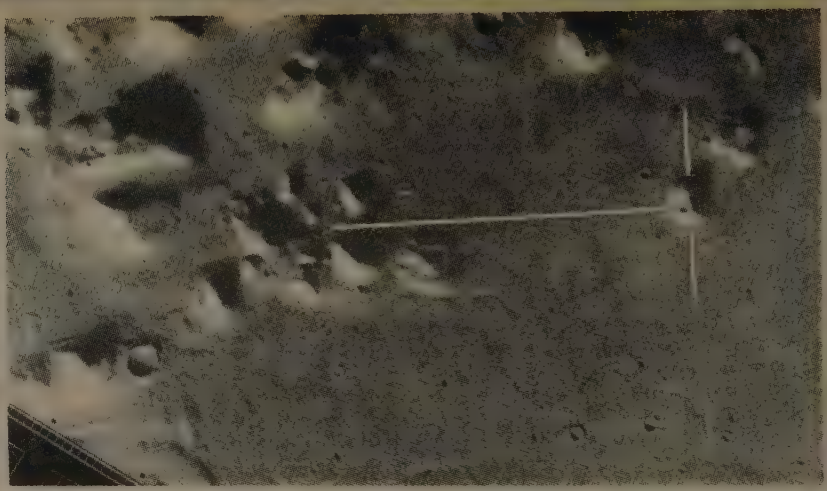

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Figure 3 Alignments of the "face" and the "rectilinear" group of features (the "city") at Cydonia.

SETI as opposed to determining the true nature of the Face on Mars says more about the politics of science than about science itself.)

Given the previous considerations, I felt that—without new data—there was zero chance of getting any real study of this issue. So, how to find new data?

Perhaps the problem was that during the previous eight years the wrong questions were being asked. Perhaps, instead of concentrating on the details of the Face, noting its uncanny features and resemblance to human analogs on Earth, someone should have been asking:

Why do it!?

The key impediment to any true advancement in researching the problem of the Face, in my opinion, was that no one—in those eight years—had apparently asked any anthropological questions. If the object wasn't natural, then —logically—it had a purpose.

What was that purpose?

Could theorizing about that purpose furnish any clues which might lead to a test of the validity of the entire Intelligence Hypothesis?

The obvious answer to the question of purpose was simple: It was there to be seen.

But by whom?

Answer: us (read: "someone flying by the planet").

(There was ample precedent for this. In the 19th century [when public and scientific interest in finding life "out there" hit an all-time peak] the great mathematician, Karl Gauss, suggested planting a huge Pythagorean triangle of *wheat* in Siberia or, alternatively, digging another one in the Sahara Desert, filling it with oil, and setting it on fire—to let the "Martians" know we

were here . . . by an unmistakable *geometric* message.)

The problem with this line of reasoning (as it applied to the Face), was simply that it left us exactly where we were before, with no further data to examine.

So the Face was a message to Mankind. So what? Its presence alone would never be accepted as a message, without some corroborating evidence.

But suppose, I thought, the object had an additional purpose? Suppose it was designed, not just to be seen by someone (like us) flying high above Mars; suppose it was also designed to be seen from the surface?

With this conceptual breakthrough, over the next several days I was amazed to be able to locate a number of striking geometric objects, some of them remarkably pyramidal, in the one location on the surface with a best view of the Face: 90 degrees to its bisymmetrical centerline, and only a few miles away (Figure 3).

This provocative discovery triggered a host of others: a series of geometric alignments linking some of these pyramidal objects with the Face, as well as an internal rectilinearity which seemed to control their position and orientation with respect to each other in a distinctly non-random manner (Figure 4). Another series of geometric relationships seemed to link some of these strikingly arrayed objects to an equally puzzling "geomorph" lying several miles to the southeast (Figure 5)—an immense, five-sided, buttressed pyramid originally discovered by DiPietro and Molenaar on frame 70A13 (Figure 6).

The discovery of this complex—an ordered collection of surface anomalies, some pyramidal and others bisymmetrical—all grouped in one tiny location on the Martian surface and all apparently interrelated by geometrical alignments and mathematical spacings, heightened my own perception of the significance of the Face to an unprecedented level.

Take, for instance, the massive buttressed pyramid DiPietro and Molenaar had found.

I determined its true geometry: that of a five-sided, *bisymmetrical* object, with three short sides and two long sides, five buttressed corners, and a central buttress composed of three sub-buttresses. (This central feature is also bisymmetrical, thus representing *another* level of symmetry within the larger object.)

The entire pyramid has apparently been damaged; a medium-size crater lies on one flank, causing distortion and the apparent total collapse of one side (the reason DiPietro and Molenaar had not immediately recognized its true pentagonal geometry).

The proportions of this pentagonal figure as I reconstructed it (*three* short sides and two long sides) triggered a memory:

DaVinci's famed "Man in a Circle." (Figure 7) The proportions are almost exact!

Could this DiPietro/Molenaar Pyramid (D&M) be a geometric representation of the humanoid form—a few miles away from the humanoid Face?! Further, was the apparently deliberate juxtaposition with the Face part of a

larger design?

You be the judge, for as best as I can determine, the central member of this object—its "head" (and thus the entire "D&M Pyramid") is aimed directly at the Face—only about 10 miles away.

Could geology and meteorology alone conspire to create such a convincingly related pattern of such diverse, yet meaningful geometric forms? If so, modeling such a process would certainly require a level of scientific sophistication far beyond the arm waving that has been used by critics to casually dismiss the Face—alone—for all these years.

The danger of reading too much into chance associations was in the forefront of my mind, of course; but the probability of the occurrence of each of the literally dozens of precise associations, ratios, and alignments located in this one microscopic region of Mars had to be multiplied together—giving, I felt, an overall probability already exceeding the proverbial million-to-one against this set of relationships being mere coincidence. In my opinion, this was strongly beginning to look like a deliberately designed association, with the Face as its specific centerpiece!

That, needless to say, was a breathtaking conclusion—but one inexorably

Figure 4 The "city." Note relative order and rectilinearity, and central feature bracketed by four others.

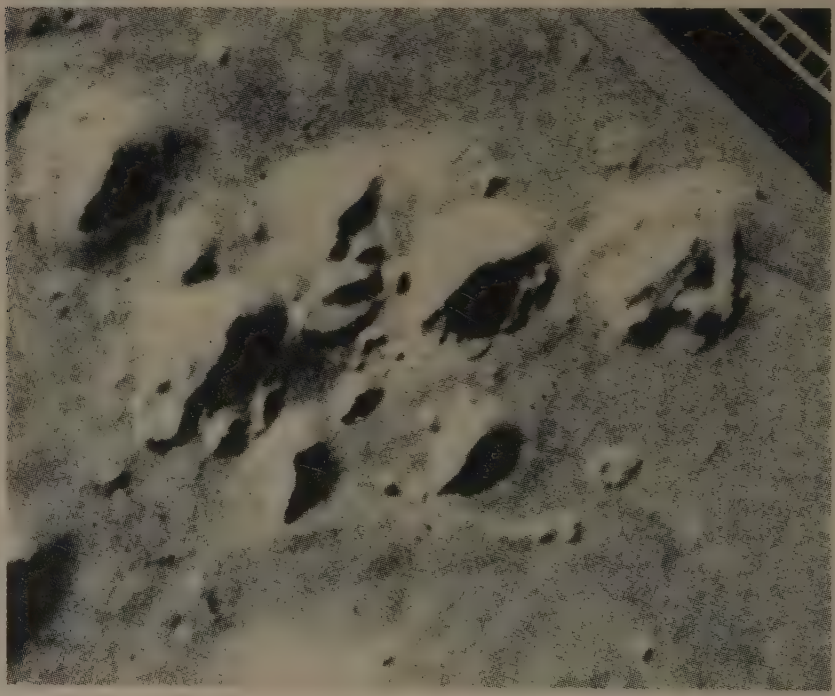

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Figure 5 Geometric alignments of features at Cydonia: Left, the "city"; right, the "face"; bottom, the 5-sided "pyramid."

forced on me by repeated discoveries over the next several weeks, of relationship after relationship. (Talk about a sense of wonder. . . .)

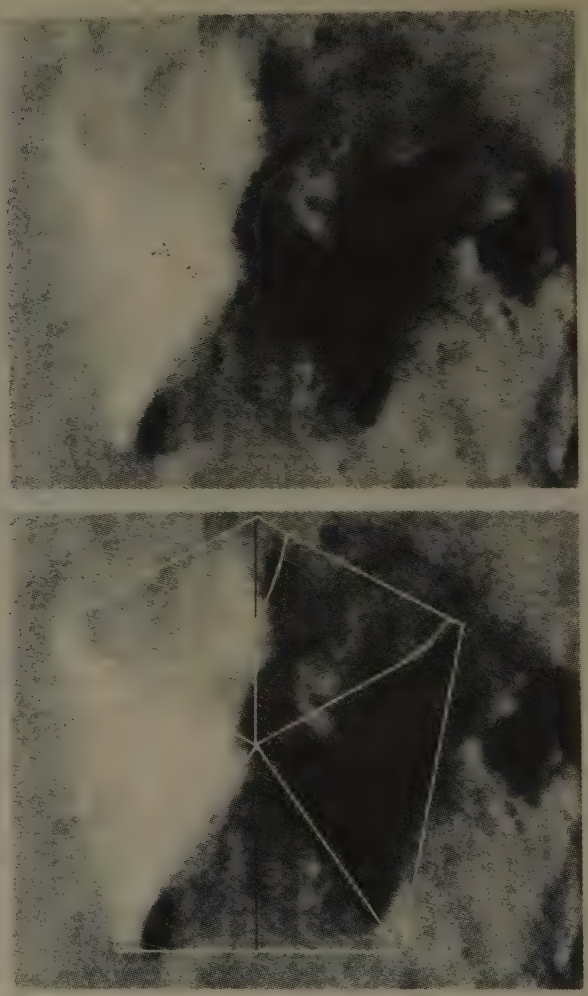
In the brief space that Stan has allotted to this story, I can hardly do the data justice (a fuller description will be forthcoming later this year in *The Monuments of Mars: A City on the Edge of Forever* [North Atlantic Books, Berkeley, CA]) But here are a couple of additional examples:

In the exact center of the "city" lies a curious set of four small, rectangular objects. (Small on the scale of the images themselves. They must each be several hundred feet long.) These four (which I named the "city square" —strictly for identification purposes, you understand) are set parallel to each other, yet at 90 degree angles, with a fifth one (circular) exactly in the center. Measurements confirm their precise central location in the larger complex.

This, then, defines at least two relationships: 1) the "city square" (those aforementioned four, precisely arrayed objects); and 2) their intriguing position (at the exact lateral center of the larger cluster of pyramidal forms).

Chance . . . or design?

Remember, the central hypothesis of this approach—the conceptual breakthrough—was that They (whoever They were) *had made this thing, the Face, to be seen from the surface*, as well as from "above." Having found this



Dr Mark Carlotto, Analytic Sciences Corp.

Figure 6
Top, the 5-sided "pyramid." Note apparent extensive damage to right side and bottom surface, and resulting debris flow around base, giving impression of shortened right "leg." One possible cause of damage is explosive penetration: note "bottomless" hole at right, and apparent domed uplift just right of center.

Bottom, one possible reconstruction (simplified), assuming near-symmetry of original structure. Note symmetrical "arms," "wrist" curvatures, and three-fingered left "hand."

"city," I determined that the monument as seen from its central square would subtend 7 degrees (14 times the angular diameter of a Full Moon on Earth): certainly a reasonably spectacular profile!

It was at this point that I noticed a "coincidence" that, any way you look at it, is truly eerie:

Behind the Face (as seen from the city square) lies a crater, about 25 miles away (Figure 8). On the near side of its ejecta blanket (the debris apron which surrounds most craters on Mars) lies a peculiar benchlike cliff—precisely straight, composed of several levels (judging from the shadows), on the top of which is a peculiar, sharply etched defile.

The entire mound or bench is unquestionably of later origin than the crater itself. The means of determining this latter fact is elegant and simple: the ejecta blanket extends beyond the cliff; if the cliff had been in place when the

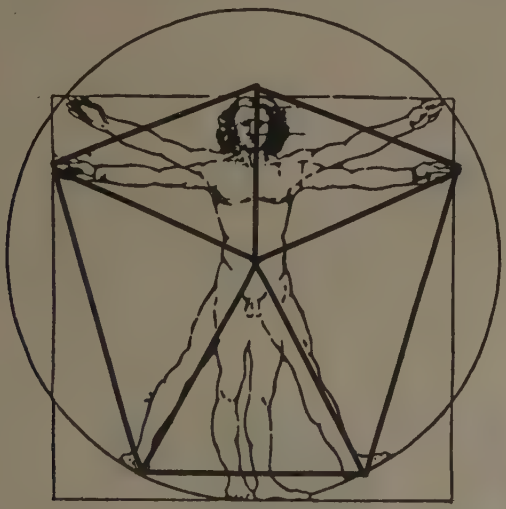


Figure 7 Leonardo's "Man in a Circle," overlaid with the approximate proportions of the 5-sided "pyramid" at Cydonia.

crater formed, its presence, as an obstruction, would have dammed the ejecta behind it (as is obviously the case for another nearby mesa, which has prevented the splash-like ejecta from flowing past it).

This peculiar cliff looks very much out of place, not easily explicable as a fault block or other type of formation which one might expect. Its relationship to the crater—90 degrees to the flow of the ejecta *and* roughly at right angles to the sightline stretching across the Face from the "city"—is even more intriguing. Its position—on the side of the crater facing the Face—is especially significant—in the context of my "the Face was designed to be seen from the

surface'' hypothesis.

Definitely intrigued now, I extended sightlines the 25 or so miles from the square, across the Face, to this funny mound . . .

And was amazed to discover that they neatly bounded the 2 mile-long formations! (Figure 9)

The northern sightline, passing directly across the eyes, came precisely to the northern terminus of the cliff; the southern sightline, passing the chin, terminated precisely at the southern extension of this peculiar feature.

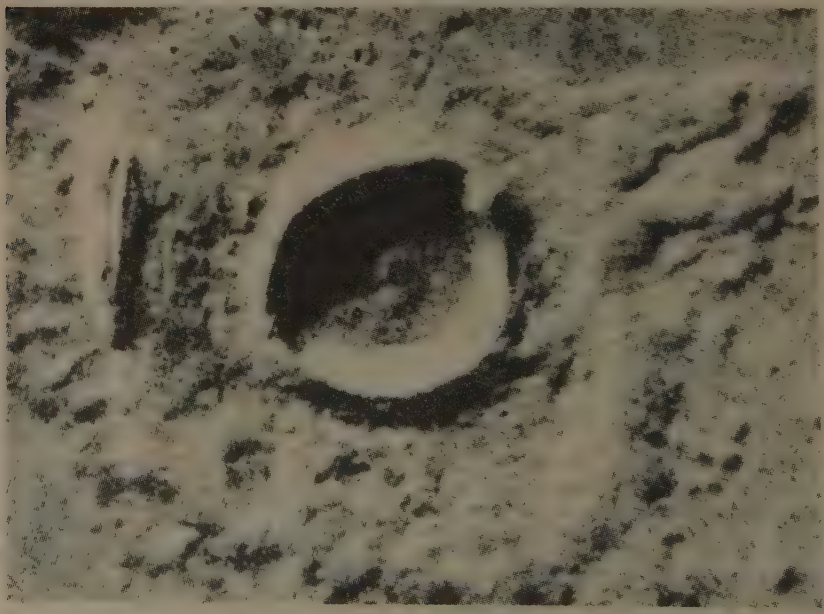
In other words, this cliff was the same angular diameter as the Face—when viewed from the one location on the entire landscape previously identified as being unusual—by virtue of its other unique relationships: ''The city square!''

(Over a year and a half later, when I showed Gerry Soffen this relationship in Washington, his first reaction to the cliff was a very gratifying, ''That doesn't belong there.'')

In terms of my model—that this amazing visage was designed to be seen as a profile from the surface—the correlation was extraordinary . . . but predictable (and that's what science is supposed to be about, isn't it?).

Because of the curvature of the Martian horizon, the presence of the crater some 14 miles behind the Face would inevitably cause severe problems for seeing it in profile—in the form of un-

Figure 8 The "cliff" on the ejecta blanket of large impact crater at Cydonia. Note texture of terrain to right of "cliff," suggesting possible excavation. Inclined "ramp" seems to wind from "excavation" upward through two "hairpin turns" ending at upper left.



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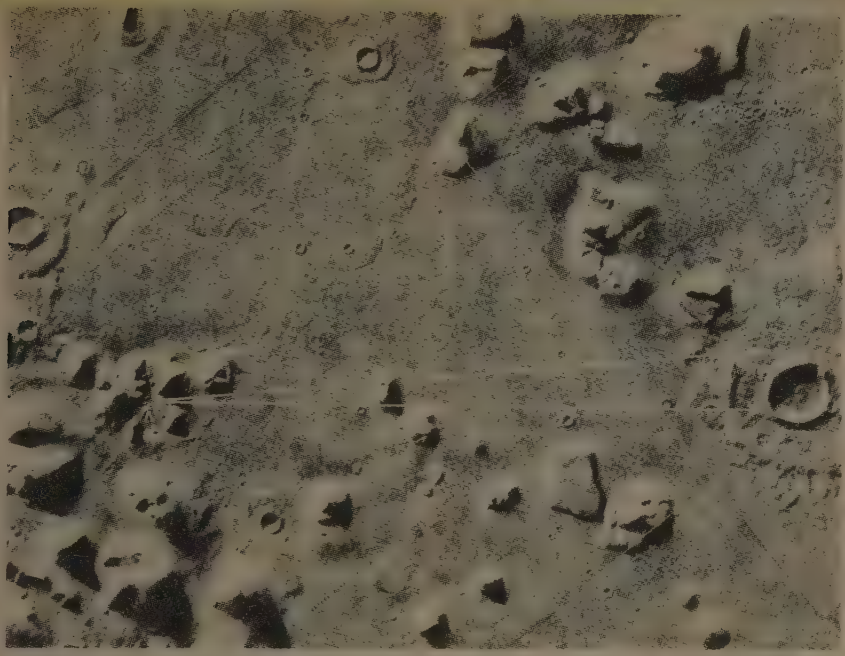

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Figure 9 The sightlines linking a) the "city square," b) the "face," and c) the "cliff" at Cydonia.

wanted hills messing up its silhouette.

What the funny cliff seemed to be, located out in front of the crater on the ejecta blanket, was an artificial horizon!

Its apparent sole purpose: to mask the crater walls behind it.

(Its placement—on the crater ejecta—was possibly related to the material out of which it might have been constructed: the frothy—and thus easily movable—ejecta debris itself.)

Why otherwise would this bizarre feature, when seen from the center of the "city," optically extend precisely as far northwest/southeast as the Face from brow to chin . . . but not a hundred meters farther?

Bingo for the "it was designed to be seen from the surface" hypothesis!

A measurement of the tilt off the meridian (the north/south axis) brought another discovery: the base of this cliff was aligned parallel with the center line of the Face: some 28 degrees! (Curiously, the defile sharply inscribed on top was not; its tilt was a shallower 20 degrees—a fact which we'll return to in a moment.)

The odds against this set of interlocking relationships being due to chance must be unbelievably small . . . but *how* unbelievable?

It was at this point that the overall alignment of the sightline of this entire

association—city, Face, and cliff—struck me as possibly significant: northeast/southwest. Something about that . . .

Of course.

That was the orientation of several ceremonial complexes on Earth, dedicated to observation and/or commemoration of, *the summer solstice sunrise!*

Could this be one reason for the northeast/southwest orientation of this entire "Martian complex?" Could this, in turn, furnish another *test* of the entire off-the-wall "Intelligence Hypothesis"—That this was all for real . . . and designed by someone with some truly awesome ideas regarding architecture?

This was, of course, total speculation (but then, so was all the rest of this exploration of "purpose" for a "Martian complex" whose presence wasn't even proven).

The interesting fact that emerged from these musings, however, was a possible *age* for these enigmatic objects; when they last could have been in use. Because of the changing Martian axial obliquity (plus or minus 12 degrees, in a million-year envelope of changing amplitude), the sun on Mars would appear to change its dawn location on the horizon over even a few millenia, irrespective of the usual seasonal movements. Using data supplied by the acknowledged expert in this field (Dr. William Ward, at JPL), I calculated that the last time the orientation of the Martian spin axis to the Martian orbit was such that the sun came up behind the Face on the Summer Solstice (and, incidentally, right over the northern tip of the cliff) was roughly half a million years ago.

So, what about the test?

Remember that strange defile on top of the cliff, the one tilted 20 degrees to the meridian? That number—20 degrees—is the obliquity of Mars when all these solstice alignments—"city" to "Face" to "cliff"—last worked!

Chance . . . or design?

It was at this point that I decided that I needed major help. Either I was crazy, or I was on to something so amazing that it was going to occupy a major portion of the rest of my entire life (to say nothing of the lives of all the rest of you).

Again, the details must be saved for someplace else. But, in the fall of 1983, with the cooperation of Dr. Randy Pozos, an anthropologist, and Ren Breck, recently appointed head of a computer conferencing company in San Bruno, California, I organized the first interdisciplinary investigation via an on-line computer conference of *all* the major questions regarding these extraordinary objects: the "Independent Mars Investigation Team."

Seven months later, at the Case for Mars II Conference at the University of Colorado, we presented our preliminary findings (see Further Readings at the end of this article).

The story of what happened during this extremely wide-ranging electronic discussion of the data, incidentally, has been published *The Face on Mars: Evidence for a Lost Civilization?* Dr. Randolfo Pozos, Chicago Review Press, 1986). Randy, as an anthropologist, brings some extremely interesting perspectives to our deliberations —and to the implications of what I believe I've found.

Which brings me back to the point I started with: how does one go about assessing the significance of these "anomalies"? How can the true probabilities of the geometrics I have discovered be appropriately expressed in the context of an Intelligence Hypothesis?

In other words: how can we *test* this whole extraordinary premise?

In this case, the practical application of that test must be applied to the existing data: the Viking digital imaging tapes. But precisely what should be the form of such a test? It seems obvious: mathematics.

In my opinion, the stark (and equally fascinating) fact is simply this: if these objects lay on Earth, their precise geometry and mathematical relationships would be accepted without question as evidence of a sophisticated, intelligently-designed architectural layout —albeit, on an enormous scale.

For example: the terminal stage of the Pershing missile guidance system—its targeting—depends on "map comparisons": the external sensors (TV, radar) in the falling warhead generate a map, which is then compared with an internal map stored in the Pershing's guidance computer. The pinpoint accuracy of the entire Pershing system is dependent on a set of computer algorithms describing what the target looks like, which are based on *geometric* and *mathematical* considerations that apparently are quite capable of distinguishing artificial structures (even after camouflaging) from surrounding hills and valleys.

Which simply means: if the city lay on Earth, chances are that it would already be "recognized" mathematically—inside some Pershing targeting computer!

The difference, of course, between this example and the Martian complex is sheer scale: the Martian "city" is composed of approximately half a dozen single large units (less than 1km on a side) and an approximately equal number of smaller ones (even the dimensions of the smaller members of this complex are on a par with the Great Pyramid at Giza!).

Critics of my hypothesis—that these awesome and carefully placed structures represent a deliberate complex, a base for some unknown purpose on the Martian surface—quickly point out the lack of roads (or farms). To fasten on these trivialities as reasons why this cannot be evidence of intelligence at work, and at the same time to ignore the overall unity and order of the geometries and relationships involved, seems to me (after the effects of perhaps a half *million* years) to be a reaction tinged by at least a touch of "terrestrial chauvinism."

Then there is the problem of the Face.

It doesn't belong there—by any paradigm applied to it. Its presence is almost a literal insult to an entire generation of evolutionary biologists steeped in the work of George Gaylord Simpson, whose view (if he were still alive to see it) could be summarized in his own words:

"Any close approximation of Homo Sapiens *elsewhere in the accessible universe* is effectively ruled out" (Simpson, *Science*, 1964).

This, in a line, explains (I believe) the reaction of most critics of this hypothesis (including that of Carl Sagan).

Carl has long maintained that if anyone ever reports aliens from "central casting," one should ignore them; to holders of this rather narrow perspective, to find an impressive representation of ourselves *on a planet right next door* must be a bit unsettling.

It is my contention that any serious evaluation of this amazing data must approach the problem—"Is this the remains of an extraterrestrial civilization?"—from an interdisciplinary perspective. The problem is literally too big for any one discipline to be allowed a veto on the subject (which the geologists have been allowed to do, mainly by default, for ten years).

Or to put it another way, what this problem needs is a good generalist.

Look, let's hit it on the head: this situation, to be properly understood, demands a full-fledged assessment of the grave epistemological questions raised briefly here: how do we "recognize" intelligence . . . especially on an alien world? Because if we can't, then a lot of current research, if not military applications, is a pure waste of time and money.

And that especially applies to SETI; how can we ask public support for a program to "talk to aliens" (with the slight language barrier implicit in the very concept), if we can't agree on the criteria for an intelligently designed layout on a planet in our own backyard?

OK, I've been very good, and haven't succumbed—in *Analog*, of all places—to even one outlandish speculation (although I've had almost three years to come up with some truly amazing ideas, I assure you). But I would like to leave you with a couple of thoughts.

Either the Face and the "city" is a fantasy . . . or it's for real. If it's truly there, it has one of two likely explanations: either it *was* meant to draw our attention to *this* site (somewhat like the "Pioneer 10 plaque," with which I have a slight acquaintance), or its message is infinitely more profound.

I can't help musing on some of the latter possiblilities.

David Brin has elegantly raised some of them in a more academic context within this very magazine; but now we must confront the fascinating possibility that some of them—or all of them—are real. Brin has pondered Mankind's place in a galaxy of myriad races, all of them—save for humankind—uplifted by a Patron Race that moves silently amid the Galaxy, reaching out to fledgling worlds. . . .

Then there is the companion problem: why is Earth—in a galaxy which theorists love to *fill* with other sentient races—apparently unvisited . . . and has been (according to Brin's assessment of the data) for the past several billion years?

Wonderful and haunting questions . . . framed from the security, the provincial isolation, of one world.

I can't help feeling that the presence of a massive monument—in the form of a humanoid resemblence to ourselves—and on the nearest "Earthlike" world that we would one day inevitably reach, *is trying very hard to tell us something* regarding the gulf between our theories . . . and the awesome possibilities that have been waiting patiently for us for countless years—

On Mars. ■

FURTHER READING

Unusual Martian Surface Features, Vince DiPietro and Greg Molenaar. Report of original 1979 investigation of the 'face,' including image-processing details. Illustrated. $9 from *Mars Research,* P.O. Box 284, Glenn Dale, MD 20769

The Face On Mars: Evidence for a Lost Civilization?, Dr. Randolfo Pozos. Chicago Review Press, Chicago, 1986. Illustrated. Anthropological analysis of the Independent Mars Investigation and Viking data.

The Monuments of Mars: A City on the Edge of Forever, Richard C. Hoagland. North Atlantic Books, Berkeley, CA, 1986. Illustrated. Detailed step-by-step description of the research, world-wide reaction, and future channels for investigation.

Planetary Mysteries, Richard Grossinger, Editor. North Atlantic Books, Berkeley, CA, 1986. Illustrated. An anthology including an extensive interview with Richard Hoagland and a feature article, "Of Mars and Men," by Jeff Greenwald.

IN TIMES TO COME

● Our December issue features an impressive cover by David Hardy for "Bearings," by Robert R. Chase. If you remember Chase's last appearance here ("Seven Scenes from the Ultimate Monster Movie," in the Kelvin Throop spoof issue), "Bearings" will show you that he's a lot more versatile than you may have realized. This one, set *way* in the future, is an adventure story of truly cosmic scope, concerning a ship lost outside its galaxy and seeking to find its way home. But it's also the story of the society that launched that ship, trying to find its own direction in another sense: given that life is something you can have as much of as you want, how much do you choose—and why? You've read many thoughts about that question before, but I think you'll like Chase's answer.

I also think you'll like the rest of the issue, from Charles L. Harness's novella "The Picture by Dora Gray" to P. M. Fergusson's short (and funny) novelette, "The Year the Indy Died." And Thomas Donaldson is back with another of his long-range speculative fact articles, this one called "New Matters"—which is about *exactly* what it sounds like.

● A strong conviction that something must be done is the parent of many bad measures.

Daniel Webster

on gaming

Dana Lombardy

I remember being amazed, absolutely amazed, at my father's navigational ability. I mean, he could ease our big, blue '58 Chevy out of the driveway, and drive through the maze-like streets of Flatbush with a rakish abandon. A left here, then two rights, another left, and then on to the highway. Now, I gasped, we're really in trouble. How could anyone know where to get off the highway?

But no problem. With a mind-boggling casualness, my father made his way to the George Washington bridge and maneuvered the car through the even more foreign streets of Hackensack to my cousin's house.

Some feat, huh?

Well, to my 5- or 6-year-old intellect it was. And I assuredly knew that there was no way that I would grow up to learn all the intricacies involved in getting from point A to point B. And that's how I initially felt playing *The Halley Project* (Mindscape, Inc., 3444 Dundee Rd., Northbrook, IL 60062), a wonderful new game that lets you cruise the solar system.

The game is delightfully put-together. There's a cassette tape you play while the program loads that informs you: "You have been chosen from the best pilots in the Solar System to compete for a spot on the Halley Project team." You must undergo a series of navigational challenges, all of them leading to a special, final challenge that Mindscape will mail to you when your training is finished.

As the program begins, you are moving your ship away from Comet Halley (at last I get to see it!). The screen shows you the comet receeding, the distance Halley is from you, the elapsed time, directional heading, and your current speed. As the comet grows smaller, you see the various constellations in the background. And if you never found it possible to learn the difference between Taurus and Gemini, this game will certainly teach it to you.

Your first mission, code name "Raven," is to land on planet Earth. Pressing "R" on the keyboard reveals a radar screen that displays the entire solar system. Push in on the joystick and all the planets spread out, pull back and the planets bunch together. You select the scale that reveals Earth at the edge of the radar screen, which also shows the planet's distance and the constellation it appears in from your current location. (Of course, you have to know that Earth is the third planet from the sun. But then, this first mission is pretty easy.)

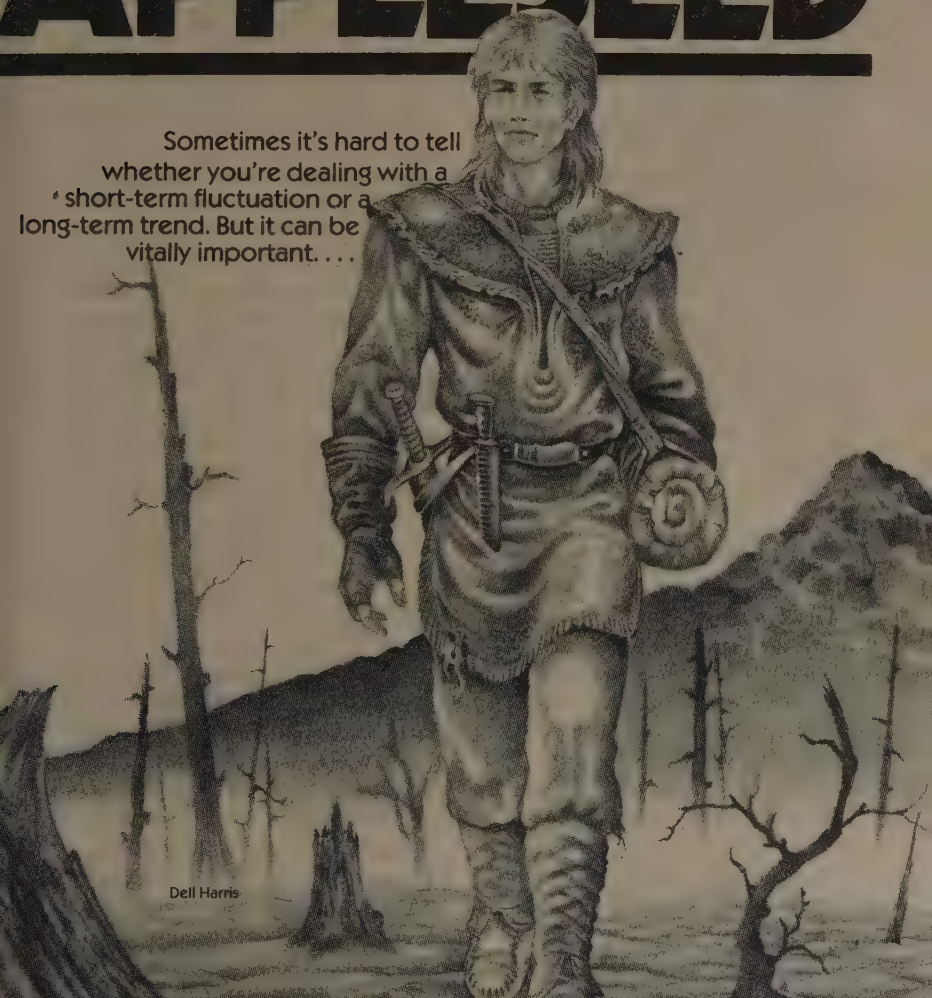
You then flip back to the control panel, scan the viewing port to find the right constellation, and off you go. As your speed approaches 250,000 km/sec, you will hear a warning bleep indicating that you're about to jump into Hyperspace. That's a fast way to get around, as the screen begins flashing and mil-

(continued on page 184)

John Dalmas

JUHANI APPLESEED

Sometimes it's hard to tell whether you're dealing with a short-term fluctuation or a long-term trend. But it can be vitally important. . . .



Dell Harris

As usual, Juhani woke up chilled and a little stiff. He had slept on the ground, against an old fallen pine tree that lay, still more or less intact, among slender young pines on a south-facing slope. For a moment he lay quiet, listening; finally rolled to his knees and stood up, stretching.

Since he'd left home, he'd walked a very long distance—about thirteen hundred kilometers actually, though he had no notion of the number. He knew simply that he was wearing out his third pair of mocassins, and had used up too much of the summer without finding what he'd been sent for.

He had no more notion of where he was than of how far he'd come, and no more interest really. He was wherever he was.

Beyond his immediate survival, and dependent on it, Juhani had a mission: Old Yrkki had said that when he'd gone far enough south, he would find crop plants that did not grow in Suomi, their homeland—Suomi where the species of both crop and uncultivated plants were few since the great cold. He was to bring back seeds, tubers—whatever was used to propogate the crop. He'd been given a leather bag to bring them in, which he carried rolled up in the larger sack he wore upon his back.

He carried little enough other—in his packsack flint and steel, a tinderbox, a half-blanket of arctic hare skins, and a roll of tanned calfskin from which to cut moccasins. Beyond that he bore only bow, arrows, knife, and shortsword, the latter to defend himself more against wild dogs than men.

He had been sent alone, but not as an only one. Old Yrkki had decided, and the council agreed, that six should go, but separately. Surely two or three would come back, and hopefully more, for those chosen were not reckless youths eager for adventure, but men a little older, who were known to be responsible as well as strong and resourceful.

First Juhani had been ferried across the sea in a fishing boat. He did not know that the sea, not many decades before, had borne the name "Baltic," although Old Yrkki knew, and other elders. Now it was called simply "the sea," and if Juhani had ever given thought to it, he would have considered it name enough.

It was not believed possible to go around the sea, not and live for long, because there was a very bad blast area at its end, considered still deadly. And after crossing the sea, he had four times detoured similar blast areas. The names they'd once had—Kaliningrad, Warszawa, Lodz, and Krakow—would have meant nothing to him.

On this side of the sea, people were fewer than he'd expected—scattered considerably more thinly than at home. There had been days when he'd seen no one, nor any occupied building, although weathered ruins had been abundant enough. And the country was more barren than Suomi. In some districts the only sign of forests was occasional dead snags, the last of earlier legions—bleached branchless fingers pointing at the sky, sun-silvered cylinders of wood surrounding crumbly rot. Their fallen brethren had largely recycled into soil, as soon they would themselves—leaving no offspring, yielding the ground to meadow plants, wild rose tan-

gles, hazel thickets, with only here and there a grove of birch from far-blown seed promising woods to come.

In other districts, within matrices of heath or meadow, young forests stood, needle-leaved, shading the decaying but still discernible bones of their ancestors, whose wood had been resinous and did not rot so readily as linden, elm, or alder, ash or summer oak.

Wild game on the other hand was abundant, notably cattle, horses, hogs, and sheep. Their generations were much shorter than man's; they'd already shed most of the non-survival genes that had accumulated through centuries of protection and selective breeding and the years of hard radiation. They'd been able to recover in numbers much more quickly. While Juhani's was only the third generation born to woman since the four-day war and the great winter that had followed . . . and followed. For three terrible years there had been no growing season at all; dark snowy/rainy pseudo-summers followed iron-hard arctic winters, after which the climate had moderated only gradually.

And only partially, at least in Suomi; for during the three-year winter, the perennial lid of thick polar ice that for ages had capped much of the Arctic Ocean had expanded far south across the Barent Sea to Nordkapp, and even to abandoned Trøms on the Norwegian coast; had encroached deep into northern Russia, down that narrow fjord-like sea once called Beloye More, to lock perpetually the once-harbor of blasted Arkhangelsk.

And atop that year-round ice lay a heavy layer of cold air which even in summer oozed southward at intervals, fronted by cold drizzles, or on the Scandinavian mountain chain by summer snows which added to the growing burden of glacier squeezing down the valleys eastward toward the Gulf of Bothnia and west to the Norwegian Sea.

Summer snows also fell on the Finnmark Plateau sometimes, even south into Finnish Lapland, adding to a white pancake of firn that thickened and grew over the decades, becoming gradually something more.

But Juhani knew nothing of these things. The resources and activities of his people were focused largely on survival, with little for exploration.

The great winter had wiped out many plant species in Suomi. Not one nuclear warhead had fallen there, but the temperature had, and dust and snow. And those humans who hadn't died of whatever sickness (abetted by fallout), or exposure, or apathy (yes, even Finns had given up, some of them)—those humans, in the direness of their hunger, had mostly eaten their seed grain, the potatoes they'd stored for cutting into seed pieces, their cattle, swine, and dogs.

The human-historical part of this Juhani knew, in outline, for the children were told the story. But he seldom thought of it. It was data, background information of small use. Some gave it more attention than he, but Juhani was a matter-of-fact man, his attention on now and the future. A man of action—of action and occasional dreams. For him, information was a tool, to be drawn forth mainly when needed, and only infrequently in simple curiosity or admiration.

The day before, he had shot a wild

dog—three in fact. But two he had left for the rest of the pack to eat, in order that they might not harry him. Now he breakfasted on a haunch of the third, along with one of the potatoes he'd bartered for two days past and baked in last night's fire.

But a part of his attention was on a dream from which he'd wakened in the night. His people took dreams seriously. His mother had been a dream reader, and he had some talent in reading them himself. His own, now—his own dreams he seldom remembered. And when he did remember one, it often seemed meaningless.

In this one he had been walking home, his bag full of seeds and twigs and budded roots and bulbs, but in his heart was a sense of loss. And back of that dream was a piece of another, from some earlier night, that had in it a beautiful white heifer with black spots, as clean as could be, wearing a garland of green ferns and meadow flowers. And it seemed to him that the heifer was an enchanted maiden, and could speak, although he never heard it.

Juhani chewed thoughtfully a mouthful of dog meat, waiting for a rootlet of understanding to sprout in his mind, but none did. He did not worry it. His mother said that one did not read a dream through effort: There might be meaning there or not, and if there was, knowledge of it came or didn't.

When the potato was eaten, he rolled up his half blanket and put it in his pack with the remains of the haunch. Then he belted his sword, shouldered the pack, slung his quiver, gripped his unstrung bow, and started down the thinly wooded slope with sunrise on his left. The country ahead was mountainous, and through the trees he glimpsed distant peaks with clouds lying on them, the first real mountains he had ever seen. Perhaps on the other side would be farms with crops they did not have at home.

The slope, still wooded, was toeing out when he heard a distant random clinking. They must bell their livestock, he thought, as we do at home. Bells made them easier to find, and the sound could unnerve wild dogs, wolves, and bears. Eager now to see what this place held for him, Juhani nonetheless slowed his steps. He'd found the people away from home mistrustful. Twice he'd been run off at spear point, and once been shot after, although in general he'd been treated hospitably once they'd sized him up, allowed him even to trade meat for potatoes, a cabbage, or a loaf.

He had not understood their tongue, however. Old Yrkki had spent much time, the winter past, teaching the chosen six a strange and difficult language used in the southwest, drilling them in it critically. "Toitsä," the language was called. But so far the people he'd encountered had not known it. Perhaps he had not angled westward far enough, or they might live farther south. He had gotten by nonetheless, with gestures, and even learned five or six words.

He moved ahead carefully; the animals he heard might well be tended by someone, someone armed and possibly quick with the bowstring. For a time, the pole-sized timber had carried beneath it a considerable undergrowth of saplings and seedlings. Now these thinned, then disappeared, browsed down by livestock; and he moved more war-

ily, slipping from trunk to trunk, pausing often to scan carefully in the direction of the bells.

Until at last, from the fringe of the timber, he saw the cows in a rich meadow—two of them with calves and two oxen all grazing near a brook, and a herd girl tending them. Two hundred meters beyond her was a large cabin of poles, a pole barn, sheds, and a barnyard fenced with rails. Beside the cabin was a large pile of firewood poles, where a man labored with an ax as if cutting up next winter's fuel.

And she had apparently glimpsed suspicious movement, for she was staring in Juhani's direction, not yet taking the bow from her shoulder, but raising the horn slung beneath one arm. Alert she was, but he would have been surprised if she weren't.

So he walked openly into the meadow's edge, then paused, both hands raised above his head, palms forward. She blew once on the horn, a high clear alto note, but showed no fear or hostility beyond unslinging the bow now and stringing it, then watched nonchalantly his approach. When he had come rather more than halfway, she nocked an arrow, though still without seeming to threaten. She must, Juhani thought, be about sixteen, and it occurred to him that she was very pretty, even forty meters distant.

The woodcutter had started toward them carrying his ax, a large red-brown dog trotting just ahead of him, while another man, white bearded, was looking from the cabin door.

Juhani paused, calling out in the hitherto useless Toitsä: *"Kuten Morken! Ik bin Freunti! Wie keht's pei Ihnen?"* he began politely, then moved quickly to business, the best way to allay distrust. *"Ik suke Hilfe für meinen Folk. Ik wolle Saat su kaufe."*

The girl turned her head and called to the woodcutter in the same language Juhani had been hearing these last several weeks. The axman paused and called back toward the cabin. The white-bearded man came out the door and started stiffly toward them while the axman continued to the herd girl, where he stopped. Juhani began again to approach them, hands no longer raised, but spread to the sides with palms still forward. His worry now was more the dog than the people.

Nonetheless, with proximity he realized that the girl was even prettier than he'd realized, and on her honey-blond hair she wore a circlet of meadow flowers. For a moment he forgot about the dog.

Then its throaty growl reminded him, and at ten meters Juhani stopped again, taking in the ridge of raised fur between the dog's shoulders, the axman's dour expression, the girl's calm and interested one, the thrifty condition of the cattle, and the approach of the old man, tall and gaunt but straight. At this distance the axman looked no older than the girl, though well-grown and strong.

When the old man arrived, he addressed Juhani in Toitsä, slowly and haltingly, as if he hadn't spoken it for a long time. Their conversation limped, suffering on one side from long disuse and on the other from inexperience, and from uncertainty because German from the mouth of the Pole sounded different from that which Old Yrkki had spoken.

But the old Pole understood quickly

enough what Juhani was looking for, and enumerated the crops that he grew, or were grown by others in the district: wheat, rye, barley, oats, onions, potatoes, sweet clover, turnips, cabbage, beans, carrots, pumpkins, apples, pears . . . Most of the names were unfamiliar to Juhani. They might be unfamiliar species, or perhaps the old man, whose name was Karol, had simply named them in his own language. At any rate their very number was hopeful: some had to be new.

"Come," Old Karol said, "I show you."

The two of them visited storehouse, field, and orchard, accompanied by the dog whose name was Ludwik. His hackles lay flat now, in acceptance of whomever Karol approved. The plants and provisions Juhani saw were familiar to him, except for beans, peas, apple, pear, and pumpkin. Two varieties of apples grew in the small orchard, one of them ripe enough to eat, and Juhani was pleased by the tart flavor, which the old man assured him would sweeten over the next two weeks. Then Karol described a little of the culture of apple and pear, with much gesturing and an occasional lapse into Cracovian Polish where his German was inadequate. And Juhani began to realize there was a lot to know about their cultivation. He would have to take home information, not just seeds and tubers, slips and bulbs.

After that they went into the cabin, where they had bread with butter and honey. Honey too was new to Juhani, for honeybees were no longer known in Suomi, and he wanted to know how it was obtained.

Karol was eighty, an Old One, remembering well before the war and the winter. People so old were rare. Of all the living people Juhani had heard of, only Old Yrkki, at eighty-seven, was older. Old Karol had been a graduate of the academic high school in Krakow, with a year in the Institute of Agriculture, aiming at a career as an agronomist. Among other things, he had learned to speak Toitsä, which he pronounced "Deutsch."

But when the war came—it was early summer then—he had been on a mountain holiday, deep in the high Tatra, and had stayed there till hunger drove him out.

So he knew of Suomi—the Finn land—and wanted to know how things now stood there. He listened thoughtfully while Juhani told him, and expressed surprise at the size of families and population which Juhani described. In Poland, Karol said, not many babies were born, and too many, visibly defective, had to be left on the mountainside. These things had improved in recent decades, but still it was necessary to marry the young girls off as soon as they'd matured, and have as many pregnancies as possible.

Karol himself had no surviving children. The herd girl and the woodcutter, Tadeusz and Elzbieta, were twins whom he and his late wife had adopted after their parents had died trying to rescue their second set of twins—infants—from their burning cabin. The roof had fallen while they were inside.

The loss had been considered a tragedy in the community; their four healthy children in but six years had been a very unusual performance. And twins! Two

sets! And besides that, the whole family, parents included, had been very strong and healthy. Tadeusz and Elzbieta both were regarded as particularly good marriage prospects, and Tadeusz was betrothed to a girl in the valley who was one of three living children. He would be married at Christmas, when the girl turned sixteen, and a large family was hoped for. Elzbieta was already sixteen, and had been severely criticized in the community for still being single. But she was strong-willed, and in a position to be selective.

Tadeusz had come in and was watching, and Karol turned to him, speaking Polish at some length as if summarizing. After that the old man gave back his attention to Juhani, and continued.

Karol's own community—the cluster of farms in this end of the valley—had more than once sent men south to gather seeds and other propagules from climates where the long winter had not been so severe. For in Poland as in Suomi, many species had been wiped out. The seed parties had gone all the way to the Dalmatian coast some thirty years earlier, and had brought back cuttings and seeds of apple and pear, among many other things. Some of which, like plums and apricots, had proven too tender for the Polish climate.

Once they had even brought back a small colony of bees in a large net cage, which they'd carried suspended on poles. These were the progenitors of all the honeybees, wild and tame, now found in southern Poland.

Karol did not believe, however, that honeybees could overwinter in Suomi, with the climate there as Juhani described. That bumblebees lived in Suomi was not relevant to honeybees. A bumblebee colony, he explained, dies in autumn in any case, except for the queen, which hibernates to produce a new colony in spring. Honeybee queens, on the other hand, did not hibernate; the colony lived or died together, awake. The problem was that honeybees would not defecate in their hive. And while they could wait for weeks if need be, in time they would fly forth to relieve themselves outside, and if it was too cold, they died before they could get back in.

Old Karol chuckled. "At my age, sometimes in winter I wonder if that will not happen to me."

Then he raised one bristly white eyebrow and changed the subject. "You know, young Finn, you would be welcome to stay here and live with us. You are strong, and of fertile stock. And it is not as if you were the only one to be sent south. It is doubtful that the others would receive an invitation like this one. It is even doubtful that any will find someone who speaks Deutsch to invite them. The Deutsch land was even more destroyed than our own, for it was there the war was fought, and also it received more warheads than ours.

"Yes, if I were you, I would stay here and settle down."

This had taken Juhani by surprise, and while he shook his head in refusal, it was without vehemence or even firmness. Then Karol spoke again to Tadeusz, who nodded emphatically and said something in return.

The old man smiled and looked at Juhani.

"He agrees with me; you should stay. In fact, he says you should marry his

sister, who finds you interesting. From such a marriage should come many children."

Tadeusz's comment stunned Juhani so that he could not answer at once. Juhani shook his head again, strongly this time because the thought was so attractive. He must, he explained, start north again as soon as possible, and offered his labor in exchange for a small quantity of whatever propagules Old Karol thought might prove useful. The old man nodded, then told him that a tradeoff was not necessary; the quantity that Juhani would take away was not great.

But the Finn insisted that he must leave something behind in exchange, and they had agreed on two days of wood cutting—that day and the next. Then Juhani had taken a second ax and helped Tadeusz at the woodpile.

At day's end, with the cattle in the barn, safe from all but the most reckless bear, they sat down to eat. There was sausage, smoked and spiced to keep in summer, boiled cabbage, and buttered rye bread with, again, honey. Afterward Old Karol played on a strange instrument, a graceful box of reddish wood with a handle on one end, and strings which he stroked with a stick-like object. And Elzbieta sang accompaniment, or perhaps the old man was accompanying her instead.

At any rate she sang beautifully, looking very lovely and desirable. And when Juhani lay down at last in Tadeusz's room, on the stack of fresh hay brought there for his bed, he could not help but look again at the temptation, considering what it would be like to be married to someone so comely, yet so strong, as Elzbieta. And this was a richer country than at home; clearly the summers were warmer, and no doubt the winters as well.

Still, there was no way around it; He must go home. What he would really like to exchange, he told himself, was seed of his own, in Elzbieta's belly. But he could never bring himself to suggest it.

Another thought occurred to him then—to go home and afterward come back. He wondered if Elzbieta would wait for him, if he asked her. But no. These people put even more emphasis on fertility and children than did the Suomalaisia. Even if she was willing to wait, her people would pressure her. "He is a foreigner," they would say. "He will never come back. Or if he intends to, he may well die along the way." And they would wear her down.

It was terrible to be in this position with so little real choice. At home there was always a shortage of women because of deaths in childbirth, while here he'd had an *invitation* to marry.

But had he? Elzbieta had not asked him, nor he her. All he had was a remark by her brother. She had looked at him a lot, that evening as they ate and afterward, and had seemed friendly, but that was well short of accepting him as husband.

Enough! he told himself, abruptly angry. *Such thoughts give you nothing but discomfort!* He turned onto his side to invite sleep, curling up beneath the woolen blanket Karol had given him to use. Tomorrow he would work hard and not look at Elzbieta more than necessary. And the day after that he would

load his leather bag and start the trek home.

It seemed to Juhani that Elzbieta had wakened him, to tell him it was time to go. And he understood her words perfectly. She kissed him sweetly, and he thought to take her to the privacy of the hayloft and make love to her, and got up, and they went to the main room, to find Karol and Tadeusz waiting. They were all going to Suomi with him, which filled him with a light sort of joy that he could not remember ever feeling before.

And somehow or other they were all on horseback, riding north, with a pack of wolves trotting beside to protect them. Juhani laughed; such a thing was so preposterous!

And the country north of the foothills was no longer barren, but covered by orchards yellow with apples. Vines spread over the ground between the trees, bearing ripe pumpkins as vividly orange as Old Karol had described them. The trail they rode upon was a well-packed lane, with people along it smiling happily, waving at him. They were singing in Polish, and he noticed that he understood every word of it, answering them in Polish as perfect as any he heard. He felt joy at how easy it all was.

Then they were at the sparkling sea, and rode down to the beach where the boat waited, with its smiling boatmen. It had not been very far to ride at all. In fact, the sea was not wide either, no wider than a large river. On the other shore, Juhani could see Suomi, bright with sunshine and aspens. Karol and Tadeusz said goodbye then, and Elzbieta also, but all very grave now, and Juhani felt that something was wrong about this. Still, he did not mention it, not wishing to bring up anything unpleasant, and set off alone, rowing. He would be back soon enough.

But the north wind from the Suomi shore was strong and cold, aswirl with snowflakes, and he began to pull very hard on the oars. A dread spread over him that he might not be able to make it, or that one of the waves would founder the boat and he would lose the leather bag. So he redoubled his efforts, pulling hard and fast on the oars.

Then Old Yrkki was helping him draw the boat onto the shore, and the ground was covered with snow to their knees. The old man was shaking his head sadly, telling Juhani that he was too late, that snow covered the ground the year round in these times. If only he had come straight home, they could have planted the pumpkin vines, and the pumpkins would have kept away the snow, because when they were ripe, they turned orange like the sun, and the snow could not abide them. But now was too late; the ground was frozen, and would always be.

Juhani had started to protest that he had come straight home, but then it occurred to him that the many people waving along the path had looked like himself or like Elzbieta, as if their children.

Then the ancient Finn had raised a mittened hand and pushed back the hood of his parka to show his face to Juhani. And his head was a skull, fleshless, skinless, without lips or eyes. With a bare and bony foot, he dug down through the snow as if to expose the

ground. And he was right: Beneath the snow was no soil at all, but ice, clear and dark. And bottomless, for Juhani could see deep into it, and deep . . .

And woke up sweating in the dark room.

Quietly he got up, not to waken Tadeusz, and as softly as he could, slipped across the puncheon floor to the outer door. Outside, a flawless night sky spread above the valley, only moderately chill. The waxing half moon stood on the meridian, to tell him it was midnight. He noticed, then dismissed it; his mind was on the dream. .

A lane led from the farm toward the next farms down the valley, and he took it, walking slowly, unseeing, plucking at the dream threads to pull back as much of it as he could. It felt like a warning, literal and direct, the kind he should be able to act upon. Yet when he looked at it, none of it made sense. Certainly the ending didn't. Still, it seemed there was a meaning there for him, perhaps too subtle for the dreamer himself to unravel.

Surely these people would have a dream reader.

Gradually as he strolled, his mind moved from the direness of the dream's end to the sweetness of its beginning, and to the notion of taking Elzbieta to the barn. And after a little he returned to the houseyard again. A hope had touched him, so real that he expected it to happen—Elzbieta would be waiting for him in the shadows and lead him herself to the hayloft. But no one waited except the dog, big hard-bodied Ludwik, who sniffed him in the moonlight before returning to his den beneath the house. And there were no sweet whispered words, but only the sound of a chicken crooning in sleep from a shed.

He wakened to Tadeusz's opening the door in departure, and after a minute got to his feet and followed into the main room. Cool morning daylight leaned through the open door, and filtered through the layer of scraped cowhide stretched parchment-thin over the south window. Elzbieta had already milked the cows, and was pouring milk from a wooden bucket into a crock. She glanced at him briefly, smiling, her smooth cheeks pink through golden tan, her neck strong yet vulnerable-seeming. If only, thought Juhani. If only.

From outside he could hear chopping, measured but slow, and knew it must be Old Karol. He went out to see. The old man looked up at him and set the ax aside, wiping his brow with a sleeve; he was not too old to sweat.

"How are you this morning, my Finnish friend? I hope you slept well." They conversed much more easily now than at first, from practice and the experience of each other's patterns and usages.

"I had a dream," the Finn answered, "a dream which troubles me. Is there a dream reader in your valley?"

The white mane nodded, the blue eyes watching. "I am sometimes asked to read dreams," Old Karol answered. He gestured toward a bench beneath a nearby fir tree, and they went there and sat. "Tell me."

Juhani told him, leaving out only his carnal thoughts about Elzbieta and the resemblance of the Poles to himself. When he'd told it all, he sat with his gaze upon the cows, where they waited

for their mistress in the cowyard. A magpie was scolding from the rail fence, and a thrush fluted in a nearby thicket. After a long minute, Old Karol spoke.

"When I was a boy in the academic high school, I learned about a time, very long ago, when all the north was buried by ice. All of the Finn land and the rest of the north—even to northern Poland—was covered by ice kilometers thick. It was thought to have started by some years without summers."

Juhani looked at Old Karol and found the even blue eyes on his.

"The ice did not come by magic," the old man went on. "It came about by snow falling on the northern highlands, far more than the summers could melt, when at last there were summers again. And it kept getting deeper and heavier, year by year, until its very weight pressed it into ice. Then the ice squeezed outward at the edges, like wet clay squeezed from a fist. It squeezed out and covered all the land around, spreading and spreading."

His old eyes glanced downward at his big, spotted hands, as if visualizing them squeezing wet clay. Abruptly then he looked toward the nearby privy, where it stood half hidden by a pear tree, low and bushy, and by overgrowing ivy.

"Tadeusz!" he shouted. In a moment the privy door pushed out half open, and a questioning voice answered from within. Old Karol called out several sentences in Polish, and received an apparently satisfactory reply. He turned again to Juhani.

"When he is done and you both have eaten, I will have him take you to a valley in the high Tatra. There you will see ice like that I spoke of. It is called a *glacier*, just a small southland glacier. It was not there when I was young, not any of it. In those times the snow in the Tatra all melted by summer's end. The glacier has come about since the great cold.

"I have not seen it myself, but others have. Tadeusz has. Maybe when you have seen it, you will know the meaning of your dream."

Then Old Karol got up as if dismissing Juhani, and walked away toward the brook.

They hiked all day through foothills, Tadeusz leading a winding way through stream gaps and over saddles, the route mostly wooded with pine but also with spruce and fir. In a few places they passed birch groves, and twice, single unfamiliar trees with dense crowns of glossy lovely green, their ash-gray bark hard as wood and pebbly smooth, each tree standing in a round patch of sprouts from its own roots. Juhani asked in gestures what it was named, and Tadeusz did not know. It must be something that had almost disappeared in the great cold, Juhani decided, something the young didn't know of. He paused to pluck leaves and a twig. From them and a description, Old Karol would surely remember.

That night they slept on the cold ground, which Tadeusz wasn't used to, though he did not complain. The second morning the climbing began in earnest, toward black peaks peering here and there over intervening ridges. As they climbed, the forest became mere patches, its trees small and crooked. Clouds appeared, to hide the sun. After a time the

young men passed above the tree line, onto steep ground rich in stones, its thin and wiry grass restless in the cold wind. Harebells nodded and bobbed, marvelously delicate, their violet blossoms no bigger than Juhani's fingertip, no higher than his ankle.

In time they crested a final ridge. On the other side a narrow valley lay, its foot in forest but its upper reach ... ...its upper reach was half filled with what Old Karol had told him of, a glacier, only a dozen meters thick at its lower end but unknowably thick, perhaps a hundred meters, farther up. It began in a great bowl in the mountainside, just below the crest, slanting steeply down, curving to an ever gentler slope until, after a kilometer and a half, it ended, giving forth a little mountain stream.

The two young men followed the ridge crest then, still climbing, hands thrust into pockets, wind cutting their faces, until they were above the mass of white. Then they picked their way slantwise down the ridgeside to stand atop the hard and crunchy glacier snow, which bore their weight without imprint. Juhani gouged some up with clawed fingers, made a little ball of it, put it in his mouth to wet his thirst, then wiped the cold, wet, reddened hand in his armpit. The two young men looked at each other, then Tadeusz turned and led the way back up the ridge.

But they did not at once start back for the farm. In a place where the slope was safe, Tadeusz led a zigzag way down into the valley below the glacier, and they hiked to the ice's end. For ice it surely was; that was easily seen here where it ended. And the stream flowing from the pool at its foot was numbingly cold.

Then, as if to accentuate the message of the glacier, the clouds sent a swarm of snowflakes riding the icy wind, and Juhani and Tadeusz left, hurrying from the omen they had seen and trod upon.

It was like many plans, indeterminate because of unknowns, its steps conditional. But his opening was simple enough. First he would speak to Old Karol, who was resting in the sun by the woodpile.

Tadeusz had gone to chop weeds from the turnip and potato patches, and Elzbieta was in the main room, churning butter, her firm round arms working the dasher steadily up and down. It had sounded to Juhani as if the butterfat soon would separate.

The cattle were tended by Ludwik alone, as was often the case.

Juhani began telling Karol what he wished to do. If Elzbieta would marry him, said the Finn, he would stay here most of a year, learning to tend the plants he would take home. Then, next summer, he would return to Suomi, but not to stay. (Elzbieta might well have borne their first child by then, he added.) In Suomi he would teach his people to start and tend their new crop species.

And he would have men sent to the arctic, to see if glaciers were growing on the highlands there. Or he would go himself to see, if no others would, though he was sure it would not come to that. There would be youths eager to adventure, and his people would recognize the need to know. And Old Yrkki would insist on it. New crop species

would be useless if, when the children had grown old, ice crept down from the arctic to bury the land.

And after a year in Suomi, Juhani would come back to Elzbieta. Or it might possibly be two years, if he had to go to the arctic himself. But he would surely return to Elzbieta and make a farm of his own here, and be a Pole from that time on.

"If she will have me under those conditions," he ended, "and if you will, then that's what I will do."

The old man examined him with pale blue eyes, at first unsmiling. But after a minute nodded slowly, a small smile escaping his sober mien.

"What are the words with which I can ask her?" Juhani wanted to know.

"Chciałbym poprosić Cię o Twoją rękę," said Karol slowly, and repeated it carefully. "Chciałbym poprosić Cię o Twoją rękę."

"Tiowbim poprosits . . ." Juhani began, then lost it.

"Cię o Twoją rękę," Karol finished for him. "Chciałbym poprosić Cię o Twoją rękę."

They worked together until Juhani approximated it. "Chiowbim poprosich Chio ohTvoyo riochio." Juhani said at last. "Chiowbim poprosich Chio oh Tvoyoh riochio!"

Old Karol nodded enthusiastically, smiling openly now, and began to turn as if to call Elzbieta from the house. Juhani stayed him with a gesture.

"Let her finish the churning; it is not good to take it almost to the end and stop."

His eyes held the old man's. "Besides, there is something else I must say first."

Old Karol waited.

"If there is glacier in the arctic—"

The Pole interrupted. "There will at least be small valley glaciers like the one you saw in the High Tatra, if there are mountains there at all. The danger lies in great glaciers, which cover large areas. For they carry their own climate with them, which allows them to grow on and on."

Juhani nodded. "If there is danger from glacier there, many of my people may leave Suomi and come south, later if not at once. They will have to. They may come to Poland. What will the Poles think of that?"

Old Karol shrugged. "I wish the young knew the past as I do—I and perhaps the one you call 'Old Yrkki.' It would be well for all men to know that the world never stays unchanging for anyone, Finns or Poles." He nodded again at his own thoughts. "Better your people come south soon, when there is so much land unpeopled here. Perhaps you, with a foot among both Finns and Poles—"

At that moment, Elzbieta came out of the cabin, and her foster father's face turned to her.

"Ah! Elzbieta!" he called, suddenly hearty, jovial. "Wait till you hear! Juhani has something to say to you."

Juhani blushed. "I have forgotten the words," he murmured in Toitsä.

Karol grinned, his teeth still strong. "Well then, I will do it for you." He turned his tongue to Polish. "My child," he said, "I have a fine strong husband for you, if you'll have him."

Elzbieta's eyes moved to Juhani and she smiled, blushing at the same time, before she spoke. Juhani didn't need to understand Polish to know her answer.■

Jay Kay Klein's biolog

When your dad dies during the Great Depression and you're rotated among collateral relatives or boarded out with strangers, you probably would have a miserable childhood—unless you're John Dalmas. Born in Chicago and sometimes raised there, John swears he had a great time growing up in places that read like a hobo's itinerary, but he admits to liking the rural places best. In a village library as a teenager he discovered Burrough's *Mars* books, and a box of old *Analogs* (then called *Astounding*) in a woodshed.

Before he could become an *Analog* writer, though, World War II had to take place. Trained as a parachute trooper, he wound up a self-taught medic after an incredible snafu sent him through advanced airborne training a second time. Hindsight has convinced him it was a very good thing: that he spent so much time training for shock tactics in combat that the war was over before he could get shot at.

After that, if you're not John Dalmas you would have gone to college on the GI bill. Instead, he logged, sailed in the merchant marine, and rode freight trains. Following all that, education didn't seem so bad after all, and he thought he'd try some, winding up with a Ph.D. in ecology at age 40. With his two earlier degrees in forestry, he worked for the U.S. Forest Service. All this time, *Analog* and other SF magazines retained their interest.

A crummy novel he picked up at a smoke shop in Flagstaff convinced him he could write better than *that*. During a lonely and snowy winter on the Coconino Plateau, he turned out three or four drafts of a novel that appeared first right here in the October and November 1969 issues, before being reprinted several times, most recently in 1984 by TOR Books (*The Yngling*). This reflects his childhood time in Minnesota that left him able to speak Swedish, along with the nickname "Swede."

After leaving forestry in 1977, John started writing in earnest, and now has another eight novels in print, plus credits for a string of shorter stories in magazines. In 1984 he gave up pencilled first drafts finished on a massive old Underwood, and went to a computer word processor. Unless you are John Dalmas, any professional writer using modern machinery would most certainly block the story out first. John still likes to start a story and then find out what happens afterward. This is the fun way to write and guarantees that he won't get into rut or employ a formula—the living characters won't allow it. Matter of fact, he loves strong characters that can't really be tamed on a written page, like Poul Anderson's Van Rijn or Jim Schmitz' Telzey.

John still loves backpacking even though he swears people are starting to call him "Grampa." What are cutting into his outdoors time are science fiction conventions, which he discovered a few years back. ■

John Dalmas

The Alternate View

THE QUANTUM HANDSHAKE

John G. Cramer

Quantum mechanics is weird. It has led respectable physicists to spin theories about cats that are half alive and half dead, about worlds which split into alternate universes with each quantum event, about a reality altered because an intelligent observer watches it, about mathematical equations describing "knowledge" rather than physical reality. This month's AV column is about my own work, a new interpretation of quantum mechanics which seeks to dispell this weirdness by depicting each quantum event as a "transaction," a sort of handshake across space-time. A long description of this "Transactional Interpretation" has just been published in the July *Reviews of Modern Physics* (available at most university and major public libraries). It challenges the standard Copenhagen interpretation of Bohr and Heisenberg which has maintained a shaky dominance as the orthodox interpretation of quantum mechanics for over fifty years.

Quantum mechanics (QM) was invented in the late 1920s when an embarrassing body of new experimental facts from the microscopic world couldn't be explained by the accepted physics of the period. Heisenberg, Schroedinger, Dirac, and others used a remarkable combination of intuition and brilliance to devise clever ways of "getting the right answer" from a set of arcane mathematical procedures. They somehow accomplished this without understanding in any basic way what their mathematics really *meant*. The mathematical formalism of quantum mechanics is now trusted by all physicists, its use clear and unambiguous. But even now, five decades later, its meaning remains controversial. One hears the platitude that "mathematics is the language of science." Quantum mechanics reminds us that this "language" may lack a proper translation, that formulating a theory is not the same as understanding its meaning.

For orientation, let's start our discussion with some fairly simple questions and answers:

Q: What *is* quantum mechanics?

A: It's the theory which deals with the smallest scale of physical objects in the universe, objects (atoms, nuclei, photons, quarks) so small that the lumpiness or *quantization* of physical variables becomes important.

Q: What's quantization?

A: It's the idea that there are minimum size chunks for certain quantities like energy and angular momentum. The minimum energy chunk for light of frequency ν is $\mathbf{E} = \mathbf{h}\nu$ where $\mathbf{h}$ is Planck's constant. We call the particle of light carrying this minimum-size energy chunk $\mathbf{h}\nu$ a *photon*.

Q: What's meant by "the formalism of quantum mechanics"?

A: Basically, the formalism is mathematics consisting of (1) a differential

equation like Schroedinger's wave equation which relates mass, energy, and momentum; (2) the mathematical solutions of that wave equation, called *wave functions*, which contain information about location, energy, momentum, etc. of some system; and (3) procedures for using wave functions to make predictions about physical measurements on the system.

Q: What's a "system"?

A: It is any collection of physical objects which is to be described by quantum mechanics. It could be a single electron, a group of quarks, an atom, a cat in a box, or the whole universe and all its contents.

Q: Why all the recent fuss about quantum mechanics?

A: Albert Einstein distrusted quantum mechanics because he perceived embedded in its formalism what he called "spooky actions at a distance." The characteristic that worried Einstein is called "nonlocality." The term *locality* means that separated system parts which are isolated by the speed-of-light barrier can only retain some definite relationship through memory of previous contact. *Nonlocality* means that some relationship is being enforced faster than light across space and time. The recent fuss has arisen because the nonlocality of quantum mechanics has been spotlighted by the EPR (Einstein-Podolsky-Rosen) experiments performed in the last decade. These measurements of the correlated optical polarizations for oppositely directed photons show that something very like faster-than-light hand-shaking must be going on within the formalism of quantum mechanics and in nature itself.

Q: Finally, just what *is* the Copenhagen interpretation?

A: The Copenhagen interpretation of quantum mechanics is a set of ideas and principles devised by Bohr, Heisenberg, and Born in the 1930s to give meaning to the formalism of quantum mechanics and to avoid certain "paradoxes" which seemed implicit in the formalism.

My RMP article lists five independent interpretational ideas which comprise the Copenhagen interpretation:

(1) Heisenberg's Uncertainty Principle: the idea that pairs of "conjugate" variables (like position and momentum or energy and time) cannot simultaneously be measured to "perfect" accuracy, nor can they have well-defined values at the same time.

(2) Born's Probability Law: the rule that the absolute square of the wave function gives the probability ($P = |\psi|^2 = \psi\psi^*$) of finding the system in the state described by the wave function.

(3) Bohr's Complementarity Principle: the idea that the uncertainty principle is an intrinsic property of nature (not just a measurement problem) and that the observer, his measuring apparatus, and the measured system form a "whole" which cannot be divided.

(4) Heisenberg's Knowledge Interpretation: the notion that the wave function is neither a physical wave traveling through space nor a direct description of a physical system, but rather is a mathematically encoded description of the *knowledge* of an observer who is making a measurement on the system.

(5) Heisenberg's Positivism: the principle that it isn't proper to discuss any aspect of the reality which lies behind the formalism unless the quantities

Illustration by William R. Warren, Jr., 1986

or entities discussed can be measured experimentally.

The first three elements of the Copenhagen interpretation are needed to connect the formalism with the results of physical measurements. The last two were devised by Heisenberg to deal with Einstein's "spooky actions at a distance" criticism and similar problems which lie in the general area of nonlocality. Let's consider an example of how the knowledge interpretation handles nonlocality.

An excited atom gives up energy by spitting out a photon. The QM formalism represents this event as a wave function that spreads out from the atom in an ever-widening spherical wave front resembling the ring of ripples from a stone thrown into a pond. The absolute square of this spreading wave function at a particular point in space-time gives the probability of finding the photon there. Finally the photon hits a silver atom in a photographic plate, giving up its energy and leaving a black spot on the plate. Instantaneously the photon's wave function undergoes a process called "collapse" which resembles the pricking of a soap bubble. The wave function completely disappears from all of space except in the immediate vicinity of the struck atom. The photon has now delivered its energy to the silver atom and has no probability of existing elsewhere. The wave function which had just been expanding through time and space has abruptly vanished.

This vanishment is part of Einstein's "spookiness" criticism. In 1929 at a physics conference he questioned how the remote parts of the wave function could possibly know that it was time to vanish when the photon was detected. Heisenberg's explanation was that the spreading wave function was not a real wave moving through space at the speed of light but rather a representation of the knowledge of an observer. When the observer had not yet detected the photon, it has an equal probability of being anywhere on the spreading spherical wave front. But as soon as the photon is detected it is known to have traveled to the silver atom, and its probability of being elsewhere must become zero.

The problem with the knowledge interpretation comes when we try to

stretch it to the EPR experiments, a system of two polarization-correlated photons traveling in opposite directions. Now there are two observers making measurements and gaining information about two photons which are out of speed-of-light contact, and yet the two measurements remain correlated in a "spooky" way. The nonlocality which enforces this correlation cannot be dismissed by attributing it to changes in knowledge. Something else must be going on, and the Copenhageners can only retreat behind the shield of Heisenberg's positivism in dealing with the problem.

The *transactional interpretation* meets the nonlocality problem head on, using a "transaction" model for quantum events which is itself nonlocal because it uses *advanced waves* that have negative energy and travel backwards in time. Advanced waves were the subject of a previous AV column ("Light in Reverse Gear II," August '85 *Analog*). This transaction model is based on the "absorber theory" originated by Richard Feynman and John Wheeler.

In the absorber theory description, any emission process makes advanced waves on an equal basis with ordinary "retarded" waves. But when the retarded wave is absorbed (sometime in the future) a cancellation process takes place which erases all traces of advanced waves and their "advanced" effects. The absorber manages to absorb the retarded wave by making a second retarded wave identical to but exactly out of phase with the retarded wave from the emitter. Thus the two cancel, and we say that the retarded wave from the emitter is absorbed. However, the absorber also must make an advanced wave. This advanced wave backtracks the retarded wave, traveling backward in time along the path taken by the retarded wave and reaching the emitter *at the instant of emission*. It continues backward in time, but now it is accompanied by the advanced wave from the emitter. The two waves are exactly out of phase, so they also cancel, removing all "advanced" effects in the process.

An observer not privy to these inner mechanisms of nature would perceive only that a retarded wave had gone from the emitter to the absorber. The absorber theory description, unconventional though it is, leads to exactly the same observations as the conventional one. But it differs in that there has been a two-way exchange, a "handshake" across space-time which led to the transfer of energy from emitter to absorber.

This advanced-retarded handshake is the basis for the transactional interpretation of quantum mechanics. It is a two-way contract between the future and the past for the purpose of transferring energy, momentum, etc. It is nonlocal because the future is, in a limited way, affecting the past on the same basis that the past affects the future. When you stand in the dark and look at a star a hundred light years away, not only have the retarded light waves from the star been traveling for a hundred years toward your eyes, but also advanced waves from your eyes have reached a hundred years into the past to encourage the star to shine in your direction. In my RMP paper this model is used to explain the accumulation of curiosities and paradoxes (the EPR paradox, Schroedinger's cat, Wigner's

friend, Wheeler's delayed choice, etc.) which have lain in the quantum mechanics Museum of Mysteries for decades. The need for half-and-half cats, fracturing universes, observer-dependent reality, or "knowledge" waves has been eliminated.

In this column we usually spotlight recent physics developments and then consider their science fiction implications. The transactional interpretation unfortunately pulls the rug from under a number of excellent SF works based on the weirder aspects of quantum mechanics. Examples are Pohl's *The Coming of the Quantum Cats* and Hogan's *The Proteus Operation*, both of which use the many-worlds or the Everett-Wheeler Interpretation of quantum mechanics (see "The Alternate View: Other Universes II," November '84 *Analog*). The transactional interpretation addressed the same problems which prompted development of the many-worlds interpretation and solves them in a more satisfactory way.

There are SF possibilities in the transactional interpretation. Advanced waves could perhaps, under the right circumstances, lead to "ansible-type" FTL communication favored by LeGuin and Card and to backward in time signaling of the sort used in Benford's *Timescape* and Hogan's *Thrice in Time*. There is also the implication in the transactional interpretation that Possibility does not become Reality along that sharp knife-edge that we call "the present." Rather, Reality crystallizes along a much fuzzier boundary which stitches into both future and past, advancing somehow in a way that defies sharp temporal definition. There must be a story in that. ■

REFERENCES

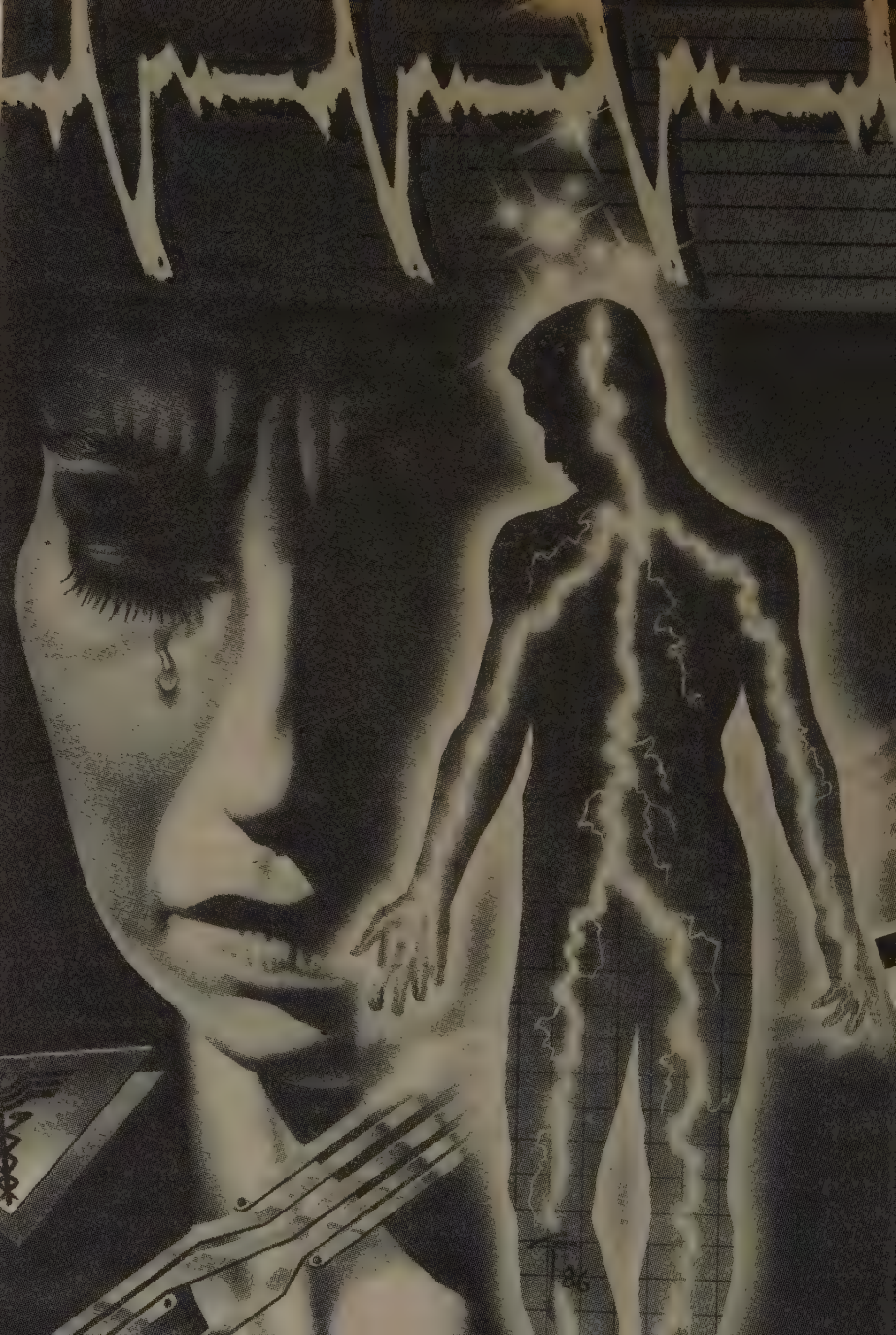
Transactional Interpretation: John G. Cramer, Reviews of Modern Physics *58*, #3 (1986); Reprint #293 available for $4.00 from: American Institute of Physics, Reprint Dept., 335 E. 45th St., New York, NY 10017

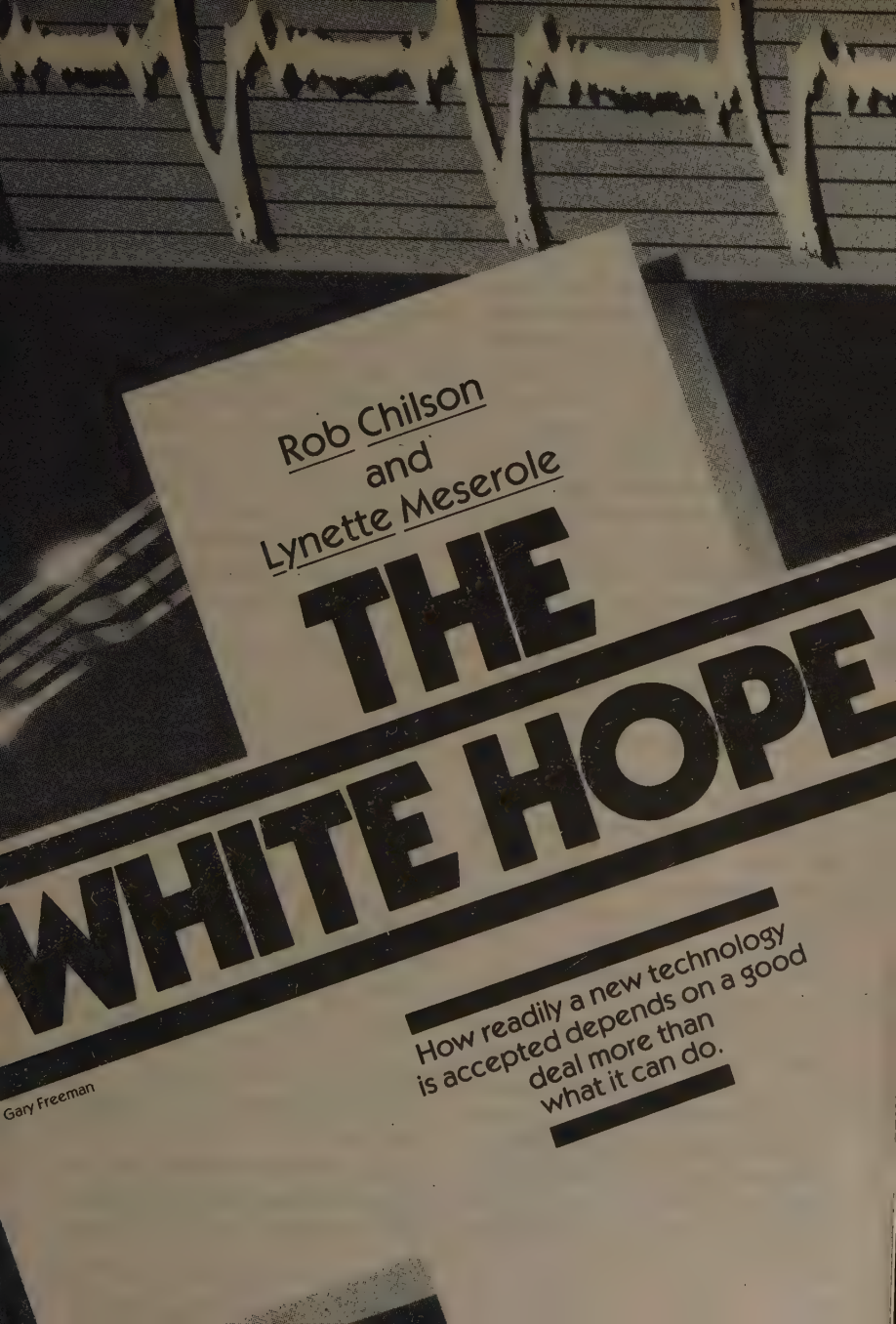
EPR Experiments: S. J. Freedman and J. F. Clauser, Phys. Rev. Letters *28*, 938 (1972): A. Aspect, J. Dalibard, and G. Roger, Physical Review Letters *49*, 91 (1982); Physical Review Letters *49*, 1804 (1982).

Absorber Theory: J. A. Wheeler and R. P. Feynman, Reviews of Modern Physics *17*, 157 (1945); Reviews of Modern Physics *21*, 425 (1949).

● Things are going to happen much faster than we think, and they are going to have much wider implications than we have considered. We need only look at the last twenty-five years.

G. Harry Stine





Rob Chilson
and
Lynette Meserole

THE WHITE HOPE

How readily a new technology is accepted depends on a good deal more than what it can do.

Gary Freeman

Gloria Bartram took a deep breath when her name was called. It didn't help. Her heart was beating so hard they wouldn't need a cardiac monitor or even a stethoscope to know it was racing.

She paused just inside the door and looked them over. Dr. Lapi wasn't there; she had hoped desperately that he would be. Cathy Tompkins, the Director of Nurses, turned a carefully expressionless glance on her. Dr. Nurbaugh was there, of course. He was the picture of righteous indignation. She returned his glare with what she hoped was a level look of confidence.

Then she faced Arthur Wigginton, Research Hospital's Administrator. The last time she'd seen him was when he had given all "his loyal nurses" a pep talk at the beginning of the strike. He hadn't even known her name then. His neatly trimmed, sparse white hair and slight palsy had endeared him to his listeners. He had seemed a sweet old man.

At the moment his blue eyes were as chill as ice and Gloria felt almost as if she faced an executioner. The large walnut desk he sat behind was barren except for a file directly in front of him and a tape recorder to one side. The only visible concession to personal comfort or taste was the high-backed leather chair he sat in.

"Be seated, Ms. Bartram." His neutral tone did nothing to reassure her. "You know Ms. Tompkins and Dr. Nurbaugh; and this," he indicated a gentleman seated on the other side of the room, "is Mr. Williams, our legal counsel." He cleared his throat. "You've been summoned here to answer to a charge—"

The lawyer, Williams, stirred. "Not charged," he said, "not formally charged."

Wigginton heard him out impatiently, then said, "An informal charge then, of mutinous insubordination. We have a written complaint against you. It *alleges,*" he emphasized the word slightly with a conciliatory nod toward Williams, "that you wrongfully approved treatment without obtaining appropriate medical orders, and did so with full knowledge that there was a standing order specifically against this electroneural therapy. This is a very serious charge. One that not only puts your license in jeopardy, but also threatens Research. As I understand it, the patient has not regained consciousness since the treatment you administered."

Gloria nodded. She'd checked on the patient, Debra Sandulescu, just prior to this meeting.

"That is unfortunate," Wigginton continued. "If the patient or her family conclude that injury has been done, we shall be facing a lawsuit. That must be avoided at all costs, especially in light of Research's present crisis." He steepled his fingers together and looked over the tips of them at Gloria. "What have you to say?"

Gloria wet her lips and wished she weren't so tired. How could she think straight? She avoided looking at Nurbaugh. "Sir, I did what had to be done to preserve the patient's life in the absence of her personal physician."

"She was admitted to the emergency room, correct?"

Again, all Gloria could do was nod.

Wigginton laced his fingers together. "Ms. Tompkins, what is standard pro-

cedure when a patient is admitted to the emergency room?''

Cathy Tompkins gave Gloria a tight but apologetic smile, then turned to the Administrator. ''When a patient is admitted to the ER the unit clerk calls the patient's personal physican while the admitting nurse takes vital signs and begins any stabilizing treatment that is necessary. And according to the records, these procedures were carried out.''

''I received no calls from Research last night,'' Dr. Nurbaugh said haughtily. ''Not from a unit clerk or anyone else.''

Gloria bit her lip to keep from shouting at him. Any outburst from her would only make things worse.

''Is there any explanation for this discrepancy?'' Wigginton asked.

She licked her dry lips. When Cathy Tompkins had called and informed her of this hearing, the Director of Nurses had recommended that Gloria tell everything that had happened on last night's shift. Gloria took a deep breath and hoped that Wigginton was willing to listen to a long story. ''In order for you to understand the necessity for my actions, I'd like to begin my explanation with what happened to me from the moment I came on duty last night.''

''Please be as brief as possible.'' Wigginton rested his chin on the bridge of knuckles of his laced-together fingers.

Gloria surreptitiously wiped her palms and said, ''I arrived in the nursing office a few minutes late—''

''Surely her being late, and what ever else may have occurred prior to my patient's arrival, has nothing to do with the fact that she *did* usurp my authority!'' Dr. Nurbaugh said with ill-concealed fury.

Wigginton straightened up, the leather of his chair creaking as he did. ''Doctor, I understand your frustration at the slowness of these procedings; however, they are designed to protect *all* of us from acting too hastily. Ms. Bartram must be heard in full before a judgment can be made.''

That took some of the wind out of Nurbaugh's sails, Gloria noted with grim satisfaction.

Wigginton folded his arms, rested them on the slight proturberance that was his stomach, then settled back more comfortably in his chair. ''Now, Ms. Bartram, please continue.''

In spite of her fatigue, her memory of last night's events was clear. ''As I said . . .''

She had been a few minutes late, thanks to Hank. She'd stopped by their, no, *his* house in Mission on her way to work. He was supposed to be there so she could pick up her last few things. But he wasn't. She'd pounded on the door furiously for several minutes. He had never been one to be there when she needed him.

Anyhow, when she arrived in the nursing office it was a little after 7 P.M. The pool nurses were waiting for her, and there was no sign of Karen, the acting day supervisor, or the 24-hour report sheets that were needed to assign any of the pool nurses a unit. She hung up her coat in the closet and took out her nursing shoes. Those poor shoes: they were badly in need of a coat of white polish. She'd pulled them on,

shrugged on her white lab coat, secured her name pin to its upper right pocket. Karen still hadn't shown up. As Gloria poured herself a cup of coffee she noticed the report sheets on the cabinet by the coffee maker. There were four units on each of three floors. A quick scan verified that there were twelve report sheets on the clipboard. No telling why they'd ended up there, but at least she could make assignments now. She sipped the stale-tasting coffee.

The reports gave patient censuses for each unit, the classification of those patients, a status report on all critical or seriously ill patients and on any patients the unit nurses had a concern about, the number of first-day surgery patients on each unit, the number of IVs, post-op patients, any special procedures or needs of the patients on each unit, and so on. She studied the information, then studied the staffing sheet. What a joke. With the strike on, units were being staffed with nurses who not only hadn't had a day off in the last ten days, but were working 12 to 16 hour shifts. Even stretching it that way, staffing was still inadequate. Gloria understood the strike was the only way most of the nurses had to express their dissatisfaction—

"We all know the reasons for the strike," Wigginton said, interrupting.

"Yes, sir," Gloria replied. Oh God, she shouldn't have let him know she was sympathetic to the strikers. "After I reviewed the report sheets, I assigned the pool nurses their units. One went to ICU and the other three went to three separate units. That still left the ER and pediatrics short. . . ."

* * *

Karen had come in while she was taking a call from a disgruntled doctor. He understood there was a staffing shortage but didn't think that should keep his patients from receiving their dinner trays on time. "Yes, Doctor, it can't be pleasant to have cold mashed potatoes and gravy. Yes, I'll see what I can do."

When she hung up Karen commiserated with her. "Some of these doctors are so insensitive to our problems, you'd think they didn't know there was a strike on. Nurses are like clean sheets to them—there's always supposed to be a supply." Then Karen gave her a verbal report.

"—Yes, ICU should do just fine with the extra person. They do have eight patients, but all eight are fairly stable. 3B West has some problems. They had six surgeries today. Five of the patients are back on the unit experiencing the usual pain, nausea, and vomiting. One patient is still in the recovery room. They had to put poor old Charlie in restraints. He wandered off the unit again. And the burn patient, what's her name? Vickie Haynes, may be having some complications. I'm not sure if it's due to the ENT therapy or not."

"What kind of complications?" Gloria wanted to know.

"Well, the third degree burn on the back of her hand is looking really strange. It's kind of a dull pink at the bottom."

"Any odor, swelling or unusual drainage?"

"No, just pink."

"Does Dr. Winston know about it?"

"Yes, but he doesn't know what to

make of it. Neither does Linda Warren."

"Excuse me, Ms. Bartram. Just what is ENT?" It was the lawyer, Williams.

Gloria brought her thoughts back to the present. "ENT, or electro-neural therapy, is a new treatment program which we recently began to offer at Research. It is based on the theory that all animals, including man, have a head-to-tail electrical polarity that is reversed in illness and injury. The ENT machine imposes 'normal' polarity on the body and increases the efficiency of the body's cells, which leads to faster healing. Unfortunately, while it is effective, it produces widely varying results. One person's healing might be speeded up by weeks, another's by mere days. Linda Warren is our resident expert on ENT and keeps herself informed of the ongoing research in this new field."

"And what sort of training has she had?"

"She's a registered nurse clinician. Her speciality is neurological disorders and she has taken every available course on electro-neural therapy." Just like a lawyer, Gloria thought grimly, he's into details. And details may be my downfall.

"All right, you may continue."

"Well, the rest of report was pretty routine. . . ."

She'd left Karen with a warning about the dark, rain-slicked streets and with report sheets in hand, started rounds. It was her pattern to check on ER and ICU first, then do the rest of the units on a priority basis. When they called desperate for help that's where she went next. If they didn't call—she'd see them when she had time.

ER was quiet. She hoped it would stay that way. They were down a nurse and a unit clerk.

ICU wasn't bad. The pool nurse she'd assigned to help out there really knew her stuff, thank God. Gloria was still getting a report on the last ICU patient when she got a call from 3B West.

"Poor old Charlie" was at it again. "He decided to take a stroll, I guess. Anyway he pulled out his IV and his catheter—"

"His *catheter?*" Gloria winced at the thought. Must've hurt like—

"Yeah," with a wincing intonation. "Anyway, he got as far as the central hallway before he fell. We tried to get him up—and made the mistake of saying he needed to get back to bed. He sat down on the floor and threatened to punch anyone who tried to move him."

Gloria told the nurse to call Security for help. She got a quick report on the final ICU patient, then rushed upstairs.

By the time she'd arrived Security had managed to get the old guy back into his bed and restrained once again in spite of his vigorous protests. A new IV set-up was brought in and Charlie's IV was restarted without too much trouble. But re-catherizing him was noisy business. Two nurses and the security guard held him down while Gloria inserted the catheter. The patient in the next bed was awakened by Charlie's cries and had to be reassured.

Dr. Nurbaugh happened by on his evening rounds and heard what had happened. He laughed and, out of the hearing of the patient, said, "I hope you

weren't too gentle with the senile old goat."

Senile? Gloria thought. Nothing suggested senility. A quick glance at his chart revealed that he had been a consistent behavior problem. While his admiring family was around he was a crusty, heart-of-gold type, full of pithy sayings. But once the moon came up—

Playing out her hunch, she checked his medication sheet. Sure enough, the poor old guy was on enough medicine to confuse an elephant. They *weren't* unnecessary medications but needed to be staggered so that no two medications would combine their effects. She gave her recommendation to the nurse on duty, who slapped her head.

"I should've seen that myself! I'm so tired and there's so much to do. I just can't keep track of everything any more."

Gloria nodded sympathetically. "In light of all the overtime, everyone has to work doubly hard to avoid overlooking such problems." She started the nurse working on an incident report —more paperwork for an overworked supervisor—then decided to check on Vickie Haynes's burns.

The young black woman was wakeful and restless.

"Are you in pain?" Gloria murmured—the patient in the next bed was dozing—"or is it just impossible to sleep in a hospital?"

"Just can't sleep. It doesn't help when I'm in bed all day, too." Vickie smiled, a flash of light on a dreary night.

"You really need to be in good health to handle hospital routine," Gloria said. It was one of her favorite relax-the-patient jokes.

"Especially if you're a nurse," Vickie said.

Gloria managed to laugh. "I didn't know it showed so plainly." She opened packages of sterile gauze and pulled on some gloves in preparation for unwrapping Vickie's bandages.

Familiar with the routine, Vickie obligingly held out her right arm. Gloria peered at the abnormally healing wounds then pulled on a fresh pair of sterile gloves so she could do a better examination. Most of Vickie's second degree burns were gone and in their place was a dull pink scar tissue, blemishing the rich brown skin. ENT was expected to speed the healing process, but those scars— They weren't pink enough. New scars were normally an angry red; the dull pink stage came much later. Strange. Gloria touched a couple of the large scar areas with her gloved fingers. These didn't even feel like normal scars. They were soft and smooth as a baby's behind, unlike the angry curled lumps of normal burn scarring. It was amazing, but the third degree burn across the back of Vickie's knuckles showed the same type of dull pink tissue in the center of the wound.

"I know I'm not supposed to," Vickie said, "but I can move my fingers, and it doesn't even hurt!" She flexed her fingers then straightened them.

Gloria warned her, "Talk to your doctor before you move your fingers any more." She re-applied the bandages then pulled a chair close to Vickie's bed and sat down. "I don't quite understand it," she said. "It appears that your hand is healing faster than we anticipated. And while you'll have some extensive

scarring, it appears that you'll retain full use of your fingers. Yet I know that should be impossible. Those burns across your knuckles were so severe your doctors doubted you'd have *any* finger movement left."

Vickie grinned up at her.

"I know," Gloria said. "I'm glad we were wrong, too. It looks like your biggest problem will be getting used to having pink scars dotting your arm."

"Will they stay pink long?" Vickie asked.

"They'll fade in time, but they won't ever be the same color as the rest of your arm."

Vickie eyed her arm dubiously then brightened. "I guess I shouldn't complain—it could be worse."

"I won't complain either, but us medical types don't like things we can't explain, so we'll be checking and double checking on you. If you feel *anything* different—a pain, an itch, or if it just *looks* different to you—let us know. And get used to the idea of scads of doctors poking at you and shaking their heads. You'll be something of a celebrity until they've figured this one out."

Vickie laughed lightly. "I've already gotten used to that. I kind of like it. I was never special before."

"Really!" Dr. Nurbaugh practically exploded with impatience. "I don't see how any of this has any bearing on Ms. Bartram's guilt—"

"Or innocence?" Cathy Tompkins interjected.

"I must admit, I too, am beginning to wonder if you have any point in telling us all of this." Wigginton's tone was mild, almost too mild.

Gloria swallowed. "Good or bad, the strike and all of my earlier actions last night had an influence on the case in question. I think, if you'll just bear with me, you'll understand."

Nurbaugh snorted.

Wigginton looked undecided.

"I was just about to describe the events of Mrs. Sandulescu's arrival," Gloria told him.

"And these events are pertinent to the treatment she received?" he asked.

"I believe they are."

The Administrator gave her a curt nod.

Gloria continued, "As I left Vickie's room my beeper went off. I checked the time: it wasn't quite eleven o'clock. . . ." It had felt as if she'd worked at least half the shift already.

At the nurses' station, Gloria answered her page. It was ER. They'd received several patients over the last hour and had just had a call from MedAct: a patient in status epilepticus was coming in. The two ER nurses were desperate; they needed help. Gloria promised to be there stat. She paused long enough to call and ask Linda Warren to fill in as a unit clerk in the ER, then she hurried downstairs.

Gloria arrived just as the paramedics were wheeling a gurney through the door. It was the epilepsy patient, a young woman with short brown hair, probably in her late twenties. She was unconscious and receiving oxygen via a nasal cannula, a blood pressure cuff circled her right upper arm, and an IV ran in her left forearm. An anxious-looking young man followed. Gloria guessed he was the patient's husband.

One of the paramedics groaned as a seizure started. "Last one was only five minutes ago," he told Gloria. "We gave her an initial dose of both Phenobarbital and Valium when we arrived at ten twenty-two. We spent thirty minutes trying to stabilize her, then decided to transport anyway. She's had a total of one dose of Phenobarb and three of Valium: the last Valium was administered about six minutes ago. But as you can see, it's not helping her at all."

He was right. The young woman's body writhed and jerked with the tonic/clonic movements of a grand mal seizure.

"Have they all been grand mal?" Gloria asked.

"Yes, lasting about three minutes with occasional brief episodes of apnea." That explained the oxygen therapy. I'd better take a blood sample for arterial blood gasses, Gloria thought. The paramedic continued his verbal report while he and his partner assisted Gloria in protecting the patient, Debra Sandulescu, from injuring herself. She was strapped down and the side-rails were padded, but her movements were so vigorous she caused the gurney to rock.

After about three and a half minutes, the seizure stopped. Gloria took advantage of the respite and wheeled the patient on into one of the two private exam rooms. She had the paramedics help transfer Debra onto an ER gurney already stationed in the room, then dismissed them so they could report back on duty.

Most ER patients were "parked" in a large, open room. But seizures tended to frighten other patients, and a frightened patient is difficult to handle. Besides, Gloria didn't need an audience while she struggled to help this young woman survive. For a moment Gloria wondered what had caused the seizures to start, but another seizure absorbed her attention for the next three minutes.

Linda Warren showed up as Gloria was trying to instruct a distraught Mr. Sandulescu to wait in the waiting room. Linda smoothly drew him aside, saying there was some information she needed. Meanwhile, Gloria began taking the young woman's vital signs. Debra's pulse was slightly irregular and elevated, her respirations were shallow. With a stethoscope, Gloria listened to Debra's lungs. No signs of aspiration pneumonia yet. She swabbed Debra's right arm and eased a needle into place. After she'd obtained several cc's of blood, she withdrew the needle and held a cotton ball on the site until it stopped bleeding.

Linda had just left with the blood specimen when Debra stiffened; another seizure began. Gloria noted the time. Just four minutes since the last one. According to the paramedics and Mr. Sandulescu, this had been going on for an hour now. Gloria wasn't sure how much longer the young woman's body could take the punishment. Debra writhed and bucked, her respirations noisy through clenched teeth and pooling saliva. It lasted three minutes this time. Gloria administered another dose of Valium.

Not daring to leave Debra's side, Gloria turned on the call light. Linda answered. Yes, the patient's doctor was Dr. Nurbaugh and yes, his office had been called but no one answered. She'd

called his home, too. No answer there either. Gloria suggested having the hospital PBX page Dr. Nurbaugh. He might be examining a patient somewhere in the hospital.

Another four minutes passed; another seizure started. Damn, where was Dr. Nurbaugh? Gloria couldn't give Debra any more medications without a doctor's orders. And poor Debra needed something powerful and she needed it *now*.

The seizure subsided. Some of the lab reports came back. Debra definitely needed the oxygen. Gloria jotted down some notes on Debra's chart. Three minutes later, she dropped her note pad to hold the gurney stable during yet another seizure. As the seizure activity lessened, Debra's respirations became more and more shallow. Gloria was sweating. Fear was a fist of ice around her stomach. Then Debra stopped breathing. Gloria put the stethoscope on Debra's chest. Her pulse was just a flutter.

Gloria yanked the call light out of its socket, initiating the emergency call system. She began CPR on Debra. Linda ran into the room.

"Call a code!" Gloria shouted.

"Right!" Linda turned and ran for the nurses' station. Seconds later Linda and one of the ER nurses were in the room. Linda began taking notes. The second nurse had brought in the Crash Cart and pulled the backboard and ambu bag out of it. Gloria gave Debra another puff of breath then pulled her body up so the other nurse could put the backboard beneath the patient. With the board in place, the other nurse put the mask over Debra's mouth and began squeezing the ambu bag. Gloria continued chest compressions. Dimly she was aware of the operator's page: "Code Blue! Emergency Room 2. Code Blue! Emergency Room 2."

The next thing Gloria knew Dr. Lapi and someone from the respiratory department were there. The respiratory therapist took over the ambu bag. The ER nurse began drawing up medications as Dr. Lapi gave one and snapped out orders for the next. Linda put leads on Debra's chest and hooked up the cardiac monitor.

"Stop CPR," Dr. Lapi demanded. Everyone watched the monitor. Blip, blip, blip. Normal heart rate.

"She's breathing on her own," announced the respiratory therapist.

Tension drained out of Gloria. Her arms ached. She began picking up the variety of waste paper a code invariably produces. Debra's body stiffened. Despair filled Gloria.

"Someone give me a history," Dr. Lapi's voice was cool and authoritative. Gloria filled him in as quickly as she could.

"Dr. Nurbaugh has been called?"

Linda nodded. "Four times, and paged twice."

Dr. Lapi rubbed his chin. "Is there anyone else you can call? We need to know what medications she's on, when she last took them, and when she was last evaluated. Was there any trauma or problem that precipitated this?"

"Her husband may know some of that," Gloria suggested. "He's in the waiting room. Linda, will you go out and ask him what Debra had been doing just before this attack?"

"Find out if this is her first case of status epilepticus," Dr. Lapi asked.

"Her husband told me she's done this a couple of times before," Linda said.

"What did they have to do to stop it?" Gloria asked, nearly in unison with Dr. Lapi.

Linda started toward the door. "I'll find out."

By the time Linda returned, Debra's seizure had abated. She hadn't arrested this time, but her blood pressure had dropped and her heart rate was dangerously irregular.

"He said they were just watching a movie on TV. He's not sure what kind of medicine she takes or whether she took any this morning," Linda told them. "He's upset," she added lamely.

Gloria turned to Dr. Lapi, hoping he had a suggestion.

The doctor rubbed his eyes tiredly; it was after midnight. "Keep trying to reach Dr. Nurbaugh. We need a more detailed history on this woman. Give her 6 mg. paraldehyde IM. We've got to stop these seizures; next time she arrests we may not be able to pull her back."

Debra seemed to react to the paraldehyde. Her seizures decreased in duration and occurred at less frequent intervals. Even her pulse and blood pressure improved. Dr. Lapi decided to check on his other patient again and then take a nap. He left instructions to be awakened if Debra's condition changed or if Dr. Nurbaugh was found.

It was almost 2 A.M. Gloria's shoulders ached with tension. She was rubbing her neck when Linda stormed into the room.

"I don't believe it!" Linda exploded. "I called his house and finally get something besides a ring-no-answer—a busy signal. So I got the operator, told her it was an emergency, and asked her to break in. She says the phone's off the hook!"

Wigginton raised an eyebrow at that. "Dr. Nurbaugh, was your phone malfunctioning?"

Gloria was spitefully glad to see the man's Adam's apple move, but Nurbaugh's voice was smooth and controlled. "I wasn't on call, I'd signed out to Dr. Lapi."

Wigginton's blue gaze came to rest on her.

Gloria swallowed. "I was just coming to that. There was quite a bit of confusion surrounding that issue."

"I hope you will reach the conclusion of your story soon." Wigginton said quietly.

"It won't take much longer," she said. Wigginton said nothing more. "After Linda told me about the phone being off the hook, I suggested she try his office again. She did and that's when we found out that Dr. Lapi was supposed to be on call. Dr. Lapi was furious when we told him. He said since he was here, he'd do it, but he hadn't been informed. . . ."

About three in the morning, Debra's condition had worsened. Her seizures were lasting three to five minutes and occurring about every ten minutes. Gloria had Linda awaken Dr. Lapi, who had been resting on a cot in the doctor's lounge.

By the time he arrived in ER room 2, Debra's pulse was irregular again and

her blood pressure was falling. Gloria reviewed the last two hours of Debra's progress with him. He watched the cardiac monitor for a few minutes, then listened to Debra's heart and lungs. Another seizure started as he folded the stethoscope and put it back into the pocket of his white coat.

"Damn Nurbaugh! He should be here." Dr. Lapi rubbed his chin, then declared, "There's only one thing left. Ether and curare."

Gloria gave orders for a tank of ether and one more of oxygen to be brought to ER from the surgery suite. She pulled the curare out of the crash cart and drew up a dose. What they were about to do was a last resort treatment, that carried its own potential problems. Anesthesia always carried a risk—pneumonia, or worse. One never knew how a patient would react to it. And curare—a little would relax Debra's muscles so that all seizure activity would have to stop; too much would relax heart muscles and everything else.

Dr. Lapi administered the anesthesia and curare. Gloria monitored Debra's vital signs, while Linda assisted by handing the doctor the items he needed. He gave Debra the minimum dosages first, then waited. Ten minutes later, she had another seizure, but it was weaker than the last. He gave her a little more medication. Again, after ten minutes she had some seizure activity. He gave her the maximum dosage. Ten minutes passed. Fifteen, then twenty.

"Oh, my God!" Dr. Lapi exclaimed. "It can't be! Get an EEG on her STAT!"

Linda hurried out of the room.

Gloria looked at her patient again. Debra's pulse was still irregular, and her blood pressure was low, but nothing seemed extraordinarily wrong. No, wait! Debra's eyes were closed, but beneath those lids, her eyes were moving back and forth at an alarming rate. Her muscles could no longer jerk with seizure activity, but *something* was still happening. Good thing Linda is already here and knows how to do an EEG, thought Gloria. Otherwise we'd have to wait for an electroencephlograph technician to wake up, get dressed, and drive here.

Linda returned and connected the sensors to the correct places on Debra's scalp. While she was busy with that, Dr. Lapi stepped out of the room.

The EEG confirmed it. Debra Sandulescu was *still* experiencing seizure activity. Gloria sent Linda to find Dr. Lapi. A few minutes later the two returned.

"I've never seen anything like it," Dr. Lapi said softly. "And neither has either of the neurologists I talked to." He had been on the phone, seeking advice. "I don't know what else to do for her." His tone was helpless and resigned.

"We could try the White Box," Linda suggested.

Gloria stared. "ENT? Don't be silly—"

"It's not silly. There have been lots of studies done with ENT for neurological disorders—paralysis, Parkinson's, even epilepsy. They aren't conclusive, but there's never been a case where it harmed the patient and there's every indication that it could help. Besides—" she indicated the young woman between them. "What else can we do?"

Dr. Lapi rubbed his chin again.

Gloria spoke up hesitantly. "Dr. Nurbagh's got a policy against using ENT on his patients, but—if we don't try something Debra will die. She may have suffered brain damage already. I'd say we don't *have* any choice."

Dr. Lapi nodded his assent.

The three of them wheeled Debra down the hall to the small section of X-ray department which had been converted to an ENT lab. It looked very similar to the kidney dialysis rooms; there were two reclining chairs squeezed between massive machines. Linda hastily pulled the chairs out of the way. Then she opened a large black binder and, referring to it, began turning knobs and pushing buttons. Linda instructed Dr. Lapi and Gloria to hook up the patient.

It wasn't easy. Debra was so limp one person had to hold her while the other maneuvered the leads. They put the expansion band around her brow and made sure the small metal plate was at the nape of her neck. Then with some difficulty they slid the waistband around her, fastened it, then slid it down to her hips, this time aligning the metal plate with the base of Debra's spine. Linda inserted a finger beneath each lead to assure herself that the electrodes had good contact, and to apply a conductive gel.

"Ready," she said, pale but determined.

The machine was turned on. A mild electrical hum filled the room. Gloria stared at the waistband and headband Debra wore. After a moment she realized she was watching for an electrical arc or something science-fictional, even though she knew better. She forced herself to concentrate on Debra.

As Gloria watched, Debra's eye movements slowed down until they seemed natural sleep movements. "We should have brought the EEG equipment with us," she murmured.

"No need," Linda said. She pushed more buttons. A panel on the machine lit up. It was an EEG reading.

"Amazing!" Dr. Lapi whispered. He stepped closer to interpret the graph. "She's definitely not seizuring."

"Of course she wasn't!" Dr. Nurbaugh exploded. "And if you'd waited a few more minutes you would have seen that before you hooked her into that infernal machine. If you'd had a little more faith in traditional medicine she wouldn't be in the coma she's in now!"

"She's in a post-ictal coma because of the severity of her attack!" Gloria shouted back. She'd had all she could take from him. "All epileptic patients have a post-ictal period following a seizure. It can be a few moments' confusion to a deep, coma-like sleep. It has nothing to do with the ENT treatment. Debra's post-ictal period was bound to be deep and long. If you'd have bothered to show up last night that would have been obvious!"

"No one is disputing that the attack was severe, Ms. Bartram."

The sound of Arthur Wigginton's voice released Gloria's anger like a burst soap bubble. She was dismayed to notice the look of concern on Cathy Tomkin's face. As she struggled to regain her composure, Wigginton continued, turning from her to Dr. Nurbagh.

"This hearing was convened to es-

tablish if last night's events were ethically and legally correct. *Not* to decide the merits of electro-neural therapy." His blue gaze was like a conductor's baton. It went now to Williams, who temporized, fiddled with a pipe but did not light it.

"Well, Art, after listening to Ms. Bartram's account I believe there are several problems here. None of which are covered by laws currently on the books. For a fair judgment, we must rely on hospital procedure and routine."

"Identify the problems," Wigginton said.

Williams ticked them off on his fingers. "First, there's a question of responsibility—was it Ms. Bartram's responsibility to find another means of reaching Dr. Nurbaugh when he couldn't be reached initially? Or should Dr. Nurbaugh be held responsible for not having a reliable answering service?

"Then there was a problem with the proper relinquishment of responsibility: why didn't Ms. Bartram know Dr. Lapi was on call for Dr. Nurbaugh? Where do Dr. Lapi's responsibilities lie? Was it within Ms. Bartram's responsibility to find another physician? Did Dr. Nurbaugh follow accepted practice in relinquishing his responsibility to Dr. Lapi?

"I don't know the hospital's routine, but I can tell you how it was in the Navy when we relieved the Officer of the Day. We went to him *personally*, saluted him, told him that we relieved him—*and* got his acknowledgment.

"Finally, there is the ethical question of how far *does* one go to try to preserve a life? Far enough to disregard standing orders? Who made the decision to use ENT last night? Frankly, from her description, it sounds like Ms. Bartram did. Was she simply doing everything she could to save a life, or was she taking advantage of a situation to further an experiment she favors?

"How well established is this technique? I understand it's commonly used for certain kinds of physical therapy. Isn't it pretty experimental for anything else, though?"

Anger reddened her cheeks again; with an effort Gloria bit back furious words.

Wigginton nodded. "I see." He thought for a moment, looked at Cathy Tompkins and asked, "How does what we've heard fit in with the routine?"

Cathy looked down at her lap, straightened and looked Wigginton right in the eye. "Up until the time that the ENT was discussed, Ms. Bartram followed hospital routine. I would have done nothing different. However—I feel she stepped out of bounds by advocating and participating in the ENT treatment."

Gloria closed her eyes. The impact inside of her was as strong as if Cathy's words had been an actual blow.

"But," Cathy added, "I'd like to point out that a doctor was present and did have the final word."

Several long moments of silence followed. Gloria kept her eyes closed as if that could delay the inevitable.

"Ms. Bartram?" She opened her eyes and gazed levelly at Wigginton. "Because of the strike and the fact that you've violated no written law, you are not suspended but should report for duty at your next scheduled shift. You will be notified of our decision in a day or two. Rest assured, we will make that

decision as quickly as possible. You may leave now. Dr. Nurbaugh, I do not think we will require your help any further."

Dr. Nurbaugh haughtily ignored her, swept out of the outer office and vanished. Curiously numb, Gloria walked down the corridor.

The decision, as Wigginton had so tactfully expressed it, would determine the fate of her career. She'd given nursing everything she had for almost ten years, and it all boiled down to a decision made by someone else. She wondered if Charlotte Stricklin felt this way. Then it occurred to her that if it hadn't been for Charlotte, Gloria might not have been in this situation.

Charlotte Stricklin had been a staff nurse at a hospital in Kansas. She had been fired for allowing an IV antibiotic to infiltrate into the flesh of one Donald Hoard. It must have been one of the more potent antibiotics because the infiltration led to sloughing of the skin and ultimately caused injury to the bones and nerves of Mr. Hoard's right hand. The loss of the use of his hand was critical to him. He was a craftsman, a jeweler, who had his own little shop in Mission. When he and his family filed suit against the hospital, the hospital denied responsibility because Charlotte had not followed approved hospital procedures. Charlotte was left with no job, a costly lawsuit, and no other hospital willing to hire her until after the suit was settled.

That was two years ago. The case recently came to court and Charlotte made another plea for support from the hospital. She claimed the incident would not have occurred had she not been overworked due to understaffing. For several months before Donald Hoard was admitted, there had been a hiring freeze, which the hospital claimed was an economic necessity. The hospital admitted the hiring freeze had been in effect and that staffing hadn't been ideal, but it maintained that the only cause for Donald Hoard's injury was Charlotte's mismanagement of the situation. The shock waves of that assertion led to a nurses' strike that affected most hospitals in the Kansas City area.

Research was hard hit. The hospital had also been in a hiring freeze for the past five months, and was heavily understaffed. Too many of Research's nurses felt that they could have been a Charlotte Stricklin.

Just like me, Gloria thought glumly. Only she wasn't sure she'd have the strength to fight it like Charlotte was. And with the strike taking most of their nurses, Research couldn't afford to lose their doctors too. They were bound to choose Dr. Nurbaugh's version of the truth.

Gloria drove mechanically. She was too tired to think about anything. She was halfway to Mission when she'd realized what she was doing. The old "automatic pilot" had taken over. Ten days in the new apartment wasn't enough time for it to adjust. Oh, well, she might as well go on and try the house again. She'd called Hank when the shift was over last night. He'd been sullen; claimed he'd changed the locks because of a neighborhood burglary. He was supposed to have left the key in the mailbox, hidden between the pages of one of her nursing magazines.

The key was there. She opened the door and stepped inside. It seemed different somehow. It was a little musty, still and silent. The drapes were closed. She'd chosen them so carefully. . . . Now she was shopping K-Mart for bargain curtains. Boxes and trunks cluttered the living room. A heavy layer of dust lay over the end tables. The place hadn't been cleaned since she'd left. She felt uneasy. It wasn't home; she didn't belong here anymore. She shook her head to clear away the self-pity, then moved forward to examine the boxes.

Wouldn't you know, not one of the boxes was labeled. She sighed and checked each of them for the things she'd left behind. Ah, linens! Somehow she'd missed that box and had been getting by on one sheet, a blanket, and three hand towels. She moved it to the door, then continued her search. Several boxes of Hank's stuff. A box of household odds and ends; she was uncertain whose that was. Some robes and lingerie Hank had bought for her; she'd rarely had time to wear them for him. With a pang she wondered if he'd meant that box for her or himself. The rest of her books; she didn't really need them, but she didn't want to have to come back here again. Her small tape player lay on top of one box; she slipped it into her purse. Thank God for that; she needed her music desperately.

Damn! Where was the box of horses? It was a small, green, fake-leather box someone had given her. She'd treasured it. It had seemed appropriate to fill it full of tissue paper and the glass horses that were Gloria, the child's, most valued possessions. She quickly checked the rest of the boxes. It was nearly four o'clock, only three more hours until she had to report for duty. Unless—No, only one emotional crisis at a time. She looked in the dining room, in the kitchen, in Hank's den; nothing. Damn him! Upstairs, the master bedroom, the guest bedroom, and what had been her music room.

Listlessly Gloria drifted back downstairs, feeling very heavy, like the first moments after climbing out of a swimming pool in which one has been as free as air. She had not closed the front door. She stood with her forehead against the cold glass of the storm door, peering out through the fog on it at the gray world. It was beginning to snow. At the moment it seemed to her that those horses were the key to her existence. . . . She had lost her marriage, and now her job. Was she also to lose her horses?

The collection had begun with a gift from a beloved uncle, the black stallion she'd called "Rain." Rain was a favorite made even more dear when her uncle had died before she saw him again.

Several years later a young friend, Geri Mallot, broke that stallion. And Gloria had cried harder when she lost Rain than she had at her uncle's funeral. To this day she did not feel the same about Geri.

The most important remaining horse was the white one. Her sorority Big Sister had given it to her upon graduation from nursing school. Big Sister had graduated the year before Gloria, and she'd been sensitive enough to buy Gloria a small but beautiful china horse. She had named it "Hope.' . . .

Ever since Gloria had seen the direction her marriage was headed, the horses

had been packed in the little green box. She thought she'd packed it in with her sweaters. But she'd searched the apartment thoroughly, and couldn't find them. They had to be here. When she recovered them—She paused and considered that Hank, in some absent-minded moment, might have sold them or given them away. He was insensitive enough not to realize how important they were to her. *If* she recovered them, she would unpack them and check to see that all the survivors were there. Then she would pack them away again. They wouldn't be safe on a shelf, with her kitten Prince Charlie around.

That wasn't fair. The bonny prince had been well behaved. But Gloria admitted to herself that, kitten or no kitten, she probably would never unpack the horses again.

After loading the car, Gloria walked through the house again for one last look. She momentarily considered keeping the house key so she could return, but couldn't face the row that might stir up.

She drove through the intermittent snow, grimly determined not to let her sleepy attention wander. At the apartment she unloaded the car, fed Prince Charlie, then grabbed a quick dinner. She tried to get a little more sleep, but couldn't stop thinking long enough to doze off.

Giving up, she tried to read the newspaper, but the want ads leaped off the pages at her. Half-heartedly she looked to see if there was something other than nursing that she might be qualified for, but she had no desire to be a dishwasher. With a grunt of frustration she tossed the paper into a corner and headed back to the hospital.

At the hospital, Gloria went straight to Debra Sandulescu's room, unwilling to face anyone in the supervisors' office until she knew the woman's condition. It hadn't changed. Debra looked as if she were sleeping peacefully, but didn't respond to anything but deep pain stimuli. ENT treatments had been halted, thanks to Dr. Nurbaugh.

Gloria took Debra's warm hand in her cold ones and squeezed it. "Come on, Debra," Gloria whispered. "Your husband needs you. And without you, I haven't got a prayer. Try to wake up. I know you can do it, try!" For a heart-stopping moment Gloria thought she saw Debra's eyelids flutter. "That's it! You can do it!" Long moments passed into several minutes with no other sign of life. Gloria patted the motionless hand she held. "All right honey, you just rest a while." She gently pulled the door shut as she exited the room, sighed, then went downstairs.

No one said anything. Gloria tried to ignore their looks of pity and concern. Thank goodness, this job was one that took her full attention.

She answered the phone: one of the pool nurses calling in sick. Some of the nurses who couldn't afford to go on strike would call in sick a few extra times to salve their conscience. But this was a first sick call for this particular nurse; she was probably genuinely ill. Unfortunately, it left a hole in the schedule. Hmm. Had anyone volunteered for overtime? Conveniently, it was the supervisor who okayed overtime. . . .

A perennial problem Gloria had, as

any supervisor did, was to make sure there would be adequate staff for the next shift. She wouldn't know till morning how the present fragile schedule would stand up, but it didn't bode well that she'd already had a sick call and it wasn't even seven-thirty.

The phone again; a complaint from an intern about an orderly. The orderly had gone home. She'd have to follow up on that. And the usual stack of incident reports. Supervisors were required to review all incidents and judge where the problem had been and how it could be corrected. She wondered briefly which of her fellow supervisors had sent her case to the administration. No point in pursuing that line of thought, she told herself sternly, and picked up the stack of papers. Oh, there was the incident report from 3B West about Charlie's little "walk" last night. According to tonight's report Charlie had been behaving a little better today. She'd wait and see how he did tonight before writing up her assessment of that situation. Time for rounds.

Activity in ICU had picked up; they'd gotten a new patient during the day. An elderly woman who'd accidentally overdosed on sedatives. She was stable, but her son was having difficulty coping with the situation and continually needed some special attention. And that duty, like so many other nursing-related duties, fell to the staff nurses. Gloria spoke with him briefly in an attempt to lighten his load. She wasn't sure if her words helped or not.

ER was quietly busy. Most of their patients were being treated and sent home. Thank God for small favors.

3B West was having a quieter night. Charlie was calmer. Gloria checked on the six patients who'd had surgery the previous day. They were all doing well. Then she visited Vickie Haynes. She looked at Vickie's scars again. Were they a darker, duller pink than last night? She wasn't sure and made a mental note to ask the day supervisor to double-check on that.

Next unit was pediatrics. Only 15 of 35 beds were filled. The nurses' station was empty, so Gloria walked through the hall, looking for one of the two nurses assigned to the unit. She found Faye Innis in the unit's kitchen. Faye was a plump, middle-aged lady who looked out of place in nurse's whites. There were circles under her eyes.

"Hi." Gloria spoke in a low voice so she didn't waken any sleeping children. "Who could eat a peanut butter sandwich at this hour?"

Faye put the sandwich on a small plate and turned to Gloria. "Hank Aaron Spelling, that's who. He has a peanut butter and jelly sandwich and milk every night. It hits him like a club, or a sleeping pill." She laughed and added. "The peanut butter companies should investigate. It's a great marketing opportunity."

"Is everything going smoothly tonight?" Gloria asked. The unit was quiet, but it never hurt to ask the staff if there was a problem.

"It's okay, but—" Faye answered. "This hasn't got anything to do with the unit, but do you have any idea how long this strike will continue?"

Gloria shrugged. "None. It depends on whether the administration is willing to negotiate. If not, it may not be re-

solved until the court case is finished and that could take months."

"Oh. I just hoped—Supervisors are in a better position to hear—"

"Not really. Working the night shift keeps us all in the dark." Faye smiled wanly at Gloria's attempt at humor. "I doubt if even Cathy Tompkins knows anything," Gloria continued. "She's allowed to be present for negotiations with the strikers, but she isn't included in hospital board meetings to discuss what those negotiations will be."

Faye sighed. "It gets to me. I volunteered for night shift because I hated to cross the picket lines. I couldn't go on strike, even if I do sympathize with that girl who's being sued. I'm a nurse, not a teacher or a miner. People's *lives* depend on my doing my job."

Gloria nodded sympathetically and asked Faye if she'd finished the afghan she'd shown Gloria a few nights back. A phone call for Gloria interrupted their chat and sent them both back to work.

The phone call was simply a request for Gloria to relieve a nurse for dinner a little later on in the shift. A note jotted down on her worksheet took care of that. Things were shaping up to be real —dare she even think it—quiet.

She was on her way to a rare event, her dinner break, when Linda Warren caught up with her.

"Do you have a minute, Gloria?"

Oh dear, maybe this will be a minor problem and I can still get dinner, Gloria thought as she smiled and said, "Sure, what's up?"

"Mostly just a bitch session. That damn Nurbaugh!"

Gloria stiffened at the name. She hoped she'd be able to handle this problem without tangling with him further.

"Do you know anything about the Chandler baby?" Linda asked.

"Wasn't her mother the one who had no prenatal care until her eighth month?"

Linda nodded. "That's the one. The baby, they've named her Marqueta, was born at one o'clock this afternoon. She weighed four pounds, six ounces. Her vitals are stable but depressed. She's flaccid and has minimal response to even painful stimuli. They think it's a neurological problem. Her doctor, Dr. Harris, was willing to start the baby on ENT when I talked to him last night while her mother was still in labor, but tonight he won't hear of it. Dr. Nurbaugh's convinced him that ENT is equivalent to voodoo!"

"That's too bad," Gloria murmured.

"Too bad! Aren't you going to do something?"

"Well, treatment is up to the doctor. There is nothing I *can* do."

"Last night you would have gone to Dr. Harris, convinced him that Dr. Nurbaugh was full of shit and before the shift was over little Marqueta would have had her first ENT treatment. What did they do at that hearing? Beat the gumption out of you?"

"Look, Linda, they aren't just talking about suspending me, or even just firing me. They're deciding if they should have my license yanked!"

"Oh. Sorry."

"I'm sorry too. I know it's tough when you know you can help someone and the doctors won't listen."

"Yeah. All those seminars, being promoted to an ENT Nurse Clinician, it's sort of like being a resident expert

in acupunture was for so long." She sounded defeated. "Some day," she said with more strength, "doctors will have to admit we're capable of assessing a patient's condition and providing treatment. And if they don't admit it soon, there'll be a nurses' rebellion—"

"Oh boy, you have such pleasant day dreams," said Gloria, thinking of a few hangman's ropes she'd like to pull.

Not surprisingly, dinner was interrupted. ER had gotten a new patient, one who had to be admitted and would probably have to have surgery first thing in the morning if not earlier.

The patient, Judd Mitchell, was a construction worker who'd become almost a regular at Research. A few months earlier he'd had surgery for prostate cancer. It had been caught early enough that Judd's doctor, Dr. Lapi, felt ENT was a better course of follow-up treatment than radiation or chemotherapy. But after just a few weekly ENT treatments, Judd began experiencing severe headaches. At first everyone was concerned that perhaps the cancer had spread. A battery of tests determined that there was no tumor, but a metal plate in Judd's skull had become crowded.

As a young man, Judd had suffered a depressed skull fracture in an automobile accident. The splintered bone had been removed and a plate was surgically implanted to cover the fragile brain tissues. The crowding of that plate was caused by an unprecedented growth of new bony tissue. The doctors had made quite a fuss over Judd after that surgery. They said the new growth was a once in a century occurrence. The old plate had been removed and a smaller one inserted. Judd went home headache free. That was three weeks ago.

But tonight, Judd had been admitted after passing out from an excruciating headache. Gloria assigned him to a room on 2A West and at Dr. Lapi's request called Judd's neurologist, a Dr. Zarter. He sleepily agreed to come immediately.

When she looked in on Judd, he was asleep, although not peacefully. The morphine he'd been given allowed him to relax some, but judging by his wrinkled brow, it hadn't killed all the pain. She shielded Judd's face from her flashlight beam and peered at the left side of his head. His hair had grown fast but was still short enough for her to see the pink scar on his scalp. It looked puffy; there was definitely something going on. Gloria hoped it wasn't a tumor that had somehow been overlooked. Judd had become a friend over the last few months.

Shortly after she left Judd's room, Gloria had to go back to pediatrics. They'd admitted a young patient of Dr. Prentice. The ten-year-old boy was a diabetic and was in ketoacidosis. Faye Innis was furious. The history she'd gotten from the boy's parents indicated that the doctor had changed the boy's insulin orders that day, because he'd read an article that said some diabetics would produce their own insulin if they received less artificially.

"You'd think the doctor would have realized that the article was about adult onset diabetes, not juvenile!" Faye was so angry she was trembling.

"Dr. Prentice isn't a pediatrician," Gloria reminded her gently.

"Then why is he treating this boy?" Faye demanded.

Gloria shrugged. "His parents like Dr. Prentice."

"But isn't there anything we can do? If he keeps monkeying around he could end up causing the boy to have irreversible brain or kidney damage!"

Gloria sighed. There weren't many physicians who tried to care for patients outside of their area of expertise, but there were a few. And there was almost nothing that could be done about it. "I'll write it up for the peer review board," she told Faye, "but that's all I can do unless he actually harms a patient." And even that may cause *me* more trouble, she thought glumly. If Wigginton wanted to he could interpret her report as another case of insubordination against a physician. But she agreed with Faye, something had to be done to try to protect the boy, and so she'd do what she could. She left Faye calmer, but still upset.

She was waiting for the elevator when she was paged again. Another emergency admission. Where was this patient to be admitted? Gloria scanned her report sheets and regretfully assigned the patient a room on 3B West. She called the unit to inform them of the new admission. The nurse who answered the phone demanded more help.

"We already have twelve patients each! And most of them have IV medications every three hours and frequent vital signs. Why can't you give this admission to one of the other units?"

Gloria patiently explained that the other units were also full and short staffed. "I'll come up and help get him admitted," she added wearily. She had to offer the nurse something or else the strike would gain another advocate.

The situation on 3B West had not quite been settled when Gloria received a call from Dr. Zarter.

"I just examined Judd Mitchell. His intercranial pressure is dangerously high. I need a CAT scan done stat. Can you arrange that?"

"I'll call the radiologist right away." Gloria scanned her on-call list. "Will Judd have to have surgery tonight?"

"Probably. The increased pressure may be due to the same sort of growth he had the last time, however I think that's unlikely. It's probably a hematoma. We may have nicked a small blood vessel during his last surgery. It must have been a slow leak, but it's caused a sizable distortion of his intercranial fluids. The CAT scan will give us more to go on. Dr. Lapi is coming in and we'll decide if immediate surgery is indicated after we've checked the results of the scan."

Gloria made the call to the radiologist, who agreed to come in.

The remainder of the shift remained hectic. She relieved nurses for dinner breaks, started several IV's, ran to the Orthopedics Unit for a foot-cradle needed on the second floor, delivered some lab specimens for overworked nurses on the third floor, and fielded several more sick calls.

Drs. Zarter and Lapi decided to do surgery at four in the morning. Gloria spent a frantic hour paging the surgery team, waiting for their return calls, and informing them of the upcoming surgery.

About five-thirty she rushed back to the supervisors' office and began jug-

gling the schedule for the day shift. When that was under control she dashed back to each of the units to gather the report sheets, and checked with Surgery to see how Judd was doing. The operation was still in progress.

"Judd's CAT scan showed some dense, calcified material beneath his skull plate," Gloria told the day supervisor. "Dr. Zarter is afraid Judd has developed some abnormal cells around the skull plate. He said he'd probably have to remove a larger section of Judd's skull to stop this from happening again." She sipped her coffee, then reviewed the other events of the past twelve hours with her relief.

She finished the reports a little after eight. Only an hour of overtime today, she thought wearily, and momentarily wished for the days of hourly wages and overtime pay. She was preparing to leave when Cathy Tompkins came in. Cathy smiled at Gloria as she went to her office, but the smile told Gloria nothing. After some hesitation, Gloria entered Cathy's office.

Cathy had just finished hanging up her coat, turned around and saw Gloria. "Good morning," she said pleasantly.

"Hi. Um, Cathy, what's Wigginton going to do?" She couldn't deal with small talk right now.

"I don't know, wish I did. We've got a meeting at three o'clock to discuss your case."

"Oh." Gloria turned to leave.

"Gloria, I wanted to let you know. You're a very fine nurse with an excellent record. What you did the other night wasn't wise but you should not be held solely responsible. I'm recommending leniency."

Was that an apology or a warning? Cathy was staring at her, waiting for something. "Uh, thanks. Call me if . . . don't worry about waking me, I need to know."

Cathy agreed and somehow Gloria managed to leave the building before tears began to flow. She wasn't sure how much longer she could take this. Her life had been in an uproar for so long now, couldn't at least one thing be resolved quickly? After a few moments the tears stopped. Gloria marveled at that. I'm so tired I can't even cry anymore, she thought. Her cheeks burned with cold. She hoped they weren't chapped. If Wigginton saw her with chapped cheeks, it'd probably confirm her lack of responsibility.

As she drove home an empty sort of peace settled over her. Her mind was full of nothing but a thick white fog. She crawled into bed wearily realizing she'd had less than four hours sleep in the last 48 hours. That was her last coherent thought until the alarm awoke her six hours later.

She sat on the edge of the bed and tried to remember why she'd set the clock so early. Another hour or two of sleep would have been nice. She rubbed her eyes and looked around the room. Oh, yeah, unpacking. With a pang she remembered that she would not be unpacking the horses. Uneasily she considered that they might be gone for good. Even if Hank hadn't given them away, he had a tendency to handle things roughly. Her imagination built an alarmingly clear picture of a small white horse etched with a mosaic of fracture lines. The slightest touch would turn it into a pile of shattered porcelain.

She rubbed her eyes to rid herself of the vision. Mechanically she pulled on a pair of jeans and a sweatshirt and settled down to work.

The move from Mission to Grandview had been a big jump. Hank was a contractor who was doing well and could easily afford a home in Mission. Her income wasn't suited to that area. Grandview was much cheaper, also much closer to Research.

She sighed. Two boxes unpacked and umpteen more to go. The worst of it was the helpless feeling that she'd soon have to do it all over. The apartment wasn't really suitable, and the way her life was going these days, she might not be able to afford even it. The little nagging doubt crept back: if you hadn't left Hank you wouldn't be in this mess. You could afford to do anything you pleased.

No, Gloria reminded herself. Our marriage was over a long time ago. I tried to fix it, but Hank . . . No, not just Hank. Part of it was her fault, too. She was really serious about being a nurse; so much so, that rotating shifts didn't bother her. In fact she rather enjoyed it. Then one of the regular night people quit and she decided to do straight nights for a while. Hank had been so busy then, it scarcely mattered anyway.

But then came fall and the usual slackening of his work. Hank hated coming home to an empty house. He'd complained some, but not so much as to worry Gloria. She didn't even get concerned when he hinted that he went bar-hopping a couple of nights a week. As a contractor it was essential that he stay close to his men, a ready-made excuse to go out drinking.

Then Gloria was promoted to Supervisor on the day shift. But by then, Hank had discovered that he liked the singles life; bar-hopping had become a nightly habit. A well-to-do young contractor with a bronzed, ruggedly handsome face, Hank got all the attention he craved at the bars. She'd tried to give him more herself, but unfortunately there was something of the spoiled brat in Hank's charming-boy act. He wanted both worlds: a doting wife and a string of attentive bar flirts. Gloria let him know she didn't like that and then things got nasty.

She suspected that he had treated her so badly to conceal his own feelings from himself. But she'd never be able to forget, nor forgive, the way he'd raged at her.

Maybe it was true. Maybe she'd rather be Gloria Bartram R.N., than Mrs. Henry Upton, wealthy contractor's wife. She supposed wealthy contractor's wives had their compensations. But they just didn't satisfy her, not like nursing did. Nothing made her feel the way she did when she knew she'd really helped a patient feel better. The thought that she might not be able to practice nursing anymore threatened her completely. She couldn't conceive of life without nursing. She shook her head. Can't go too far down that abyss.

She ignored the other boxes waiting to be unpacked and took a shower. Afterwards she felt a little better. Strong enough to call Hank again. He was almost civil.

"What I called about, uh—I couldn't find my little green box full of glass horses. Uh, Hank . . . you didn't—give them away, did you?"

"Of course not," Hank said indignantly. "I know how much those silly horses mean to you. Look, I'll take another look through my things for them, if you want."

"I'd appreciate it."

"You said they're in that green box?"

"Yes. Um, give me a call if you find them. And—thanks."

She hung up, relieved that he had not given or—thrown her horses away. And he was going to look for them. It was nice to know Hank still cared enough to do that much for her.

Her hand had barely left the receiver when the phone rang. It was Cathy Tompkins. They'd reached a verdict and could Gloria be at the hospital in say thirty minutes? Gloria moved mechanically as she got ready to leave. She couldn't think, didn't dare think, about what might be said or done in the next hour.

"—maybe an enema would clean out some of the crap he's full of!"

"She's gonna end up just like poor Charlotte Stricklin—"

The nurses noticed Gloria and fell silent. Well, I knew they'd talk about it, she thought. But their comments had gotten to her just the same. She was shaking. Couldn't let Wigginton and crew see that. Have to look in control, no matter what. Gloria ducked into the restroom and in the privacy afforded by a stall, tried to calm down. She sent silent prayers to the powers that be to keep Nurbaugh away from the meeting. She didn't want him there if the worst was to happen. The press of time drew her out of the stall before she really felt ready, but then she supposed one could never get really ready for one's own demise.

In Wigginton's outer office, she told his secretary her name.

"Go right on in, Ms. Bartram. They're expecting you."

She squared her shoulders and pushed the door open. Wigginton, the lawyer Williams, and Cathy Tompkins were in their original seats. No Dr. Nurbaugh, thank God. No Dr. Lapi either. She hadn't really expected him to be here, but was disappointed just the same.

"Ah, Ms. Bartram, please be seated," Wigginton said as he reached shakily for a glass of water.

Feeling suddenly remote and detached from it all, Gloria noted that his palsy was more visible today.

Wigginton put the glass down and looked straight into her eyes. "Ms. Bartram, we have spent a great deal of time investigating the incident involving Mrs. Sandulescu. I have before me copies of current articles on ENT, written statements from Dr. Nurbaugh, Dr. Lapi, Linda Warren, a transcript of the statements you made to us, and we even went so far as to read your annual reviews dating back to your first one done here, at Research." He cleared his throat. "Now we'd like to know if you wish to change or add anything to your earlier statements."

They're giving me a chance to beg for forgiveness, Gloria thought. But I won't do it; I didn't do anything wrong. "No sir," she said steadily, "there's nothing more for me to say."

"Very well then, I'd like you to explain something to me." That blue gaze locked with hers.

"I will if I can," she said warily.


STRIKE

"We have had an increasing number of incident reports over the last few months. There is no consistency—some are medication errors, some are patient accidents, missed treatments, a variety of events that are potentially harmful to the patients and ultimately to the hospital. Could you tell us why you think these are on the increase?"

Why was he asking her that? Surely Cathy Tompkins was better prepared to answer him. Gloria gave Cathy a distrustful glance. An almost imperceptible shrug and a smile of encouragement was all she got in return.

She considered the question for a moment. Wigginton wasn't going to like the answer she had to give, but at this point she had nothing more to lose.

"Well, I think the greater percentage of them can be attributed to poor working conditions."

"Poor working conditions? Why, Research has the best facilities and most modern equipment in the entire city!"

That was more true for public relations purposes than medical purposes, but Gloria wasn't going to argue it.

"I wasn't speaking of the physical working conditions," she said. "Morale is at an all-time low around here. Research's nurses have lost all pride and job satisfaction. They see doctors courted with all sorts of extra perks like nice lounges constantly stocked with fresh fruit, special parking areas, and free meals; doctors treated like little tin gods—given any equipment they deem necessary. While they, the nurses, must make two thermometers and two stethoscopes suit the needs of an entire unit with thirty to forty patients. They must take care of ten patients each, even though federal guidelines recommend a maximum patient load of six. They must work longer hours with less time off, because the shortage of funds has led to a hiring freeze. Which in turn led to a strike, less nursing staff, and a still-greater patient load for those who remained. As tired and overworked as the working staff is, it's a wonder there aren't more accidents—ones with far more serious repercussions."

Gloria realized that she was pouring her words out like water from a broken dam and stopped. But anyway, she'd said it. She sat back and looked at them, waiting.

"You mean," Williams began. He lit his pipe and reached for an ashtray, squinting at her through the smoke. "We might have our own Charlotte Stricklin, Donald Hoard, or maybe worse, just because we didn't settle with the nurses?"

She nodded. That was exactly what she meant though she hadn't dared say it so plainly.

"And I suppose your position would be that Debra Sandulescu comes under this category?"

She hesitated, feeling trapped. "I was speaking of general conditions, not personally. I was not charged with an error, but with insubordination. It's not unlikely there'll be a lot more incidents like that, though; doctors refuse to accept that the nursing shortage might require changes in their expectations. We often *can't* provide them with the services they demand."

"And yet I understand," said Wigginton, "that only a little over half the nurses walked out. Less than sixty per-

cent, I believe. And we've replaced about half of them with pool nurses."

"It's worse than it looks, sir," said Cathy Tompkins. "Pool nurses are generally good nurses, but they don't know routines at Research. They've got to be oriented not only to the hospital, but to each unit as well. That takes time. As for the non-striking staff—all the supervisors, like Ms. Bartram, were loyal. So were most of the older nurses. Of course many of them stayed on because they simply couldn't afford to not work. There's no union to pay them striker's wages. But most of our young and energetic nurses, and far too many of our brightest nurses, walked. And found jobs. Not necessarily at restaurants either. Most of them are making more money now for less work." Cathy paused a moment, then went on. "The nurses that have remained to work through the strike are frequently ill because of inadequate rest, and many of them are suffering 'burn-out' at a phenomenal rate."

Wigginton and Williams nodded in counterpoint. Gloria realized that this was all part of a long-running debate at the upper levels.

"Did you check on Sandulescu before you came in?" Wigginton asked.

Ice filled Gloria's veins. She'd been so worried about this meeting, she hadn't even thought about Debra. She shook her head.

"You should have," Wigginton said, with palsied grimness. "According to the report Ms. Tompkins received, the patient woke up at 8 A.M. and demanded breakfast."

Waves of relief washed over Gloria. No matter what else happened, at least she didn't have to deal with guilt. Debra made it, she's okay.

"—burn patient, a black woman, who was treated with ENT and instead of normal scar tissue has grown new skin."

He had to mean Vickie Haynes. New skin! Of course, she should have known. The pinkness had fooled her, she'd forgotten that black babies are born with pink skin which gradually darkens. Gloria forced herself to concentrate on what Wigginton was saying.

"Then there is that man who had surgery this morning. His skull is growing shut!" There was a wistful, yet incredulous tone to Wigginton's voice. He trembled as he reached for the glass of water again. Gloria had a moment's distracted wonder if ENT would cure his palsy.

Cathy Tompkins said, "The value of the White Box—"

"The what?" Williams asked.

"That's what ENT therapists call their machine," Cathy explained. "Its value has been recognized by some very prestigious institutions. And research on its effects continues. It begins to seem that those effects are going to be vastly more far-reaching than anyone had dreamed of even a few months ago."

"That's all well and good," Wigginton said, crisp once again. "But we are here to address a different problem."

Gloria stiffened. She'd allowed the news about Debra and the other ENT patients to give her hope. It was hard to brace herself now.

"Ms. Bartram, do you realize how desperate conditions at Research have become?"

"Sir?"

Wigginton made an impatient gesture. "Failing to stand behind Charlotte Stricklin was an error, an instinctive flinching away from a problem. It's unfortunate, but there's nothing we can do about it. That is another administrator's problem." He pushed the thick file on his desk aside, and leaned forward. "I must deal with the problems at Research. The hiring freeze was something we had little choice in. Research Medical Center is near bankruptcy, Ms. Bartram. Being a non-profit hospital we have had substantial federal assistance, but even so we are nearly bankrupt."

Gloria met the bleak thrust of his gaze. "Conditions must be improved if we are to avoid major difficulties," he continued. "We were coming to this conclusion before your case and that of Debra Sandulescu hammered it home. Unfortunately we haven't the money to hire more nurses."

He sipped deliberately from his glass of water, set it down firmly. "Fortunately, however, you showed us the way out of the impasse. Would you be willing to act as a representative of the hospital at the negotiating table?"

She opened her mouth, closed it, then looked at Cathy Tompkins. Cathy nodded encouragingly and said, "We've arranged for Karen Anderson to work your shift tonight."

Gloria turned back to Wigginton. "I'm willing to try, sir," she said, puzzled. "But I don't see how *I* can help—"

He smiled, and for the first time Gloria realized how warm Arthur Wigginton's blue eyes could be.

An hour later she left the Administrator's office and dashed upstairs. Even at the risk of running into Dr. Nurbaugh, she had to see Debra Sandulescu herself.

Debra was in the lounge with some visitors, laughing and talking. It was hard to believe this was the same young woman whose life Gloria had fought for—was it only two nights ago? Gloria had to introduce herself to Debra. They chatted for a few moments; then Gloria left. Debra would be going home in a day or two on a new treatment regime, one that included the White Box. When she'd heard that, Gloria couldn't suppress a smile. That was the closest thing to an apology that she'd get from Dr. Nurbaugh.

She glanced worriedly at her watch. She didn't want to be late for the negotiations. But she had enough time for a short visit with Vickie Haynes and Judd Mitchell.

When she entered Vickie's room she was greeted with a wave of an unbandaged right arm.

"Look!" Vickie cried. "I'm turning brown again!" She threw her arms around Gloria in a huge bear hug. When Gloria could disentangle herself, she studied Vickie's arm. Sure enough, most of her scars had darkened; some had completely disappeared. Even the third degree burns on the back of Vickie's knuckles had advanced beyond the dull pink stage. Gloria could see that they, too, would regain their natural pigmentation.

Judd Mitchell was the only one of the three who looked as if he belonged in a hospital. His large, robust frame looked out of place but his head was swathed with gauze bandages and an IV ran into his right arm.

Gloria greeted him in a low voice, aware of how sensitive a patient is to sound after a surgery like Judd's. "Hello, how's my favorite patient?"

An ear-to-ear grin lit Judd's leathery face. "I'm fine."

She glanced at his chart. He hadn't had any pain medication for over eight hours. "Are you sure?" she asked. "Would you like something for pain?"

"What pain?" Judd said. "If it weren't for this fool tube in my arm, I'd be up dancing a jig. All they did was take out some unnecessary hardware." He thumped his bandage and grimaced. "On second thought maybe not a jig. But you know something, I'm gonna miss that old plate of mine."

"Why?"

"It sure was fun to go through the metal detector at the airport and see all those security guards get all flustered till they found out I had a plate in my skull!"

After Gloria left Judd's room, she called Dr. Harris about the Chandler baby, telling him about the other cases they'd seen. "Talk to Linda Warren about putting her on ENT," she urged him.

"Hmmm. The Sandulescu case is interesting. However, this kid has grave neurological damage. Hmmm. . . . Does Linda Warren have case studies of neurological effects on newborns?"

"I don't know exactly what Linda has available," Gloria said. "But I'm sure that if she doesn't have it, she'll find whatever you need."

"A newborn's nervous system does continue some growth after birth. If ENT can enhance that. . . . I'll study the problem, okay? What's Linda's number?"

Gloria hung up. She stood with eyes closed for a moment, feeling thankful and drained. Then she drove home to change clothes and grab a quick bite of dinner.

Gloria sat at the speakers' table in a room full of Research's rebellious nurses and marveled that she should be here. It hadn't been more than four hours ago that she'd thought her nursing career had ended.

Wigginton had briefed her thoroughly on the proposal. He'd even had Linda Warren provide copies of some of the ENT documentation. She'd been so busy she hadn't had time to absorb everything.

Mr. Wigginton had not come, so after the strikers' spokeswoman made a few comments, Mr. Williams introduced her. As she stood he lit a pipe, leaving it to her. She refrained from wrinkling her nose and began.

"I can tell by your faces that you're wondering what sort of trick the administration is up to now. Using a supervisor whom most of you know *could* be a trick. It's not. Maybe you think I've sold out, taken the side of the hospital. Well, I hope you'll overlook those feelings for a few minutes and listen."

She studied the crowd seated in front of her. Most of the faces were familiar to her, some she could even supply a name and unit for, but even those faces were skeptical if not downright hostile.

"As a supervisor I know, at least indirectly, what you've had to put up with; the shortages of equipment and personnel, and the lack of respect. Perhaps

some of you have heard that I recently had a *first hand* experience with that sort of thing."

A murmur rose from the nurses; yes, they'd heard.

Gloria briefly reviewed her experience caring for Debra Sandulescu and the trouble she'd gotten into as a result. She avoided mentioning Dr. Nurbaugh by name, but occasional loud whispers from the nurses made it clear that they knew who was involved.

"At eight this morning," she told them, "Debra Sandulescu awoke from her post-ictal coma and asked for breakfast."

Her audience murmured in surprise. She waited a moment, then continued.

"This afternoon I was called in to see Mr. Wigginton. The review board had decided my fate. I was sure that, like Charlotte Stricklin, I would be thrown to the wolves. But Mr. Wigginton asked me some questions before he announced their decision. He asked me why my problem, and so many other incidents, were occurring these days at Research. I told him the truth. That poor staffing, equipment, and poor job satisfaction were directly responsible."

Gloria raised a hand to halt the smattering of applause that had begun. "He said that he and the Board were agreed that things should change. Then he told me I was absolved of any wrongdoing in caring for Debra Sandulescu as I did, and that the doctor involved had received a reprimand for unprofessional conduct the night Mrs. Sandulescu was admitted. In addition, the doctor was warned that if he is unavailable at *any* time in the next six months he will lose all privileges at Research."

This produced a swelling murmur of satisfaction. How rarely nurses saw doctors suffer for their errors! But a hand was raised. It was one of the younger nurses; Gloria couldn't remember her name.

"Yes?"

"I don't mean to sound callous, I'm glad your patient's all right and that you weren't suspended or anything. But what has all this got to do with us?"

"I'm getting to that." Gloria paused to make eye contact with some of the nurses she knew. She was surprised to notice respect in their return gazes. "Mr. Wigginton had taken my side, supported the actions of a nurse over those of a physician. He emphasized that he would have done this in any case, because in his opinion, it was the only just decision. Then he asked me—almost begged me—to act as a liaison for the administration and bring their proposal to you. He knew that you've all been disappointed in half-promises made during the past few months. He thought that if this proposal came from me, someone who had received an unprecedented amount of support from the administration, you might understand that they mean every word in the proposal. To further illustrate his sincere desire to end this strike, he allowed me to come and speak to you alone. The only official representative of the hospital board is Mr. Williams, who as you all know is Research's chief lawyer. He is here only because I asked him to advise me so I make no legal error that could possibly jeopardize these negotiations." She nodded to Mr. Williams, who began handing out written copies of the proposal.

"I'll review the main points with you now," she said. "But the papers you're receiving go over each of these points in greater detail. Number One—no one will be penalized for having been involved with the strike so long as they return to work immediately after negotiations are completed.

"Number Two—the hiring freeze is suspended. Enough nurses will be hired to meet federal staffing guidelines. Unfortunately this will result in a financial crisis for the hospital. So a review board of nursing personnel will be elected to make recommendations regarding salary adjustments that might be necessary. They will also monitor the hiring and firing of nurses."

Groans issued from the crowd. Hostility and tension filled the air.

"Just a moment!" Gloria said. "I have every reason to believe that this will work to our benefit. As you can see in point number three, Mr. Wigginton has approved the purchase of at least two more ENT units, possibly three. Presently our ENT unit can treat a maximum of four patients. Each of these new units will have a capacity for treating eight patients. This will multiply our ENT capacity by five, more if he buys the third machine."

A shout came from the back of the room. "How can a bunch of White Boxes help us?"

Gloria nodded. She'd expected that. "You heard how Debra Sandulescu responded to ENT. There are many more cases where the White Box has produced remarkable results. Several have been documented right here at Research. The machine cuts healing time by half, sometimes more. These people not only heal faster, but they heal *completely*. Burns are replaced, not with scars, but with *new skin!* I don't know about you, but having to send home a patient with disfiguring scars or handicaps due to an injury tore me apart. We don't have to do that anymore."

The nurses exchanged glances and raised eyebrows. "Come on," someone called. "The White Box is not *that* good!"

"In selected instances, it *is* that good. We've had some cases right here at Research. But remember: research is still continuing on ENT. This is a technique as new, marvelous, and unexplored as antibiotics were when they were new. Try to picture medicine without *them*. In the future, that's how nurses will react to the idea of medicine without ENT!"

The tension in the room seemed to decrease. The spokeswoman sitting beside Mr. Williams spoke. "It will be wonderful to be able to see my patients go home well. But if the machine really works and it does cut healing time in half, that means I'll be taking care of twice as many patients. I'm not sure *that's* an improvement."

"Let me tell you something else about the White Box. It can be operated by a nurse using recommended standards. In other words, the nurse makes the assessment and initiates treatment without a doctor's orders!"

That made the crowd buzz, Gloria noted with satisfaction. "ENT is going to revolutionize medicine. I anticipate a day in the near future when doctors will be needed only for initial diagnosis and for surgery. The rest will be in the hands of the nurses proficient in using

the White Box. That will drastically reduce a hospital's expenses. That is what the Board is counting on to enable them to end the hiring freeze.

"But the best thing is, at last, nurses will no longer be physicians' handmaidens." Gloria leaned forward, her lips trembling with the intensity of her feelings for the future she foresaw. All the troubles and tensions of the past months had yielded to this ray of hope. "We'll be able to use our special knowledge and skills to the maximum. Hospitals will become what they should have been all along—centers of the healing art—places where *caring* is done by those who *care*."

She hummed a tune as she climbed the stairs to the second level of the apartment building. Gloria had not been so wrung out since she had gone on the night shift. But it wasn't a bad feeling. It was almost as good as the feeling she got from sending home Debra Sandulescu, fully recovered.

The strike had not automatically ended, of course. The nurses wanted to study the administration's proposal—and of course, to chisel a little more out, if possible. Gloria grinned. Not likely, against Arthur Wigginton! But it looked as if Karen Anderson was going to be taking her place on the night shift for a while to come; Gloria was wanted on the negotiating team.

Since her apartment was the first one at the top of the stairs she saw the little green box leaning against her door before she'd cleared the steps. The last six stairs were taken two at a time. She hesitated a moment, then bent down and picked up the box. No note or anything, of course. Hank should have left the box with a neighbor. Anyone could have taken it, or stepped on it, or—kicked it. Gloria unlocked her door and, before she took off her coat, began unwrapping the treasures inside the box. Nine of her horses were there and intact.

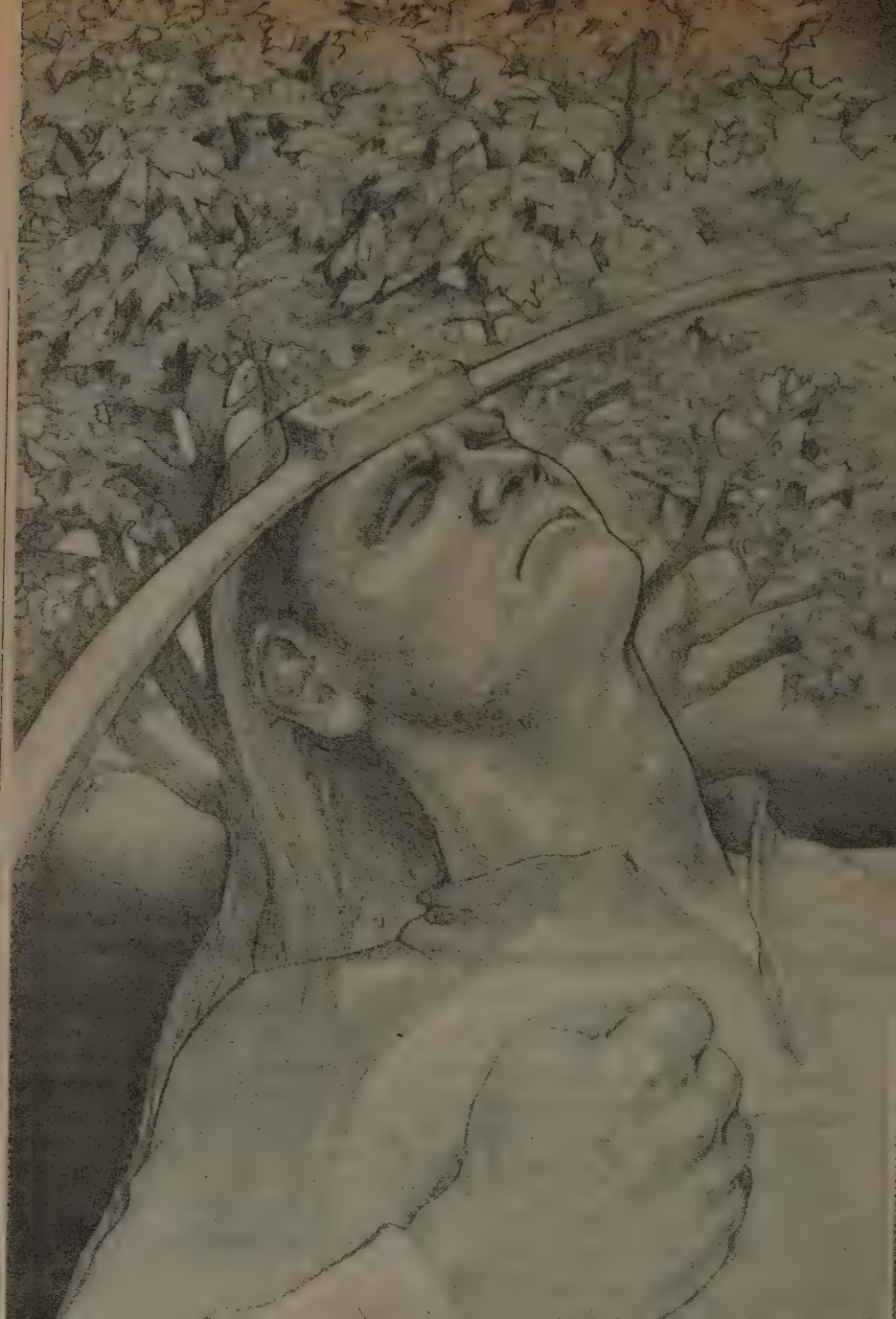
Her heart stopped. But where was—

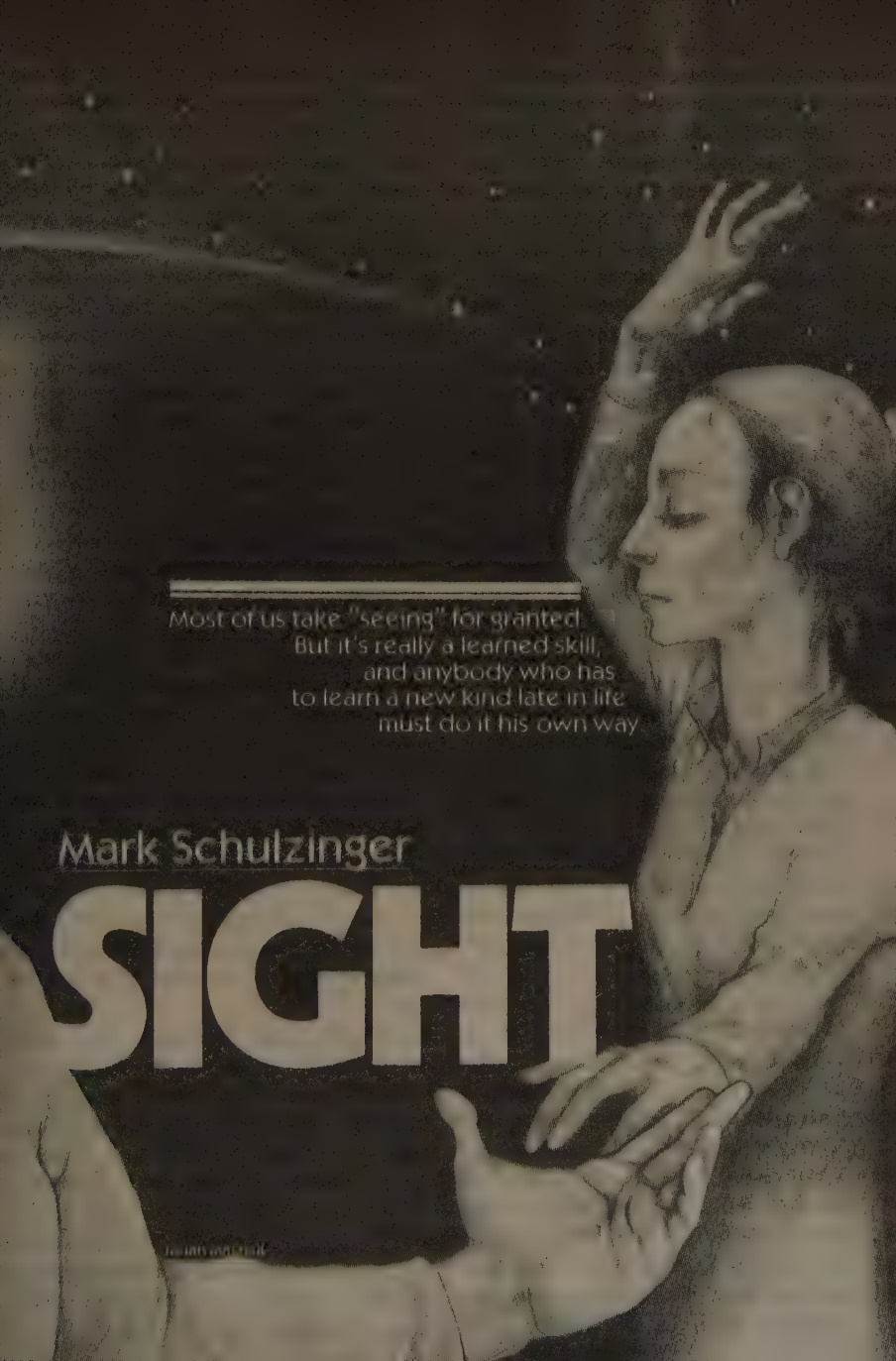
There it was, the smallest and now most precious, the little white horse. She took it out and touched each of the slender, delicate legs gently, touched the aristocratic face, the tiny ears. Intact. Not broken, not even chipped. Gloria fumbled for a tissue; her eyes had overflowed.

Tomorrow she'd go shopping at K-Mart for a shelf and bracket. There was a good space near her bed. . . . ■

●Life is no alien intruder into the universe but is native to it. Here is no mindless machine, running down to inevitable extinction, and carrying, in one insignificant fragment, a solitary phenomenon called "life," which had happened by accident.

Dr. Leslie Weatherhead




Most of us take "seeing" for granted.
But it's really a learned skill,
and anybody who has
to learn a new kind late in life
must do it his own way
Mark Schulzinger
SIGHT

"Now Jason, try again."

Jason MacNab pressed his forehead against the cool metal of the head rest and concentrated on the images he "saw" before him.

"Do you see the threads?"

"Damn it, Carlie, I don't see anything that looks like anything."

"Relax, Jason," said Carlie Skriver. "Hyperspace 'looks' different from anything you ever saw before. Sometimes you just have to let the impressions flow before you can see it."

"I can't see it, Carlie. Just like I can't see anything else." Jason pushed himself angrily away from the head rest and felt himself bob against the seat restraints in the weightlessness of the training ship.

"Okay, Jason. I'll ask the captain to rotate us back to normal space. We'll rest a bit and talk, then try it again." Jason heard her blow into a speaking tube and tell the bridge talker of the *Lobachevsky* that it was safe to re-enter normal space. There was brief silence and then he heard the power systems of the ship start up, felt the faint breeze of air being circulated again and his body sink back into the couch as the artificial gravity was restored. He exhaled and realized that he had been holding his breath.

"What was that?" Carlie asked. "Did you see something?"

Jason snorted. "Don't make me laugh. I can't see in normal space and I'm sure I'm blind to hyperspace as well."

"There's no reason why you can't see in hyperspace," said Carlie. She reached out until she touched Jason's arm. He turned toward her, the smell of fear reaching her nostrils as he did so. "Listen," she continued. "The only things damaged in the accident were your eyes." She felt him stiffen as she spoke the words and rushed on. "The nerves from the eyes through the optic chiasm were undamaged. Since that's the part of the visual system used to 'see' hyperspace, you should be able to do as well as any other navigator once you get the hang of it."

"Why do you keep using the word 'see'?" Jason shook her hand away from contact with him and sank back into the couch. "I'm blind—I can't see. I'll never be able to see again and what good is an artist without eyes? I can't see the canvas or the pigments, I can't see the brushes or the subject. Hell, forget it Carlie, I'm useless."

Carlie listened to his anger and his despair and felt herself tightening inside in response. She fought her body for control and spoke, keeping her voice deliberately mild. "Take a break, Jason. The crew has to freshen things up before we can try again anyhow." There was a knock on the door and she called out an invitation to enter.

"Hi gang." She heard the breezy voice of Hank Wells, the ship's surgeon, as the door opened. "How'd it go?"

"Not bad for starters," she answered more confidently than she felt. "I think Jason needs a little rest before we continue."

"Sounds reasonable. Jason, do you want something to help you sleep?"

"No." The voice was still bitter but with an edge of tiredness to it. "Just leave me alone for a while."

"I could use some coffee," Hank said brightly. "Join me, Carlie?"

Carlie nodded, then said, "Sure, Hank," for Jason's benefit. She unbuckled her straps and followed the man out of the cabin.

"He's not doing well, is he?" asked Wells once they were in the wardroom.

"No. I'm sure he's resisting the whole process." Carlie felt for the mug before her and raised it carefully to her lips.

"It's a shame. He was a brilliant artist before the accident and there's every indication he could be an excellent navigator. From what I've read, the ability to grasp spatial relationships is essential to such work. He's got a leg up on all the other trainees."

"That's the problem, Hank. He was 'brilliant' as an artist. Now he's nothing—just another blind man." She sipped the warmth of the liquid again.

"It doesn't make sense to me. The discovery of hyperspace opened up a whole new world to the sightless. In an environment where electricity won't work, where rotation equals linear movement, and where the sighted are visionless, the blind navigator is the only person who can tell the captain how to steer the ship." He laughed. "I remember how I felt the first time I shipped out, having to sit in the dark without gravity, afraid to move. That was the first time I envied the blind."

Carlie turned to face him. "Never envy us, Hank. Don't pity us either. We're handicapped but we got along pretty well before hyperspatial travel came along. Sometimes the ability to 'see' hyperspace reminds us of all the things we can't see in normal space." She smiled. "On the other hand, it feels nice to be indispensable."

Jason lay on his bunk, his eyelids closed against the polished plastic hemispheres that filled the sockets where his eyes had been before they were destroyed in that silly accident. He thought back to it—he was casting some gold charms using the lost wax technique. The centrifugal caster, designed to hurl the molten metal into the wax mold, malfunctioned and threw its contents across his face. He couldn't remember the pain but he remembered the sound of his screams.

Reconstructive surgery helped. The surgeon assured him that the scars had been erased from his face and that the insertion of acrylic eyeballs would give him a normal appearance. There was nothing, though, that could give him back his sight. His gift was still there but his eyes, the organs that guided his hands toward the turning of talent into tangible reality, were gone.

He heard the door to his cabin cycle and then the soft tread of feet. It was Carlie's walk—his sense of hearing had increased dramatically since the loss of his vision.

"May I sit down?" she asked softly.

Jason shrugged. "It doesn't matter."

He felt the bunk give way beneath her mass. "Tell me what you saw, Jason."

"I saw my house," he said. "The house where I had my studio. It was an old house with a tin roof streaked with sienna and cerulian. It showed glints of gold where the sunlight reflected from it and reflections of green from the old maples growing alongside it."

"No, I meant what you saw when we were in hyperspace."

"That's what I'm telling you. I saw the house."

"Jason." He felt the light touch of her hand on his, warm and dry. "What you saw was what you wanted to see. Hyperspace looks different from anything we've seen before . . . before we lost our sight. To me it looks like colored threads on a black background. To

some others it looks like connect-the-dots patterns."

"I saw the house," Jason repeated stubbornly.

"Okay," she squeezed his hand. "Try and get some sleep. We'll make another run in a few hours." The bunk rebounded as she rose and Jason heard the door open and close as she left. He put one hand over the one she had touched and tried to visualize how she looked. He got no image. Hoarsely he began to sob.

"We're going to make a short run now," said Carlie. "Four lights to Centaurus. It's a straight run if you go by ship's drive but," she chuckled, "an awfully long one. In hyperspace it's shorter but more complex."

"Explain it to me again," said Jason.

"Hyperspace seems to fold differently from normal space. In normal space if you wanted to walk two city blocks you'd start at point 'A' and walk directly to point 'B.' If you were doing it in hyperspace you might have to go straight for two steps, turn 45 degrees and walk ten steps, turn 60 degrees and walk five steps. That's a poor analogy but it serves as well as any."

"It doesn't make any sense."

"No, it doesn't. But it's the way things work. Are you ready to try?"

Jason nodded, then remembered she couldn't see the gesture. "Okay."

Carlie gave the talker the request to enter hyperspace and felt the almost subliminal hum that meant the ship's gyroscopes were being brought up to speed. Then the sound of motors stopped as all electrical systems were shut down. A whistle over the speaking tube told her that translation had been accomplished.

"Now look," she told Jason. "What do you see?"

He concentrated on the blackness before him. "Alicia," he replied.

"Huh?"

"Alicia as I painted her ten years ago. She was sitting on a chair under one of the maples. I dressed her in a yellow sundress and a broad straw hat. The shadows chased around her in the spring breeze."

Carlie sighed. "Just follow along with me, Jason. Our first thread goes off at an angle to the left." She blew into the speaking tube. "Ten degrees port." There was a slight disorientation as the helmsman cranked the handles that rotated the gyroscopes and moved the ship in the proper direction. "Stop . . . Two units thrust." Microweight gripped them as hypergolic jets were valved on. "Reverse thrust." On the bridge the helmsman, timing by his own pulsebeat, followed her directions. "Thank you."

"Now, Jason, we moved along the first thread. I can see our transfer point here. We're going to have to swing almost fifty degrees to starboard. Do you see it?"

"I see the old rowboat I painted in Kennebunkport. It was drawn up on land and placed upside down next to a building. The weathered wood was streaked with white and the shadows were cool blue."

"Forty-eight degrees starboard . . . A little slower . . . One unit thrust . . . Reverse thrust . . . Thank you. There's the last leg, about two degrees down and to the left."

Again Carlie questioned Jason about what he saw and again he described a painting he had created. She ran through the rest of the trip mechanically, trying

to tell him what she saw but not demanding any responses from him.

"It's frustrating, Hank," she told the ship's surgeon at supper. "He just doesn't seem to see anything but his own art. Is it possible that the medical results were incorrect, that he can't see in hyperspace?"

"I don't know how that could be, Carlie. The rehab centers do a pretty thorough job of testing potential navigator candidates. I can run him through the on-board equipment, though, if you think it'll do any good."

"I'd appreciate it. Without the ability to do navigator work he'll be handicapped *all* the time." She bit nervously at her lower lip. "That's something I want to spare him."

Later he asked her to come into his surgery. "I can't see anything that would interfere with his ability," he told her. "I can stimulate the optic nerves and get signal registration in the optic centers of the brain." He shuffled through test readouts. "I can even get some photic driving. By every test available to me he shows up fit."

"By every test available to *you*, Hank. Maybe what we need is a psychologist."

"This bucket doesn't rate one. Remember, we only do training runs —boring stuff but we get to sleep in our own beds on weekends. As the trainer you've got to fill that slot yourself."

Carlie made a face at him. "Thanks. I usually have enough trouble teaching the candidates what to look for and how to estimate angles and thrusts. Well," she shrugged, "maybe a little personal reminiscence would help."

"Carlie," Hank placed his hand over hers, "do you think you should?"

She reached out and felt his face, touched the frown lines around his mouth. "You really care, don't you?"

"I always have." He smiled and her fingers trapped it. "You're a great gal and I admire you tremendously. I just don't want you to hurt yourself more than you have to."

"Do you say that to your wife, too?"

"Uh-huh. Less than I should, I'm afraid."

She laughed. "If it's too much for me I'll come and cry on your shoulder. Okay?"

"Agreed."

She knocked softly on the door to Jason's cabin, entering when he invited her. "I wanted to talk with you again," she explained as she entered.

"Suit yourself."

His voice told her he was on the bunk so she moved toward the chair bolted to the cabin deck. "Do you have much trouble getting around the ship?" she asked as she seated herself.

"Some," he admitted.

"Do you ever wonder why I seem to get around so well?"

A rustle told her he was moving his head. "No. I never thought about it."

"One of the reasons has to do with the fact that I've served on this ship for a few years, but there's another reason." There was no response. Carlie took a breath and continued. "Do you remember Carlotta Russell, the ballerina?"

"Yes."

"That was me. My stage name."

"But you—"

"Yeah. Mugged, raped, blinded —right in the lobby of my condo."

"You were wonderful." There was

awe in his voice.

"I was, wasn't I? But no more. No more *pas de deux* with some tight-bummed hunk. No more *entrechats*. No more pirouettes while the crowd applauded and begged for more. Jason—"

"Huh?"

"I wanted to kill myself. I wanted to dance because I knew that if I danced I could feel cleansed of the other things that were done to me—I could burnish it out of my soul through my art. But I couldn't dance."

"Damn!"

"Yes, damn. And now, when we're in hyperspace, I can feel myself dance among the stars. I can *feel* up and down and right and left and all the other positions. Jason, navigating saved my life. I'm still blind in the real world but when I'm doing my job it's as if I'm whole again."

Jason stood up and cautiously moved toward her voice, reached out and found her. "Did it hurt?"

"What, the mugging?"

"No, the learning."

"It felt uncomfortable until I got used to it. Then it felt wonderful."

"Do you miss dancing?"

"More than I can ever say." She felt tears start from her eyes.

"I feel the same way about painting."

"I know."

"Can I try again?"

"You bet! Give me time to freshen up and I'll show you the way back home."

"Don't feel so bad about it, Jason." Carlie sat back in the trainer's couch and forced herself to relax. "I could tell you were really trying."

"I feel like a total failure." Jason's voice sounded strained, as if he were holding back tears. "No matter what you did to help me I still couldn't see anything but paintings."

"Yeah, but this time you got away from your own works. Once at least. Remember you said you saw Van Gogh's 'Starry Night' on the second leg."

"I remember, but it wasn't Van Gogh's, it was my own copy of it. Carlie," she heard him shift in the couch, "I'm still too focused on my painting—on myself. I can't let go!"

"I can't accept that, Jason."

"You don't want to accept it."

"Yeah, that's true," she said reluctantly. "I *want* you to succeed. I want you to have a use for your abilities the way I do. I don't want you to be blind forever."

"You pity me."

"I don't know," she admitted. "Maybe I pity myself because I'm not as good a teacher as I thought I was. Maybe I want you to see so much that I've developed a different kind of blindness myself—a blindness to why you can't see hyperspace."

"Blindness and sight," Jason's voice was reflective. "You use those terms a lot."

"That's how I think about it."

"But what did you tell me you felt in hyperspace?"

"Floating? No, dancing. I'm dancing in hyperspace."

"And you feel the directions."

"Right." She paused. "Maybe you see hyperspace differently because you're used to seeing paintings."

"Um. That's what I thought. But I

see a different work every time."

"No repeats?"

"No."

"I wonder." She grasped the speaking tube and blew into it, then asked the normal space navigator for a position check. "Jason," she said, "we're going to make another Earth-Centaurus run, just like the first one. This time just describe what you see." She gave the order for rotation. "Well?"

"I see one of the maples that grows next to my house. I painted it in the fall when its leaves were deep into scarlet."

"Can you see the house?"

"Yes, a small corner of it. Carlie?"

"What?"

"I don't remember painting the house when I painted the tree."

"Okay, remember that fact." She gave the order for the first leg of the journey. "Now what do you see?"

"Alicia." His voice was tense. "Carlie, I saw this painting before."

"Yeah, on the last trip out."

"But not in this way. The shadows are different. Wait a moment. Hey, her position has changed! It's subtle but it's there."

"Uh huh. Let's go on."

At each leg of the journey the pictures repeated themselves but with subtle differences. Carlie, excited by what was happening, ran the ship through the round trip without stopping and her head ached a little from the fouled air by the time they rotated back to normal space near Earth.

"So I *can* see in hyperspace," Jason's voice was elated.

"That's for certain." Carlie began unfastening the straps that held her to the couch. "But it certainly is a different way of seeing it."

Jason laughed. "I see my own paintings. I suspect the differences between one trip and the next are due to slight positional changes."

"That's what I think." She got up from the couch and reached out a hand for him. "I also think there's another problem."

"How I can tell the proper 'line' for each leg of a voyage?"

"That's it." She took his hand and began to walk toward the wardroom.

Jason stopped and turned her toward him. "You're thinking with a dancer's mind," he said. "For you everything is position and posture and muscle balance. For me, a visual artist, things are light and shadow and color and orientation on the canvas."

"You mean, the way I orient myself is postural and the way you do it is visual?"

"Yeah. Each one of us 'sees' something different out there and translates it into something familiar. I guess I'm the first oddball trainee who was so visually oriented he couldn't translate into any other terms. All I have to do is learn the various routes, then I can reposition the ship to reproduce what I saw on each leg. It won't be easy but we artists are used to doing difficult things."

"As opposed to dancers?" Carlie's laugh was soft.

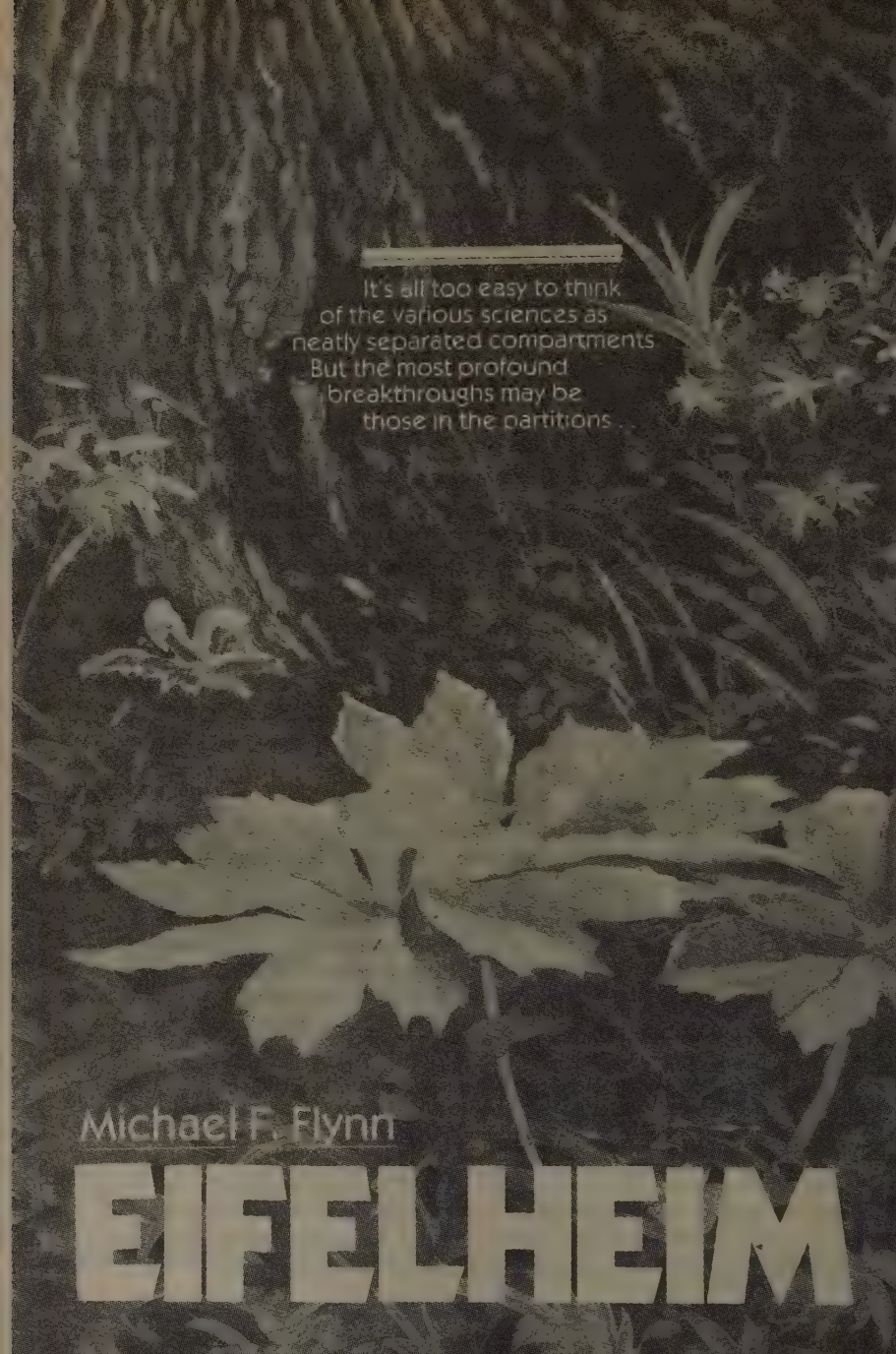
"Ouch, I deserved that. Carlie?"

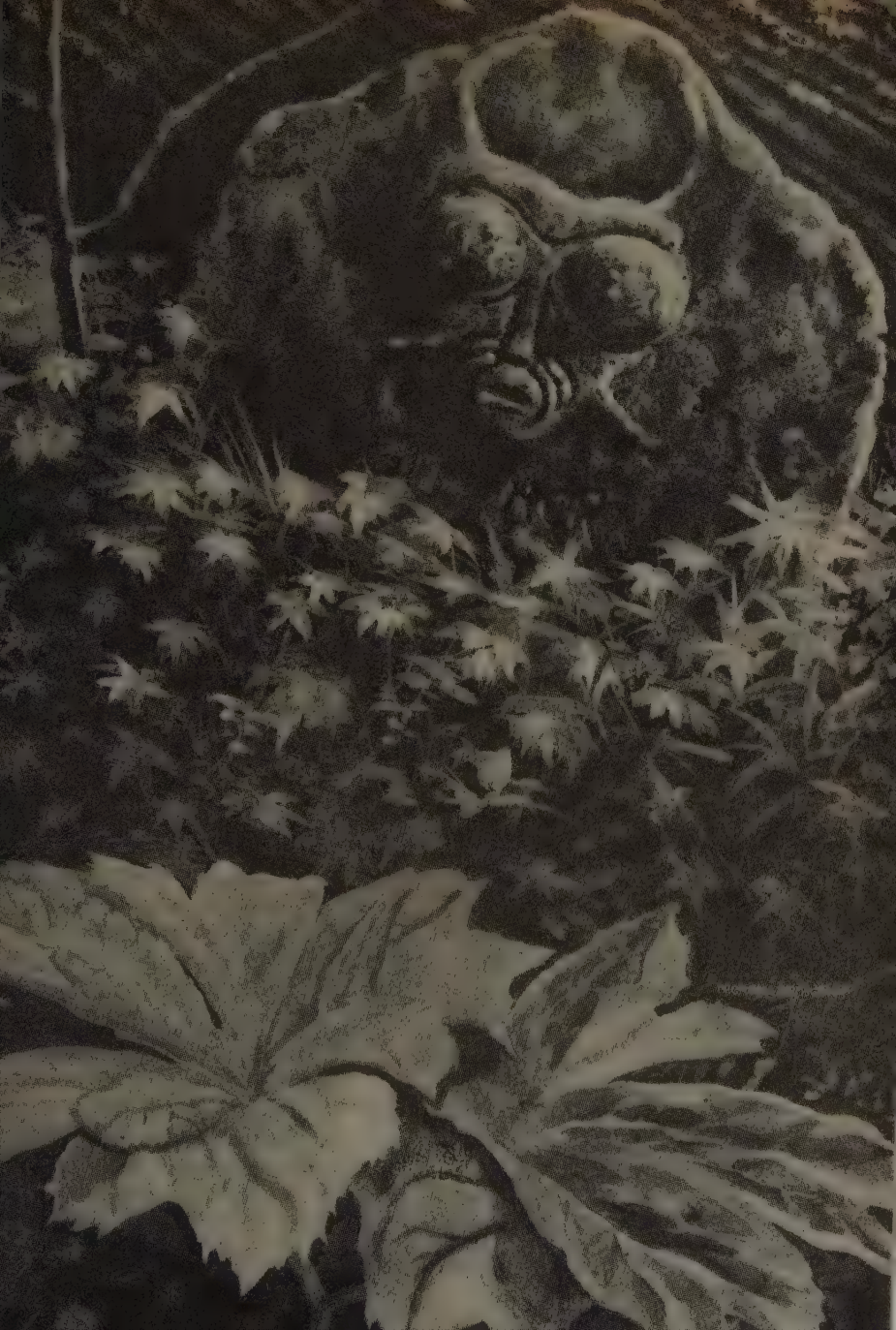
"What, Jason?"

"May I touch your face?"

"Of course."

He brought his hands up, ran them lightly over her features. "Thanks," he said. "I just wanted to see the person who gave me back my sight." ■


It's all too easy to think
of the various sciences as
neatly separated compartments
But the most profound
breakthroughs may be
those in the partitions
Michael F. Flynn
EIFELHEIM



I know where the path to the stars lies. The gate opened once, a long time ago. And then it closed, all but the tiniest of cracks. Now we have a wedge in that crack.

You see, Sharon Nagy was a physicist and Tom Schwoerin was a psychohistorian. That was the heart of the business right there. That was the beginning of it and the end of it, and most of what happened in between.

Or perhaps you don't see. Well, neither did they, at first. Who would? Medieval settlement patterns and unified field theory seemed worlds apart. They were worlds that touched at only one point: in the living quarters that Tom and Sharon shared.

They were an old-fashioned couple, holding to the old-fashioned values. They "lived together" in a "condo," one of a cluster that had been built back in the '70s or '80s. She furnished it with antiques: water bed, pillow furniture, that sort of thing. Quaint, but nice.

During the summer sessions they both worked out of the condo. Tom was usually hunched over the PC, tracking down obscure references on the DataNet. Sharon preferred the organic computer she kept between her ears. She liked to lie in the pillow-sofa, her notebook open, surrounded by wadded up balls of paper and half-finished cups of herbal tea, thinking about whatever it is that theoretical physicists think about. At such close quarters they couldn't help learning something of each other's work. That was the fulcrum on which they turned the world.

But I was into the affair last and least of all and perhaps it would be better to let the story tell itself.

* * *

I

She floated in a world that was not a world. Spheres were not spheres and the geodesics were warped and twisted things. Space and time fell away in all directions in curious vortexes. But she sensed order. There was something patterned underneath the chaos. She intersected the world with a slice of 3-space, sneered at the result, and changed into a Lobachevsky 3-space. That was better, but still not right. It was ugly. Ugly.

"Damn!" she heard Tom smack the terminal across the room. She squeezed her eyes shut, trying not to listen. A lattice formed and danced before her. Almost. Almost, she could see it. The equations hinted at multiple rotation groups connected by a meta-algebra.

"Durák! Bunözo! Jaki!"

The lattice shattered into a kaleidoscope of disconnected thoughts. For an instant she sat, overwhelmed by a sense of infinite loss. Then she threw her pen at the coffee table, where it clattered against the china tea cups. God obviously did not mean for her to solve the geometry of Janatpour space quite yet. She glared at Tom's back.

"All right, dammit," she demanded. "What is it now? You've been muttering multi-lingually all day. Something's bugging you. I can't work, and *that's* bugging *me!*"

He spun in his swivel chair and faced her. "I can't get CLIO to give me the right answer!"

She made a pout with her lips. "Poor CLIO! I hope you were able to beat it out of her."

He opened his mouth and closed it again. He looked embarrassed. With a

scowl, he crossed his arms across his chest. Sharon knew that meant he was about to get stubborn.

"Look," he said, "I've run twenty-three simulations of the Schwarzwald settlement pattern and Eifelheim won't go away!"

Tired, she massaged the bridge of her nose. Be patient and eventually he would make sense. "I take it from context that Eifelheim is a settlement in the Schwarzwald, the Black Forest. Why should it go away?"

He threw his arms out wildly. "Because it's not there!"

She greeted that announcement with the silence it deserved.

"Okay, okay. Rosen-Zipf-Christaller theory says that there should still be a village on the site of Eifelheim. But there's not. It was abandoned during the Black Death and never resettled."

She shrugged. "Then change the theory."

He goggled at her a moment. "Oh sure," he sputtered. "Throw out one of the cornerstones of psychohistory!"

"Why not?" she snapped. "Theory has to fit the facts, not the other way around. At least it does in the *hard* sciences."

"Does it? Does it really, *a cushla?* Galileo's first tests seemed to show the Earth stood still; and Newton's initial calculations of planetary positions were dead wrong. They didn't junk their theories. Which at the time, I might remind you, had very little to back them up. They tried to find out what was wrong with their so-called facts. And wasn't it Dirac who said it was more important for the equations to be beautiful than to fit the experiment?"

She clenched her teeth. Curse Dirac! Why had he ever said that? It was true, of course; but why had he ever said it? So soft scientists like Tom could quote him at her? She remembered how she had felt earlier, before his interruption. She had known her equations were not quite right because they were still ugly. The real world always held an elegant simplicity within itself. But Tom made it sound so . . . arbitrary.

"Besides," he continued. "I read somewhere that each measurement of lightspeed has been lower than the previous one. Why don't you throw out the *theory* that lightspeed is constant?"

She frowned. "Don't be silly!"

"Silly, hell!" He slammed his hand down sharply on the terminal and she jumped a little. Then he turned and faced the screen once more. She could see the CRT over his shoulder, flashing green on green.

We're both being silly, she thought. She could see the two of them, as if from the outside. Sitting across the room from one another, bickering over some problem. And she didn't even know what the problem was. She looked down at her own work. I'm not helping me by not helping him.

The silence dragged on.

"I'm sorry."

They both said it at the same time. She looked up, startled, and he turned around. They both laughed and the tension evaporated. Sharon decided that the fastest way to get peace was to hear him out. She crossed the room and perched herself on the corner of his desk.

"All right," she said. "Tell me about it. What is this Zip whatever theory?"

"Rosen-Zipf-Christaller," he said.

"It describes how human settlements are distributed. The Department's working under a grant from Matsushita-Bandierantes Corporation. They hope that with better understanding of the forces that influence settlement location, they can site their orbital, lunar, and ground facilities to best advantage."

She nodded. "You've mentioned it. But what 'forces' are you talking about?"

He tugged on his lower lip thoughtfully. "Well, there are market forces, and population forces, and—"

"Oh, not 'forces' like in physics, then?"

He looked annoyed. "I'm not sure what you mean by that. If you mean they're not real, you're wrong. If you mean they're not based in matter, you're wrong, too. Take . . . oh, take affinity. People choose behaviors that maximize their positive reinforcement. Natural reinforcers like food, sex, and approval are built into our genes. Conditioned reinforcers like money or prestige serve as substitutes for them."

"Well . . . that makes sense, but—"

"Let me finish. Now imagine a landscape. Each point gives reinforcement to those living there. Soil fertility, mineral resources, connections to other sites, and so on. Got it? *Doğru*. That defines a potential function over the landscape. A force—the desire for material reinforcement—proportional to the gradient of the potential, draws people toward the more desired locations. We call that affinity."

"A 'desired location' can be different things to different people," she objected. She didn't feel like a mindless particle drawn by a mindless force. She had free will, dammit.

His lips thinned and she knew she had annoyed him again. "Don't you think I know that? Not everyone wants to be a farmer; but the good farmland will attract those who do. Ditto good fishing grounds, or silver lodes. And along with the, ah, herbivores come the carnivores. A concentration of farmers draws millers, equipment salesmen, and loan officers, just like the land itself drew the farmers. It's just like an ecosystem, but with money or trade goods instead of calories."

Tom put his hands behind his head and leaned back in his chair. "Population density defines a second potential, one that works against the first. People prefer low density to high density. So there's a tendency for the population to spread out evenly across the landscape. A kind of cultural 'heat-death.' "

He sat back upright and clasped his hands together. "The interaction of these two forces define a set of equilibrium sites where population will accumulate. As the region approaches equilibrium, the sizes of the settlements follow Zipf's rank-size law. Each one will be the center of a cultural-economic potential field that obeys the inverse square law and defines market regions and political territories. Geographically, the settlements form interpenetrating hexagons called Christaller grids. *Ert, Nagy kisasszony?*"

"*Ertek jol, Schwoerin ur*. Reinforcement is your gravity and Christaller grids are your solar systems. And to think: all these years, when you've talked about the forces of history, I thought you were using a metaphor. You've always meant real forces—"

She couldn't help wondering if his cultural forces were warps in some sort of cultural continuum, the same way gravity and the rest were warps in space-time. What sort of topology would such a space have?

"Here," Tom was saying as he tapped keys on the terminal. "A picture is worth ten thousand words. I've tested the theory on scores of regions over the last couple months. Colonial America, medieval Russia, ancient Mesopotamia—" He paused and grinned. "In fact, the theory predicted an ancient Eblaite city on a particular site. I sent old Hotchkiss a cable, telling him to move his dig. That made him mad; but what really pissed him off was when he *found* the ruins right where I'd said they'd be." He chuckled. "Well, anyhow, take a look at these maps and tell me what you see." He pressed the return key and a series of Christaller grids marched across the screen.

Sharon studied them carefully. They looked like honeycombs. Each cell contained a dot inside it. The brighter the dot, Tom explained, the larger the settlement.

"Wait. Go back one," she asked. Tom entered a command and the previous map reappeared and remained on the screen. One of the cells was blank. Just one. She looked at the heading: Black Forest, this year.

She stretched out a finger toward the screen and touched the empty hex. "This is the only one like this?" It *did* seem odd. She looked at the nearby villages. They formed a rough hexagon around the empty cell. She frowned. Yes, dammit. He was right. There *should* be a village in between.

"You think that's something?" he asked. "Check this." He hit three more keys. A web of lines appeared on the map. "The road system," he announced.

She saw immediately what was wrong. The roads all went *around* the empty space. Some of them went out of their way to go around it, doubling back. She turned her head and looked at Tom.

"That," he announced sourly, "is Eifelheim."

She looked back at the screen. "The little town that wasn't there," she murmured.

Tom snorted. "Quite the contrary, my dear. It *was* there, but it isn't anymore. Watch. Here's the same region in 1300, reconstructed from LANDSAT photos." He looked at her and smiled. "It's funny. Up close, on the ground, you can't see a thing; but from miles above, the . . . ghosts of vanished villages stand out clearly. So do the outlines of ancient fields and roads. It's amazing how space science has helped historians and archeologists." He looked at the screen and pointed. "There's Eifelheim."

She looked. The little dot stared back at her. "I don't suppose you can just call it a ghost town and forget it."

"You mean like Ashcroft or Fourth-of-July? Or the colonial iron towns in the Jersey Pine Barrens? No way. They became ghost towns for well-known psychohistorical reasons. The resources were depleted to a level where the sites didn't give enough reinforcement any more. That's not the case here."

He entered another command and the computer began running the map back toward the present. A score of dots van-

ished abruptly, others dimmed. Sharon glanced at the heading. 1348.

"That was the Black Death," Tom explained. "See? Eifelheim's gone."

"So are a lot of other villages."

"Yeah; but wait. See there? And there?

One by one, the lights reappeared and brightened, sometimes on the original site, sometimes nearby. In the end, every ghost town had been reoccupied or replaced. All but one. Tom clenched his fist.

"You see the problem? People lived there for four hundred years; then no one ever lived there again."

She shivered. The way he said it, it did sound unnatural.

"The place became taboo. I have a copy of a letter written in 1810 by a traveling gentleman who writes that he will 'abide this night in Urach, lest darkness catch me on the malign ground of Eifelheim.' And Anton Zaengle sent me a newspaper clipping." He opened a file drawer and pulled out a slim manila folder. He shoved it into her hands. "It's on top. Go ahead. Read it."

She opened the folder. There was a clipping from the *Freiburger Wochenbericht*.

DRACULA CULT FINDS NEW GRAVE

(Freiburg i/Br.) Although officials discount it as superstition, some US soldiers on maneuver here believe they have found the tomb of Count Dracula, hundreds of miles from Transylvania. A spokesperson for the US Third Infantry Division acknowledged that something between a cult and a fad had emerged among the soldiers over an obscure medieval headstone decorated with a carving of a demonic face.

The grave is the second adopted by the cult. The first lies near their divisional base in the Bavarian town of Kitzingen. The new grave, which authorities date to the 13th or 14th centuries, generations before the real Count Dracula lived, lies deep in the Black Forest on the site of the medieval town of Eifelheim. The region is heavily forested and the precise location of the tomb is unknown. The soldiers refuse to divulge the information, fearing that tourists would offend the grave's alleged inhabitant. This suits nearby farmers also, who have a superstitious dread of the place.

Monsignor Lurm of the diocesan office is concerned about possible desecration of the cemetary, even though it is centuries old. He also pointed out the possible connection between the supposed carving on the stone and the local folk-tales of flying monsters. "After a few hundred years of wind and rain," he said, "my face would not look so great, either. If modern American soldiers can make up stories about a carving, so can medieval German peasants."

She looked at Tom. "There's your answer," she said. "The place is taboo. They've got their own version of the Jersey Devil flying around."

He made a face at her. "That's no reason. Name one town in South Jersey that's taboo."

"Camden."

"Funny. I'm serious, Sharon. The abandonment caused the stories and the taboo, not the other way around. People don't wake up one morning and decide that the place they've lived in for four centuries is suddenly *verboten. Das ist*

Unsinnlich. No, there must be a material reason."

"The Plague? That must have been a pretty horrifying experience."

"A third of Europe died. The Mongols allowed more organisms than Marco Polo to cross Asia. But that was a common cause, not special to Eifelheim. The answer has to explain not only why Eifelheim was abandoned, but why *only* Eifelheim was abandoned. The Plague affected nearby villages, too; and they were resettled." He rubbed his eyes wearily. "The trouble is, there's no data. *Nada, Nichts, Tida,* Zilch. A few mentions in gazetteers or letters. Nothing contemporary. The *earliest* reference is a theological treatise on meditation, written three generations after Eifelheim had vanished. That's it there." He jabbed a finger at the folder.

Sharon looked. It was a computer facsimile of a Latin manuscript. Most of the page was occupied by an ornate capital D. The capital was supported by a trellis of vines, weaving and branching in a complex pattern, breaking out into leaves and berries and, here and there, oddly shaped triangles.

"Not very pretty," she said.

"It's positively ugly. Worst example of manuscript illumination I've ever seen. The contents are even worse. It's called "The Attainment of the Other World by Searching Within." *Gottes Himmel,* I'm not kidding! Gobbledygook about a trinity of Trinities; and how God can be in all places at all times 'including times and places we cannot know save by looking inside ourselves.' But!" Tom stabbed his index finger straight up. "The author credits the ideas to an earlier manuscript by—and I quote: 'an old man whose father knew personally the last pastor at the place we call Eifelheim.' Unquote. How's that for first-hand data?"

"What a curious way to phrase it: 'the place we call Eifelheim.'" She flipped idly through the printouts. She wondered if there were some way of getting him out of the condo for a while. All he was doing here was spinning his wheels and making her life miserable.

"If this is all the data you have," she said, "you need more data."

"*Kini o mu ni ārọ?* Tell me something I don't know! *Bozhe moi,* Sharon. *Ya nye durak!* I've looked and looked. *Povtorenia—mat' uchenia,* after all. CLIO's chased down every Eifelheim reference in the Net."

"Well, surely not everything's been coded," she replied testily. "The Net's not that old. Aren't there musty old papers in archives and the back rooms of libraries that no one's ever *read,* let alone entered into the database? I thought that's what you historians used to do before you got computers: rooted around in dusty shelves, blowing away cobwebs."

"Well—" he said doubtfully. "Anything off-line can always be scanned into the database by phone."

"That's if you know what's there and what's in it. What about the unlabeled stuff?"

Tom pursed his lips and looked at her. He nodded slowly. "There were a few marginal items," he said. "They didn't look too promising at the time; but now . . . *Cantābit vaceus cōram latrōne viātor.*" He grinned. "A penniless man sings before the robber," he explained. "Like me, what can he

lose?" He leaned back in his chair and stared at the ceiling, pulling absently on his lower lip. Sharon knew that habit and smiled to herself. Tom was okay, but he was like an old-time motorcycle. You had to kick hard to get him started.

Later, after he had gone to the library, she noticed that CLIO's screen was still lit. She went to turn it off, but paused with her finger over the cancel button. She stared at the map. Eifelheim. The empty cell . . . there was something sinister about it. A singularity. A black hole—with a ghost inside—surrounded by a constellation of living villages. Something horrible must have happened there once. Something dark. She shuddered, suddenly chilled, as if by a draft.

Abruptly, she cleared the machine. *Don't be silly,* she told herself. But that made her think of something Tom had said. And that made her wonder, What if . . . and nothing was ever the same afterwards.

The Teliow Library kept its uncatalogued papers in cartons. There were letters and notebooks, registers and estate papers, ledgers and accounts. The raw material of history. Primary sources, never edited, never published. They were grouped loosely by subject and origin into separate folders, tied in stacks between pieces of heavy cardboard, and hidden away to await a scholar desperate enough to want to wade through them.

Tom spent several hours planning his assault on this jungle. He laid out scores of theories on an Ishikawa cause-and-effect diagram, free associating, letting his imagination run wild. Most of the theories, he knew, would be utterly implausible; but the important thing was to keep the ideas flowing.

Then he applied K/T analysis. Listing everything the problem was and everything it was *not*. Who, what, where, and when. Who not, what not, where not, and when not. Like he had told Sharon, a successful theory had to explain why Urach, Donaueshingen, and other nearby settlements were *not* abandoned.

He prepared a list of cartons whose contents might prove helpful, and gave it to the night librarian. Then he took a deep breath and plunged in.

A few hours later, his eyes red and his brain muzzy, he came up for air. . . .

The night librarian brought another carton and laid it on the reading room table. Tom rubbed his eyes and stretched. His back hurt. He sighed and checked the carton tag against the list he had prepared. He jabbed his pen at the carton he had just finished. "You can take that one back now," he told the librarian.

He took a folder from the new carton, untied the string, and gazed bleakly at the contents. Halfway through his list already and nothing useful. He had found only one passing reference to Eifelheim, in an 18th century index of episcopal court cases. The index had been compiled partly from an earlier 16th century index, based in turn on the 14th century originals. *Whoopee,* he thought sourly, *I'm hot on the trail.* It was a simple note that "*de rerum Eifelheimensis,* the matter of the baptism of one Johannes Sterne, wayfarer, has been mooted by the death through Plague of all the principals."

He closed his eyes and rubbed his forehead. Give up. If there ever was an answer, it's been long lost.

"You know, Doctor Schwoerin, we don't get many live ones in here any more."

He looked up. The librarian had not left. She stood there with the other carton braced against her hip. She was small and fine-featured, with her hair tied severely into a bun. She wore a long dress and large, plain glasses.

Lieber Gott, he thought. *An archetype! The Librarian!*

"I beg your pardon?" he asked.

She flushed. "I meant, usually you professors just phone in a request if what you want isn't on the Net already. One of us scans it in, charges it to your grant money, and that's that. It is terribly lonely here, especially at night. I try to read everything I scan. That helps some."

The lonely librarian wants some company. A human conversation. Well, the lonely psychohistorian wants a break from his fruitless hunt. He smiled at her. "I just needed to get out of the condo a while, is all."

"Oh, you do not need to make excuses. I'm glad you came. I've been following your research."

"What?" He was startled. "Why would you do that?"

"History was always my first love. I mean, how could the present ever make sense if we did not know and understand what went before? I majored in history, under Doctor LaBret at Massachusetts, but switched to computers and library science. Differential topology was just too tough for me."

"It's not easy," he agreed, remembering his own difficulties with Thom's catastrophe surfaces. "Sit down, please."

She remained standing. "I don't mean to keep you from your work. It's just that I meant to ask you—" She seemed hesitant. "Oh, it is probably very obvious. I just do not see it."

"See what?"

"You are researching a place called Eifelheim?"

"I'm trying to discover why it disappeared." Briefly he outlined his problem. She had taken enough theoretical history to see *why* it was a problem. Ghost towns were always replaced by other towns, unless the soil or the silver gave out completely.

"Then there is one thing I do not understand," she said humbly.

"Only one?" he chuckled. "Then you're way ahead of me."

"Why have you never cross-referenced Oberhochwald?"

"Oberhochwald?" The name was vaguely familiar. He had run across it here and there. "Why Oberhochwald?"

"That was Eifelheim's original name."

"What?" He stood up sharply, knocking the heavy reading chair backward. The librarian, startled, dropped her carton. Folders spilled across the floor. She stooped to gather them up.

Tom came around the table and pulled her to her feet. He was surprised to see how small she was. She came only to his chest.

"Never mind that now," he said. "It was my fault. I'll pick them up. Tell me how you know about Oberhochwald. Are you sure?"

She loosened her arm from his grasp.

"Well . . . I thought you already knew . . . I think it was a month ago. A brother in the theology school was researching the witch mania in Europe. We located and scanned a book for him, a little known supplement to *The Hammer of the Witches*. As I said, Doctor, I read everything I scan. There was a reference in it to Oberhochwald and someone had added a gloss that the name had been changed to Eifelheim. I recognized the name because I had already scanned it several items for you."

"Do you have it here? I need to see it."

"It's at Yale, but we have a facsimile in memory. I can call it up on the terminal, if you like."

"I like. Do it." She crossed the room to the CRT in the corner. Tom noticed his hand was shaking. Calm down, he told himself. Sure, it's a lead, but . . . hot damn! Another blow struck for serendipity. He stooped and began gathering folders together. A name change. That's why he could find no contemporary references to Eifelheim. It probably hadn't been called that very long before it had been abandoned.

He glanced at the librarian. She was busy at the keyboard, her back to him.

"Excuse me." She paused and turned. "What's your name?"

"Judy. Judy Cao."

"Thank you, Judy Cao."

It was a slim enough lead. At some unspecified time in the 14th century a wandering Minorite named Fra Joachim had preached a sermon against the "witches of Oberhochwald." The text had not survived, but Brother Joachim's oratorial fame had. Comments on his sermon had been included in a treatise on homiletics directed against witchcraft and devil-worship. A later reader —15th century to judge by the calligraphy—had added a marginal gloss: *Dieser Ort heisst jetzt Eifelheim*. This place is now called Eifelheim.

Together, he and Judy went through the two cartons in the reading room. This time, they looked for references to Oberhochwald. They found two.

One was a fragmentary journal entry in a collection of miscellany. No date. No author. But it described graphically the anguish of the plague years. A brief glimpse into the suffering of one soul.

"My friends are dying," Judy read from the Latin original, "in spite of all that those remaining here at Oberhochwald can do for them. They eat but take no nourishment from it. I pray daily that they do not succumb to despair, being so far from their own hearths, but face their Creator with hope and faith in their hearts. Two more have taken Christ in their last days, which gratifies Hans no less than me. Nor do they place blame with us who took them in, knowing full well that our time, too, is coming."

She flipped some more pages over, then looked up. "That is all. Just the one page."

Tom handed her the sheet he had found. "Not much concrete information in this, either. It's a letter of complaint from the smith at Donaueshingen to his lord. He says that one hundred feet of finely drawn copper wire, made specially to order, has been returned by Pastor Dietrich of Oberhochwald in lieu of payment. It's dated 1348, 'two days before the feast of the Virgin.' "

"Perhaps there will be more in the other cartons on your list."

Tom looked at all the carton numbers he had already crossed off and groaned. "I don't look forward to re-reading all the offline stuff I just finished."

"I could help," she said shyly.

He looked at her. "Are you serious?"

"It really shouldn't be too difficult. I must do these cartons in real time, of course, but I can also research the Net Master Index. You have already tried Eifelheim. I can write a worm to search out Oberhochwald, Pastor Dietrich, Fra Joachim, and Johannes Sterne, as well. Whenever it finds something new, it can add it to its search list. No offense, Doctor Schwoerin, but no one can mouse in the Net like a trained librarian. There is so much information out there that knowing how to find it is a science in itself."

"All right," Tom agreed. "I'll pay you a stipend from my grant money. It won't be much, but it'll give you a title: Research Assistant; and your name will go on the paper with mine."

Tom gave Judy a special access code that allowed her to load whatever she found directly into CLIODEINOS.

When he left the library building it was late at night. The campus was deserted and quiet. The classroom buildings blocked the traffic noise from Olney Avenue and the only sound was the rustling of the leaves as soft breezes shook the branches overhead. The shadows of the trees danced eerily in the moonlight.

He was halfway across the quadrangle when it suddenly hit him. According to the two items they had read, Eifelheim was still called Oberhochwald right up to the plague. The name change must have come afterward. But why would a village that no longer existed change its name?

It was Judy Cao who found the answer. Like all good answers, it led to more questions.

Sharon watched Tom from the corner of her eye as she chewed her salad. He seemed light-years away. They were dining *al fresco* at a small vegetarian restaurant she had found in Chestnut Hill. Tom was somewhere else. Back in the Middle Ages, she decided.

She pointed to the stores across the street, getting his attention. "The crowds get thinner all the time. Boutiques aren't as popular as they were when we were young. People hardly go out to shop anymore."

Tom shrugged. "It's easier to shop on the Net. Besides, the styles they sell here, the ones you and I grew up with, aren't in fashion. Who wears jeans or decorates in earth tones anymore?"

She speared a cherry tomato with her fork. "I know," she said. "I like coming here because it's like the old days. It hasn't changed."

"Maybe it has," Tom said smiling. "The past is never really the way we remember it."

The past. Time. She thought about her problem, and about his. She asked him about Eifelheim and he told her about the name change.

"In hindsight, it seems so obvious," he finished. "I've been kicking myself all week. Oh well. *Lúchshye pózdno chem nikogdá.*"

Sometimes his habit of scrambling

languages annoyed her. "Why don't you just say, 'Better late than never'?"

He looked baffled. "I just did."

She sighed and let it pass. He really didn't know when he was doing it. Sometimes she thought he had his own private language inside his skull and when he spoke it was a matter of luck whether it came out in English or not.

Well, she had her own success to celebrate. She raised her wineglass in toast. "To Tom Schwoerin," she said. "The best lay physicist around."

He paused with his own glass in midair. He frowned. "Best lay, I can understand; but why physicist?"

"Remember what you said last week about light-speed measurements getting lower? Well, I checked it out and you were right. A fellow named Shewhart first made note of it in 1939. He showed that the differences were not statistically compatible with random chance. In 1974, Halliday and Resnick noted the same thing. There were only two exceptions to the downward trend, and both of those came from the Soviet Union. Taken as a whole, the measurements form an exponentially decreasing series approaching an Einsteinian constant as an asymptote."

He put his glass down and stared at her. "I wasn't really serious when I said that. I thought it was just the usual problems of operational definitions. Different test methods, or even different test sets, never give precisely the same measurements."

"Oh, there was some of that all right. Scientists and engineers have always been a little careless with their definitions. They assume that a number obtained by one method means the same thing as a number obtained by another method. But I asked myself, What if progressively lower measurements meant that light was actually *slowing down?*"

"What if? is an annoying kind of question. It can lead to all kinds of trouble."

She grunted. "Don't I know it? Wait till I publish and you'll see what trouble means. You see, when you include experimental error, each one of those measurements is compatible with a constant light-speed. It's only as a *series* that they look suspicious."

Tom cocked his head. "I don't know much about physics, but aren't there good reasons why light-speed is supposed to be constant?"

She grinned to herself. "What if it's both?" she asked.

He shook his head, confused. "You lost me. How can light be both constant and variable?"

"How could Schroedinger's cat be both dead and alive? This is physics, not common sense. Let's just say that light-speed is constant in a higher geometry but has been decreasing in the perceptual universe."

He smiled. "Makes perfect sense to me."

"No, seriously. It fits in with my own work on Janatpour space. That's why I'm so excited—and so grateful to you. Even if your help was unintentional."

"Thanks. I think. What is the 'perceptual universe' you mentioned?"

"Oh, that's the surface of the balloon. The part of reality we can perceive." She saw the look on his face and hastened to add, "The balloon is an image some physicists use for the expanding universe. You see, galaxies

are racing away from each other, not from a common center. They aren't flying out into space. Space is expanding between them. If you imagine galaxies as dots painted on a balloon, you'll see what I mean. As the balloon expands, all the dots appear to be receding, no matter where you are on the surface of the balloon. We just happen to live on the three-dimensional 'surface' of a very weird balloon."

Tom jerked up. "Hey! I think I understand. Velocity is distance over time, right? Well, if a beam of light has constant velocity in, what was it you said? A higher geometry? And space is expanding the way you described, then the light will take longer today to cover the same number of kilometers as yesterday. Because the kilometer itself is a little longer."

She reached across the table and patted his cheek. "Tom, sometimes you amaze me. You really do. You're about one-third right. If you paint a meter stick on the balloon and expand it, the stick will grow longer, even though it's still labeled 'one meter.' "

"One-third right?"

"Yes. Forces like gravity and the strong force keep physical standards from growing as fast as 'empty' space."

"But then—" She saw the realization grow in his eyes. "Distance over *time? Wo, madoda, ngi hudelwa yi hubulu!*"

"Exactly," she said. "What if time were accelerating? If seconds were getting shorter? Then a constant beam of light would cover fewer kilometers in the 'same' length of time, and thus appear slower. When I project the lightspeed series, extrapolating backward to the Big Bang, I get an infinitely long second—and infinitely fast light-speed at the decoupling, and that's . . . Well, it's interesting because it ties in with Milne's theory of kinematic relativity, developed back in 1933. Experimentally, there was never any way to distinguish between his model and Einstein's."

Tom leaned back in his chair. He linked his hands behind his head. "So, time is accelerating, eh? Y'know, I've always thought the years went by faster as I grew older."

She took another forkful of salad. An advantage of salad, she had always thought, was that it never grew cold while she jabbered.

"No," she replied. "That's a psychological phenomenon. The effect is negligible over a person's lifetime. Less than experimental error, so it's practically indetectible."

"Who knows. Maybe the subconscious is smarter than we think."

Now that was a thought. She had assumed that the perceptual universe was restricted to the usual four dimensions. Perhaps we *could* sense other dimensions as well. After all, if time were accelerating, didn't that argue for at least one other sort of time? She realized he had spoken. "I'm sorry. What did you say?"

"I just asked if this meant you were going to throw out old Einstein."

"What? No, certainly not! Look, for all practical purposes, lightspeed *is* constant. It's the same regardless of frame of reference, too. It's just that it's a special case of a more general theory." She waved her fork in the air. "We don't *replace* a valid theory, we *expand* it." She suddenly remembered that Tom

had said almost the same thing about one of his psychohistorical theories. "I mean, for all practical purposes we still use *Newton*."

She paused with her fork in midair. A trolley car rumbled noisily past, up the cobblestoned street, but she scarcely noticed it. She had just remembered what it was that Newton had said. A change in velocity requires a force to explain it. So, if time were accelerating . . .

She patted her lips with a napkin and began building geometries in her mind.

He looked up from his reading when Sharon handed him the phone. "Here," she said. "It's your new girlfriend."

Tom chuckled and plugged the phone into his terminal. "Did you hear that, Judy? Sharon thinks you're my girlfriend."

The image on the CRT looked troubled. "That would not be proper," she said. "I hope I have not caused you problems."

Tom looked at Sharon and grinned. She rolled her eyes upward. Sometimes the stuffy conventionality of the younger generation was a little hard to take.

"No, Judy," he said to the screen. "Everything's fine."

"Ah. Then I have something that you ought to read."

"Good. Load it over." Tom waited eagerly. Judy's literature search had yielded a moderately bountiful harvest, now that they had the right key. Items had been appearing in his Eifelheim file for two weeks now. All properly referenced and annotated. She had found monastic annals, manorial accounts, tantalizing odds and ends. One day it had been a memoire of a local knight recounting his discussions with the pastor of Oberhochwald concerning seven league boots, talking mechanical heads, and other notions of Fra Roger Bacon. Another day it had been copies of the annual *corvee* going back to the times of the Dukes of Zähringen.

"What is it this time?" he asked.

"I think I know why the name was changed."

"What? Why?" The name change and the site's inexplicable abandonment had occurred at roughly the same time. There had to be a connection.

Judy's face was replaced by a manuscript facsimile. Crabbed handwriting. It looked like fourteenth century work. The Latin was awful; Cicero would weep. As he read, he listened to Judy's voice.

"I took another shot at the witchcraft files, using the Soundex to pick out variant spellings. Most of what turned up was not relevant to our purpose, but I did find this: a 1377 bull denouncing the Beghards, the Brethren of the Free Spirit. It seems that Oberhochwald's new name was not originally Eifelheim at all, but —"

"Teufelheim," he finished. He held his place with his finger. Devil-home. He chewed on his thumb knuckle. What sort of people lived there, he wondered, to have earned such a name from their neighbors? "Shun them as we shun the unholy soil of Teufelheim. Pastor Dietrich was tried and found wanting and God has passed judgement on his actions," he read. "The writer doesn't care much for our friend Dietrich. I wonder what he did that was so terrible; besides sticking the smith with a hundred feet of wire, that is." He dumped the

file over to the printer and Judy's face reappeared on the screen.

"Did you read the descriptions of the devils?" she asked.

"Yeh. Pretty gruesome. Yellow bulging eyes. Gibbering incantations. 'They danced naked but sported no manhood.' Why do you ask?"

"They flew, too."

He snapped his fingers. "The folk tales of flying monsters! This may have been what started it."

"A story in a bull? Would that do it?"

"No, you're right. The writer was repeating a story already in circulation. Ergot of rye, maybe."

"What of what?" Judy's image cocked its head.

"Ergot of rye. A natural fungus that produced LSD. It was a chronic problem with cereal grain in the middle ages. People who ate the bread made from the contaminated rye had hallucinations. They saw the skies open; heard voices. They saw the Virgin, saints, devils. The so-called traditional description of Satan as a giant goat-like satyr dates from then. The worst outbreak, as I recall, started at Aix-la-chapelle in 1374 and spread down the Rhineland; but there had been sporadic outbreaks before then. It was called the Dancing Mania because one symptom was a heightened sensitivity to rhythmic sounds. People broke into wild, uncontrolled dancing." He smiled, remembering. "The same thing used to happen at rock concerts in the '70s. But think how terrifying a bad trip would be if a whole village were dropping acid without knowing it. One effect was to convince the authorities that witchcraft was real. Too many respectable people were seeing devils."

"Oh. I didn't know about that."

"You sound . . . what? Disappointed?"

"I don't know. The writing was so detailed. The descriptions of the devils; the behaviors of the villagers."

"As if the people of Oberhochwald really had befriended demons and 'welcomed them unto their hearths'?"

"Yes . . ."

"Or?"

"Or something else."

After Judy had logged off, Tom remained seated by the terminal, pulling thoughtfully on his lip. Ergot hallucinations were another common cause, not special to Eifelheim. People had seen demons, and written vivid descriptions of them, in many places. If visions had been the reason for the taboo, there would be Teufelheims all up and down the Rhineland.

There were many horrors in the wrack of medieval civilization. Cannibalism followed the famine of 1317–1318. 'Children were not safe from their parents,' one chronicler had written. No villages had been shunned on that account. Bands of communist peasants had roamed the countryside, espousing poverty and free love, sacking manor houses and monasteries to make their point. The people who fled soon returned. Witchcraft and heresy; flagellants and plague. With so many reasons around, why had Eifelheim alone of all stricken villages remained anathema?

He called up the document file and went through it again, item by item. He studied the screen intently, as if he could

wrest answers from it by sheer concentration; copies of *corvees* and other taxes; a scattering of manorial records of the vassals of the Counts of Urach-Freiburg and the earlier Dukes of Zähringen; the knight's memoir; the religious treatise on the 'inner world'; seignorial approvals of marriages and vocations; enfoeffments encompassing Oberhochwald and feudal levies calling upon its knight; the newspaper clipping; a cabalistic prayer citing 'eight secret ways to leave this earth of sorrows' and attributed at third hand to 'Saint Johan of Oberhochwald'; an episcopal letter addressed to Pastor Dietrich affirming doctrine that a person's outward appearance did not reflect the condition of the soul. The letter was doubly interesting because the bishop had consistently used the sexless *homo* rather than the masculine *vir*. At one point, he had even written *naturae voluntarum*, beings of free will. That at a time when schoolmen were seriously debating whether women had souls at all.

Then there were the usual monkish chronicles of harvests, fairs, gossip, and such. One spectacular event, a lightning strike in March 1348, had set several acres of forest (and not a few superstitious minds) ablaze. The plague was then spreading north from the Mediterranean and the bolt had allegedly heralded Lucifer's coming.

I could almost write a complete history of this village, he thought. Harvest and tax records would let him estimate economic and demographic growth. The fief records showed how it fit into the local feudal structure. The knight's memoir and the bishop's letter even gave him a glimpse of the village's intellectual life, such as it was. What *were* seven-league boots? Oh, yes, the wearer could cover immense distances with a single stride.

In fact, he realized glumly, the only thing missing was the only thing that made it important. Why had it never been resettled?

What if it's not here? he wondered. What if the key document has been lost? Or if it was never written down at all? There's no guarantee. *I might not even recognize it if I had it.*

"Tom? What's wrong? You look pale."

He glanced up. Sharon stood in the kitchen archway, a freshly brewed cup of tea in her hands. The odor of rosehips and chamomile wafted through the room.

"Nothing," he said. "Nothing at all." But he had had the sudden dreadful sensation that he already had a key piece of information in his hands, that he had read it several times already, and it had meant nothing to him.

That evening Tom accessed EuroNet and loaded onto my computer at the Albert-Louis University, asking me to look through the uncatalogued papers for references to Oberhochwald, Eifelheim, or Teufelheim. It was an odd request to come out of nowhere like that, but I rummaged about as best I could and, a few days later, sent him what I could find.

II

"Sharon?"

She heard his voice, distant, as if through a fog. It was easy to ignore. The universe was lovely. No, not the universe; the *poly*verse. The same lattice she had glimpsed before. But with

twelve dimensions, not eleven after all. Three dimensions of space, three of time and three of . . . something else. And three more "meta-dimensions" to join the others together. A triplet of triplets. It made sense. The rotation groups and meta-algebra made sense. The speed of light business fit, too. Her pulse quickened. So, by God, did K/K theory.

She reached out a mental hand. Warp those three dimensions just *so* and create a gravitational force. Smart lad, that Einstein; he got it just right. Another warp *there* produced electromagnetism. Kaluza and Klein were no dummies, either. And *there*, a warp produced the weak force; and *there*, the nuclear force.

And *there?* What if she were to warp *those* dimensions?

"Sharon, are you all right?"

Her eyes popped open. "I had it! It was beautiful! I almost had it! Quick, give me paper. It's too much to remember." She saw Tom, sitting across the breakfast table from her. He already held her notebook out, open to a blank page. She snatched it from his hands and scribbled fiercely. It was slow going at first, but partway through she invented a new notation. *Please*, she thought, *let me remember what it means.* After that it went more quickly. Finally, she wrote a row of question marks, sighed and shut the book. "Wait'll I tell Hernando," she said.

"Who's Hernando?"

She scowled at Tom. "I don't know whether to be angry because you interrupted me, or glad because you had my notebook handy. How did you know?"

He pointed. "Because you don't normally pour tea on your scrambled eggs."

She looked down. Breakfast was a sodden mess. She groaned. "I must be losing my mind."

"You'll get no argument from me. When I saw the glazed look come into your eyes, I knew it was notebook-serious."

He took her plate to the sink. "You can have one of my soft boiled eggs," he told her over his shoulder.

She shuddered. "Too runny. I don't know how you can eat those things." She reached across to his plate and snagged a piece of bacon.

He sat back down. "Tea?" he asked. "No. *I'll* pour."

When she was sipping contentedly on her cinnamon brew, he asked, "So what was the Great Revelation?"

"You don't understand GUT physics."

"And you don't understand psychohistory. But when we try to explain things to each other it helps to clarify our own thinking. You go ahead. I'll just sit here, smiling benignly, and nod in all the right places."

"I don't know where to start."

"Start at the beginning."

"Well . . ." She thought about it. She took another sip of tea. "All right. Before the Big Bang—"

"Whoa!" said Tom, laughing. "When I said to start at the beginning, I didn't mean the Beginning."

"Honestly, Tom. Try to be serious." She waited until he had composed himself. "Why do apples fall?"

"What?" He was startled by the question. "Gravity?"

"Right. Now, why do currents flow?"

"Electromagnetism. Do I get a prize?"

"Maybe. Ask me tonight. Now, why is time accelerating?"

He opened his mouth to reply, closed it, and looked at her quizzically. "Some sort of force," he said slowly, almost to himself.

"Exactly!" She clapped her hands together. "Accelerations require forces. Uncle Isaac said so. I call the force acting on time *chronity*. Look at it this way: we don't move forward through time at all; we fall downward, pulled by a kind of temporal gravity." Pulled by what, she wondered. She thought about the Big Bang. "Or maybe we're pushed. I haven't decided on plus or minus signs yet."

"Chronity," Tom repeated. "Then you would say that entropy is a chronic problem."

She looked at the table for something to throw at him. She settled for an old tea bag, but he dodged it easily, still laughing. "Brace yourself," he warned. "I won't be the last to make that pun."

She groaned. "I know."

"So. Are these theories of yours just philosophy, or do you plan to experiment? *Can* you experiment?"

She nodded. "The first step is to detect and measure the force. Hernando is building a chronon detector for me."

"Right. Who is Hernando, and what's a chronon?"

"A chronon is a quantum of time, a carrier of the time force. Hernando Kelly over in nucleonic engineering is building an instrument to detect them. I dream up the circuits and he puts 'em together. I'm no good at etching bubbles." She wiggled her fingers. "Too clumsy, see?"

Tom shook his head in admiration. "Out of the sofa and into the lab. This must really be important. It sounds terribly fundamental. A new force."

"Oh, it is. It'll change our whole outlook on the universe." She looked at her watch. "I'm supposed to meet Hernando in an hour. Mind if I work while we talk?"

"Hmmm? No. In fact, I'll walk you over to the engineering center. I have a meeting with Judy over that way."

She looked at him. "More Eifelheim? Or is she just too good looking? Getting your jollies with her?"

He twisted his face up. "Get serious. These aren't the eighties, y'know. Her generation wouldn't know how to dress for an orgy."

She patted his cheek. "Still panting for a glimpse of calf? I know how you feel. No respect for the values of our generation. Hernando's the same way. Totally devoted to *one* woman."

"*Tempus fugit,*" he shrugged. "*Andere Sitten,* and all that."

At their desks, Tom pulled his hard-copy file while Sharon snapped computer bubble-modules into a carrying case.

"So, how will chronity change our outlook?"

"What? Oh. It expands the universe and changes its shape."

"Makes sense to me."

"All right, all right. Forces are space-warps. I thought everyone knew that. Long time ago, Uncle Albert showed that gravity was a warp in space-time. That was an exciting insight, so the physicists tried to do the same with electromagnetism. Nothing seemed to work until Kaluza and Klein expanded the universe by tacking on some extra dimensions. Then we discovered the weak

force and the nuclear force, and tried to express them as warps, too. It got to be quite a game for a while, almost as much fun as finding 'new' subatomic particles. I got in on the tail end, when I was doing graduate study back in the '80s. Anyway, when the smoke finally cleared, we had eleven dimensions on our hands."

"*Merde!* You mean physicists kept adding imaginary dimensions because they had arbitrarily decided that forces were warps?"

She snorted and closed her bubblecase. "Those dimensions are no more imaginary than Newton's 'force fields.' And it wasn't arbitrary. Certain symmetry relations—"

Tom held his hands up in mock surrender. "Okay, okay. I give up. How does your chronity fit the scheme?"

"Perfectly. I can describe it as a warp, too; provided I add a twelfth dimension. Trouble was, that messed up the accepted models for the other four forces."

"Until this morning," Tom guessed. "At breakfast."

"Right. I discovered that if I organize the dimensions as a nested hierarchy instead of an orthogonal array, everything works out. In fact, it becomes simpler." She explained about her triplet-of-triplets model. At one hierarchical level, the meta-continuum, there were three dimensions: Space, Time, and a third quality she hadn't named yet. A limitation of earlier models was the assumption that all 'extra' dimensions were spacelike. At the fine level, each of her meta-dimensions decomposed into three orthogonal dimensions. She called the whole the polyverse. The perceptual universe was a subset of this.

"A warp in the polyverse," she finished, "can intersect the universe in different ways. A single warp, seen at different angles and cross sections. Like the blind men and the elephant, we think we see different forces."

"Hmmm. We can't actually see these 'hidden dimensions.' The whole elephant, so to speak."

"No. Remember the balloon analogy? Well, you can think of the extra dimensions as forming the inside of the balloon. That's not strictly correct, but it'll have to do. The original monobloc was slightly asymmetrical. When it expanded some of the dimensions got rolled up. They're still there: inside the quarks; inside everything. What you've always thought of as a simple, dimensionless point is really a complex, multidimensional hypersphere."

The condo buildings were arranged in a U-shape around a central courtyard set back from the street. The air, when she stepped out, was fresh and clear, but muggy. A spin-off of the new hydrogen cars and their water vapor exhaust. She could remember the hydrocarbon cars of her youth—how the air stank and her eyes watered. Not to mention the cancer rates.

Tom continued to bounce questions off her as they walked. "Seems to me," he said, "that if we could take a shortcut through the inside of your balloon, we could reach the planets in less time."

She smiled. He really was very bright for a soft scientist. "That would be a neat trick topologically. Like a donut jumping through its own hole. But, who

knows? If we could control the proper energies and focus them in the proper directions . . . When do you think the Brazilians will finish the L4 accelerator?"

"Eh?" He stopped, puzzled by her change of subject.

"You see, the really big accelerators take us into the past. They recreate conditions as they were in the first seconds after the Big Bang, when the separate forces weren't all that separate. We can stick our noses a little way into the balloon and see a world in which the seconds were longer and the kilometers shorter."

"And the *Bandierantes L4* will do that?"

"Not all the way back to the Bang, but it should yield enough energy to fuse chronity with the electroweak force. Since we've been manipulating electromagnetism for generations, that should give us a way to manipulate the time force."

"Question mark."

"Simple. If you can make A jump through hoops and you can attach B to A, you can make B jump through hoops."

"No, I didn't mean that. Logic, I understand. What do you mean about fusing forces?"

"Oh! That's simple, too. In the Beginning, at the Bang, there were no separate forces, just a single Superforce. As the energy level dropped the metacontinuum warped and the individual forces, ah, 'froze out.' Gravity froze out at Planck scale energy, 10^{19} proton masses; and the nuclear force, at unification scale, or 10^{14} proton masses. Those are enormous energy levels, of course. Way beyond what we can achieve even today; but even back in the 1980s they could reach Weinberg-Salem scale at 90 proton masses and fuse the weak force and the electromagnetic force into the electroweak force."

"Wait, I remember. That was the breakthrough that led to the anti-nuclear shield, wasn't it?"

"One of the breakthroughs. Like I said, we can manipulate electromagnetism; so if we fuse the weak force to it, we can manipulate atomic decay. The result was the fission suppression field."

"So how does . . ." He cocked his head and frowned. "Hold on. Something's wrong. What were those energy scales? 10^{19}, 10^{14}, and approximately 10^{2}? Why's there such a big gap between the last two? What kind of series is 19, 14, 2?"

"A question that's bugged physicists for over forty years. It's that notion of beauty again. Most series in the physical world are mathematically recognizable: arithmetic, geometric, logarithmic, Fibonacci, and so on. Just like Mendeleyev and the periodic table of the elements, the gap says something's missing. There's really no gap at all. At about 10^{8} protons the electroweak force is unified with—"

"—chronity," he finished. "Very impressive."

"Right. I modestly call that Nagy-scale energy. That's why I asked when L4 would be finished. It's within its capabilities. Do you think it will be finished? Do you know how many orbital factories have gone bankrupt this year?"

"Know it? I predicted it. Psychohistory isn't just for the past, you know. And being in orbit doesn't make anyone

immune to the four business cycles. Don't worry, though; things'll pick up in another year or so. I've calculated it."

She squeezed his arm. "Thanks for the encouragement." They resumed walking. "Anyway, the point is that with Nagy-scale energy we can get inside the balloon, as you put it, and go anywhere. If we can solve the topology problem. Lightspeed is still the upper limit on velocity; but if we go far enough in the right direction, the kilometers become very short and the seconds very long. In effect, we can pick any lightspeed we want."

He blinked. "Instantaneous interstellar travel?"

She shook her head. "Instantaneous is a dirty word. But it could be as near as made no difference. Tom, we wouldn't need spaceships at all. We just disappear here and reappear there. We could drive our cars. With protective suits, we could *walk* to the stars. A single stride could cover immense distances. Could you imagine the looks on the crew of *BRJ Yoshiba* if they reach Van Biesbroek 8 and find people already there? They'd have to commit seppuku to save face."

"Shades of Asimov! Sounds like you've discovered hyperspace."

"No. *Hypo*space. Topology is conserved. The eight hidden dimensions are *inside* the universe, remember? To travel to other worlds we have to travel inside. She laughed, but he was oddly quiet. She looked at his face. "Tom?"

He shook himself. "Nothing. I just had the oddest feeling of *déjà vu*, is all. As if I'd heard all this before somewhere."

* * *

Tom met Judy at the old Pigeon Hole, where they discussed her latest findings over a couple of cheese-steak hoagies. Tom liked his with everything on it and watched with amusement as Judy carefully plucked the green peppers from hers.

"It was my worm," she explained. "I sent it looking for Pastor Dietrich." She rolled her eyes up to heaven. "Do you know how many medieval Germans have been named Dietrich? Some of what turned up I could weed out immediately. The others I had to read, one by one." She spat the words out. "And this one?" she asked, waving a printout in the air. "The idiots didn't put Oberhochwald in their index, so it was never cross-referenced that way in the Net Master Index. Otherwise, it would have popped out right away." She bit her hoagie savagely. "Jerks," she muttered.

Tom laughed. Nothing so offended a professional librarian as bad indexing. He stopped, suddenly sober. How much more information was hidden away the same way? Buried forever in the mountains of words written over the last six centuries. He took the document from her, grateful that he had it at all.

It was an odd item. During the 1960s an enterprising group of liberals had published a book called *Tolerance Through the Ages*. The contents purportedly showed enlightened attitudes in many times and places. One of these was a letter from Pastor Dietrich to his bishop:

Excellency,

I have remained silent while my detractors have whispered vile accusations in your ear, hoping to turn your

heart against me. Reason and truth will prevail, I thought. Yet the latest incident regarding the flagellants in Stuttgart causes me to wonder whether reason be still highly regarded in Christendom. Fra Joachim has told you we are witches here who have welcomed flying devils into our homes, and has asked that the Holy Office be used against us. Permit me now to speak in my own defense.

While it is true that Alexander IV, may he Rest in Peace, granted the use of torture by the Holy Office in pursuit of heretics, Canon Episcopi *clearly states that witchcraft, albeit a civil crime, is no heresy. Thus the request of Joachim and his ilk is improper, regardless of the merits of his argument.* Quod erat demonstrandum.

Furthermore, the same Canon *declares that witches do not fly to their Sabbat, save in dreams induced by belladonna and other noxious herbs, and that to believe otherwise is sinful! Therefore, it is my accusers who sin when they claim that my guests fly by supernatural means.* Quod erat demonstrandum.

(Thierry, old friend, do we not both read God's Word through the means of wonderful eye-glasses, so recently invented? Though these be but natural, mechanical contrivances, yet many of the simple folk mistrust them. Simil atque, *flying, if it be possible, would prove itself natural as well, accomplished either through God's Will as with the birds of the air, or though the skills of clever artisans.)*

We also know that demons cannot abide the touch of Holy Water. Yet, after all their art had failed to win them home and my guests had given themselves to despair, I preached to them and won at least one soul to Christ, he who celebrated his new birth by taking the Christian name Johann. The Water of Baptism caused him no discomfort. Therefore, he is no demon. QED.

Thus do I refute Fra Joachim. "Whatsoever ye do to the least of My children, ye do unto Me." I have aided travelers lost and hungry, some grievously hurt, when they appeared here in the spring. Fra Joachim finds them ugly and calls them devils. Certes, they fare from a far land and folk there have different visage; but if Pope Clement can shelter Jews in his palace at Avignon from fear-maddened townsmen (and how marvelously rational was his bull of September last demonstrating the innocence of the Jew in the matter of this new Plague!), then surely a poor parish priest may shelter the helpless wayfarer, no matter the color of his skin or the shape of his eye.

Christ with us this Year of Grace 1348.

Given by my own hand at Oberhochwald in the County of Urach Freiburg. Michaelmás Eve.

Dietrich

"Quite a remarkable man," said Tom.

"Yes," said Judy quietly. "I should have liked to have known him. My parents were also helpless wayfarers. They lived in a boat on the water for three years before their "Pastor Dietrich" found them a home."

"Oh. I'm sorry."

She shrugged. "It was a long time ago, and I was born here. The American story." She smiled in embarrassment.

Tom looked at the letter again. "Chinese, do you think?"

The almond eyes looked at him. "What do you mean?"

"Dietrich's guests. The comments about skin and eye shape sound like Chinese."

"There was such travel in the fourteenth century."

"Damn right. Marco Polo's father and uncle went to China and back twice. We know of two Chinese Nestorians who came west at about the same time. They may even have passed the Polos along the way. Oddly, one of them was named Marco, also. When they reached Babylon, Marco was selected Catholicos, the Nestorian pope. He sent his companion, Sauma, on embassies to the Roman pope and the English and French kings. Dietrich may have taken in a similar party, one that had met with disaster. Some were wounded, he says."

"Perhaps," Judy agreed, "but—"

"But what?"

"Why would Joachim call them flying devils?"

"If their arrival coincided with an outbreak of ergot hallucinations, they might have been connected with the visions in the popular mind."

Judy pursed her lips. "Well, Dietrich seems to have converted one of the 'hallucinations' to Catholicism. Johan. Do you suppose it is the same person as that Joannes Sterne, the one whose baptism was referred to the bishop's court?"

"Almost certainly. I received a transmission this morning from my friend Anton in Freiburg. He did some digging over there and came up with more of that journal. Remember, we found only that one page?"

"Yes. I believe it was kept by Pastor Dietrich."

"So do I. In small villages like Oberhochwald, the priest was often the only literate man." He handed her the pages and watched as she read through them.

She finished, nodding. "Chinese or demon," she said. "Dietrich thought well of our Johan. Or whatever his name really was." She flipped through the pages. "What was it he wrote? Oh, yes. 'I call him Johan because his own name is too difficult for my tongue.' "

"Uh-huh. He would never have heard a non-Indo-European language before. And Chinese has a lot of tonal subtleties."

"He also wrote how Johan and some of his companions helped care for stricken villagers after the first bout of Plague."

Tom nodded and retrieved the papers. He flipped through them. "Right. What did he write? Here it is. 'While they themselves remain untouched thus far, Hans and three of his friends daily risk contamination by visiting the sick and burying the dead. How sad that those who fled from their sight throwing rocks and dung will not return to witness true Christian charity.' "

Judy took a sip of her soda. "And there's more in the same vein," she said. "Johan and Dietrich pray together for strength. Some of the wayfarers grow despondent and Dietrich comforts them."

"So they cooked up a scheme," Tom added, "to keep their hopes up." He licked his thumb and searched through the printouts. "Uh-huh. 'The folk of the

village try in their own fashion to repay our guests' kindnesses by aiding them in their efforts to win their way home. I have bethought myself to secure from artisans certain items which Hans declares would be sorely needed for the endeavor. However, our own smith has already gone to his reward and I dare not venture into Urach since Joachim has been preaching.' That fits. Donaueshingen is in the other direction."

"Dr. Schwoerin?"

"Oh, call me Tom."

"Very well. Tom. There was one other scene that Pastor Dietrich described. It was on the last page but one. I should like your opinion of it."

He read the page she had indicated. "I'm not sure what you mean," he said finally. "Dietrich says he found Hans one night alone on the edge of the village, looking at the stars. They talked awhile and Hans asked how he would ever find his way home again. A homesick traveler, *nicht wahr?*"

"No, Tom. He wrote that Hans pointed to the stars and asked how he would find his way home again."

"I still don't understand. People in those days generally used the stars as guides for traveling."

"I'm . . . not sure. It's just a feeling. Something we've read . . . It means something different. Not what we think at all."

He didn't answer her. He'd had the same feeling himself. He took a last bite from his hoagie and shoved the plate aside. It bothered him that, despite all the material they'd unearthed, they were no closer to finding the reason for Oberhochwald's abandonment. So far there was nothing that would not apply equally well to scores of other places. The cause had to be unique. He remembered the case of a Manchurian village, inhabited by mentally retarded people. That had been traced to an iodine deficiency in the soil they farmed.

Shun them as we shun the unholy soil of Teufelheim. In the last year of its existence, Oberhochwald was an ordinary village. Yet a mere 29 years later it was being called the Devil's home. Of course, the great outbreak of the Dancing Mania had come between the two events. But nowhere else had the hallucinations led to a taboo.

The subconscious is a wonderful thing. It never sleeps, no matter what the rest of the mind does. And it never stops thinking. No matter what the rest of the mind does.

Tom awoke in a cold sweat. He sat suddenly upright in bed. *No, it's not possible!* It was absurd; but everything fit. Or did it? He had to know.

He glanced at Sharon where she sprawled fully clothed on her side of the bed. She must have returned late from the lab and crashed. He could not remember her coming in. She smiled faintly in her sleep, dreaming of chrononons, no doubt.

He eased out of bed and tiptoed to the terminal, where he called up the Eifelheim file. He carefully checked and cross-referenced each item. Data are not information, he knew, until they had been properly organized. He put events in chronological order, placing the undated items through context or logical relationships. Michaelmas Eve, for example, could have been either May 7 or September 28, depending on whether

it was the Feast of the Apparition or of the Dedication. But Dietrich's letter referred to the Pope's Bull, which had also been written in September.

When he had finished, he reviewed the list:

1348, Mar.	Lightning strike "heralding Lucifer's advent."
Spring	Foreign travelers arrive. Some villagers flee. Others shelter and care for them.
?	Sir Manfred visits Dietrich; later writes memoir.
Jun.	Dietrich receives letter from bishop (apparently a reply to a query from Dietrich). "The condition of the soul is not manifested in the aspects of the material body."
Summer	Joachim is preaching against witches.
	Travelers growing despondent. Dietrich preaches and converts Johann to Catholicism.
Sep.	Dietrich writes *apologia* to bishop.
	First signs of plague. Smith (and others) die. Johann helps care for ill.
?	Travelers determine to try for home. Surviving villagers help.
	Dietrich gets copper wire.
	Travelers begin dying. Two more converted.
	Dietrich returns wire.
late 1348.	Village abandoned.
1348–1400.	Heterodox theologies attributed to Oberhochwald apparently circulating locally.
1374	Major outbreak of ergot poisoning. Hallucinations.
1377	First specific mention of taboo. "Teufelheim."
1384	Cabalistic prayer of "St. Johan." "Eight secret ways to leave this earth."
1423	Religious treatise: "Trinity of trinities." First mention of "Eifelheim."

Tom chewed on the end of his lightpen. The record was spotty, incomplete. When, for example, had the gravestone been carved? He envied physicists. The answers were always there. If only the physicist were persistent enough or clever enough, she could pry them loose from the universe. Cultural scientists were not so fortunate. The facts themselves did not always survive. No amount of persistence could decipher a record that had perished in a long-ago fire.

He studied his list, referring to the actual documents to refresh his mind on details. In the end, he saw no other explanation. What had he said to Sharon that day in the restaurant? Maybe the subconscious is smarter than we think.

Or maybe not. He needed a second opinion. He looked at the clock on the wall, an old-fashioned digital with an antique liquid crystal display. It was 03:20 hrs. That meant 09:20 hrs. in Freiburg. He copied his file and added a summary. Then, before he could lose his nerve, he zapped it to my office, a

quarter of a world away. It contained a single question: *Was glaubst du?* What do you think?

Tom's second message piqued my curiosity. I coded back that a reply would require several hours in the *Bücherei*. I found some documents that he had asked about and compared them to what he had sent. Then I searched out other documents and blew off the centuries and read them as well. Afterward, I smoked my heavy carved Schwarzwalder pipe and was disturbed. I thought about appearing the fool. Dignity, after all, is something we save for our old age; and I had earned it.

I sighed and tied ZEITGEIST into CLIODEINOS and transmitted what I had found. Cautiously—very cautiously—I outlined my conclusion. If Tom had the brains that God gave a turnip, he could read between the lines.

"What are you doing up so early?"

Tom started violently. He looked around. Sharon stood behind him, rubbing her eyes. "Don't sneak up on me that way! I thought you were crashed."

"Are you kidding? A Mack truck could sneak up behind you, you're so intent on that printer." She yawned. "That's what woke me up. The printer."

He watched the printer head run back and forth. "The wonders of engineering. It's supposed to be noiseless."

She padded into the kitchen and turned on the tea kettle. "It's time to get up anyway. What's going on?" she called.

Tom pulled the last sheet from the printer. He had been reading my message as it emerged. "It would take too long and sound too ridiculous."

She poked her head around the archway. "Tom, I'm a physicist, remember? Next to strange, charming quarks *nothing* sounds ridiculous. So, what's on those printouts?"

"Anton sent them."

"Anton Zaengle? How is the old dear?"

"He's fine. He wants me to come to Freiburg."

"Oh? Why?"

"I think he thinks what I think."

"Well, I'm glad you cleared that up."

"No, seriously." He waved the printouts. "This is the bait to lure me there." He paused. "Sharon, why would a medieval backwoods priest need a hundred feet of copper wire?"

"Why . . . I don't know."

"I don't either; but he ordered it specially made. And some special iron forgings of odd shape, according to Anton. And later, he brought it all back." He pulled out another sheet, heavily underlined in red. "And during the summer of 1348, monks in a monastery near Oberhochwald heard thunder when there were no clouds in the sky. Short, sharp thunderclaps echoing in the hills." He put the sheet down. "The Germans say that gunpowder was invented in Freiburg in 1350. Interesting timing.

"And *peccatores Eifelheimensis*, the Sins of Eifelheimers. Something Anton found. It denounces as heretical the notion that there could be men with souls who were not descended from Adam."

Sharon shook her head. "I'm still asleep. I don't get it."

He took a deep breath. He was surprised how reluctant he was to say his thoughts out loud. But Sharon's the one can tell me if my guess is all wet.

"All right," he said. "Nearly seven hundred years ago, sentient beings from another world were stranded near Oberhochwald in the Black Forest." There, he'd said it. He held his hand up to forestall Sharon, whose mouth had dropped open. "They were traveling through Nagy space when their vessel malfunctioned. The energy leak must have been tiny, but it started a forest fire and injured some of them."

Sharon had found her voice. "Wait a minute. Wait a minute. What sort of proof—"

"Let me finish, please." He gathered his thoughts and continued. "The aliens' sudden appearance out of nowhere and their physical features, yellow bulging eyes, for example, frightened many villagers, who fled, starting rumors of demons. The others, including the village priest, Pastor Dietrich, saw that they were creatures, if not precisely human, in need of help. Just to be safe, he got a carefully worded ruling from his bishop, something he could do in Latin without giving the show away.

"The aliens lived in Oberhochwald for many months. While Fra Joachim and others were accusing them of witchcraft and demon-worship, the villagers tried to help the aliens repair their hypocraft. I should have seen that in the business of the copper wire. What possible use would that have been for earthly travelers?

"I'm sure everyone knew there was no real hope of repairing the equipment; but it was a necessary self-deception to try it. Perhaps the aliens taught the villagers how to make blasting powder. They also flew. Anti-gravity? Perhaps. Pastor Dietrich wrote a letter in which he carefully denied only that his 'guests' flew by supernatural means."

He looked at Sharon, searching for a sign of her reaction.

"Go on," she said.

"The aliens were immune to the Plague—different biochemistry—and repaid the villagers' kindness when they became ill. At least, some of them did. Others, I'm sure, had succumbed to apathy by then. Dietrich even converted some to Catholicism. We have a record of one baptism, at least. Joannes *Sterne?* Oh, he knew where his guests came from. He knew.

"Eventually, the aliens, too, began to die. Not from the Plague, but from the lack of some vital amino acid. That different biochemistry again. 'They eat but take no nourishment' was how Dietrich put it. When his friend Hans died—this is a guess now—when Hans finally died, Dietrich buried him in the churchyard and had a carving of his face put on the stone so that future generations would know. Only he didn't realize how many generations that would be, or that the village itself would vanish.

"The taboo? Easy. There really were 'demons' there. And shortly after Joachim cursed the place, it was struck by Plague. But were the demons really dead, or simply asleep, waiting for new victims? People shunned the place, and passed the warning to their children. In a fairly short time, Joachim's tag of Teufelheim was euphemized to Eifelheim and the original name of Ober-

hochwald forgotten. All that was left was a custom of avoiding the place, vague folktales of flying monsters, and a gravestone with a face on it."

She stared at him, her head spinning. *Aliens?* she thought. *In medieval Germany?* It was unbelievable, fantastic. Was he serious? She listened as he described his evidence. Certainly it resolved his problem of the taboo, but the solution seemed even more bizarre than the original problem.

"And you think this scenario is credible?" she asked when he had finished.

"Yes, and so does Anton, I think. And he's nobody's fool."

"No," she said thoughtfully. "But then he didn't come and say it flat out, did he?"

Tom grinned. "I said he was no fool."

"Hunh. That's better left to you, I suppose. What I'd like to know is why you dragged Nagy space into it."

"That's easy. No one ever mentioned spaceships. Medieval people weren't stupid. They were having a technological revolution themselves. Camshafts and waterwheels. They would have recognized a spaceship as a vehicle of some sort, even if they thought it was Elijah's chariot. But, no. Both Dietrich and Joachim and the writer of the 1377 Bull insisted the aliens 'appeared.' Isn't that how you described hypospace travel yesterday? A single stride covers great distances, was how you put it. No wonder Dietrich was so interested in seven-league boots. And that's what Johann meant when he pointed at the stars and asked how he would ever find his way home again. Traveling the way he did, he had no idea which was his home."

" 'Appeared.' That's a lot to read into a single verb."

He held up the computer printouts. "It all ties together, though. Rope-logic, not deduction. No single strand is strong enough to support the conclusion; but together . . . A prayer attributed to Johann says there are eight secret ways to leave the Earth. How many dimensions in your hypospace?"

"Eight." The word came out reluctantly. She felt her pulse begin to hammer in her ears. What if. *What if?*

"And the religious treatise attributed at third hand to Dietrich: to travel to other worlds you have to travel inside. You used almost the exact same words. Your twelve-dimensional geometry became a trinity of Trinities. The writer mentioned 'times and places we cannot know, save by looking inside ourselves.' "

"But that really was a religious treatise, wasn't it? The other worlds were Heaven and Hell, and traveling inside meant searching one's soul."

"Sure; but the ideas weren't written down until seventy-five years later. The writers took something they'd heard at third or fourth hand and interpreted it in some familiar way. Who knows what Dietrich himself understood when Johann tried to explain it to him. Quantum physics just wasn't in his medieval *Weltanshauung*. Here." He handed her the folder. "Read through it the way Anton did and see if it doesn't make sense."

She looked in his eyes as she took the folder from him. *He really is serious,* she thought. Which, knowing Tom, could mean he couldn't come to grips

with the problem's insolubility. Or else his idea wasn't so crazy as it sounded. Give him a fair chance. He deserves that much.

She read through the items slowly and carefully, relying mostly on his English translations. The old-style German was too hard to follow, and the Latin was Greek to her. She could see Tom fidgeting nervously at the edge of her vision.

Crazy. Disconnected items. But there was a thread that ran through them. She came at last to the treatise. She recognized the ugly, angular capital.

When she had finished, she thought long and hard. Finally, she shook her head. "It's all circumstantial," she said. "No one comes right out and says they had alien visitors from another planet." The tea kettle began to whistle and she went to the kitchen and turned it off. She laid the copy of the treatise on the kitchen table, where she had dumped her own papers last night, while she searched for a morning tea.

"Yes they did," Tom insisted. He had followed her to the kitchen. "They did come right out and say so. In medieval terms and concepts. Oh, *we* can talk about planets orbiting other stars. We can talk about multi-dimensional continua. *But they couldn't*. They didn't have the words to define the words. Everything they learned had to be filtered through a *Weltanschauung* that wasn't equipped for it."

"I'm still not convinced," she said. It suddenly occurred to her that she was *not* playing Devil's Advocate. It was Tom who was advocating the devils. She wanted to share the joke with him, but decided it wasn't the right time for it. He was too deadly serious. "Everything you have," she continued, "could be read another way. It's only when you put them together that they seem to form a pattern; but have you put them together right? Why should there be any connection at all? Maybe the journal was not kept by Pastor Dietrich. There could be other Oberhochwalds in Bavaria, in Hesse, in Saxony." She held up a hand to forestall his objection. "And maybe the lightning flash was really a lightning flash, not an energy leak from a crippled hypospace craft. Maybe Dietrich sheltered Chinese travelers, like you thought. Maybe Joachim was high on ergot when he thought he saw flying demons. And copper wire and iron fixtures must have other uses than repairing alien machines!"

"What about the descriptions of the hidden inner worlds and the trinity of Trinities? Doesn't that sound like your hypospace?"

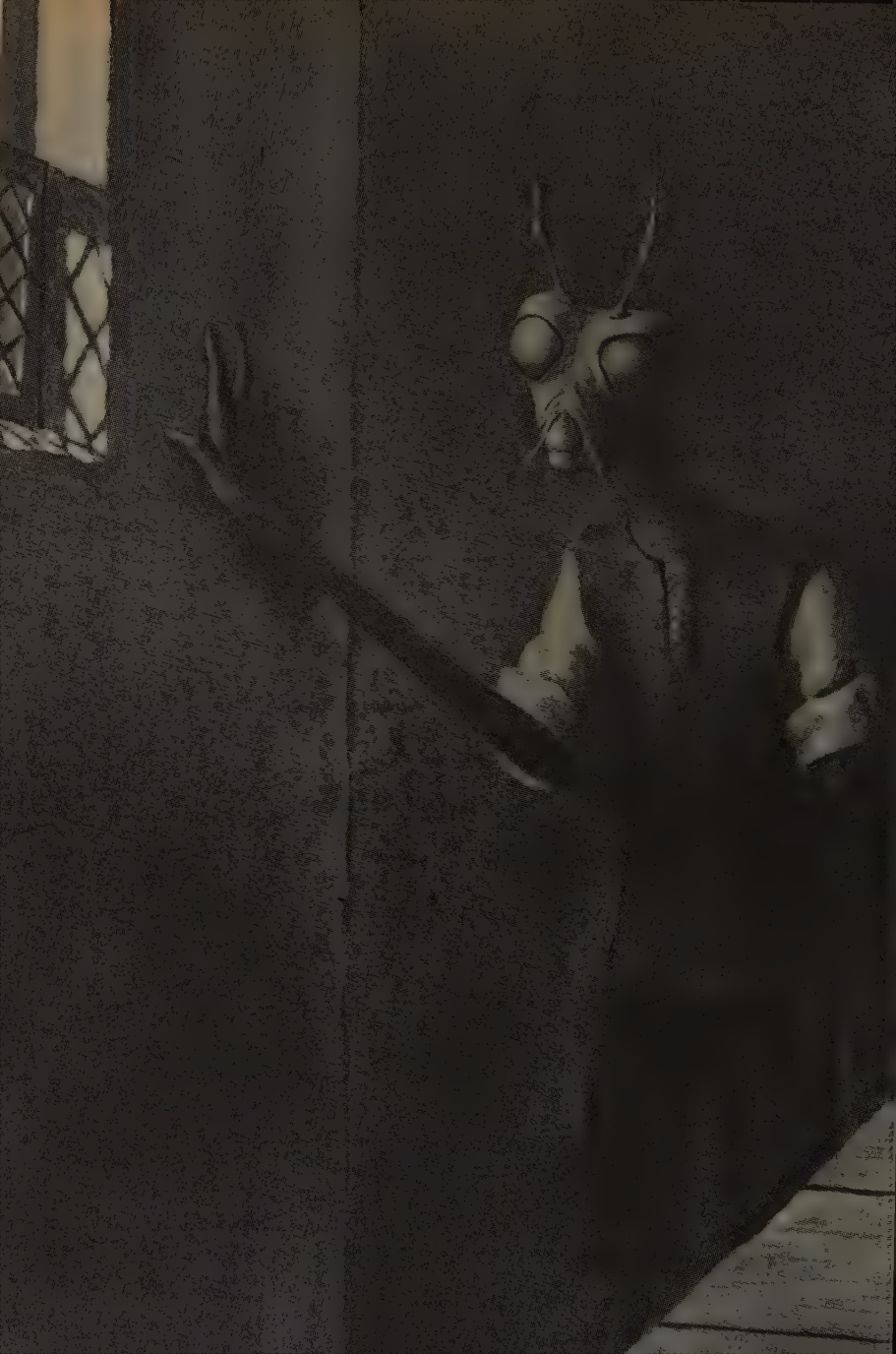
She shrugged. "Or it sounds like medieval theology. Physics and religion both sound like gibberish if you don't know the axioms."

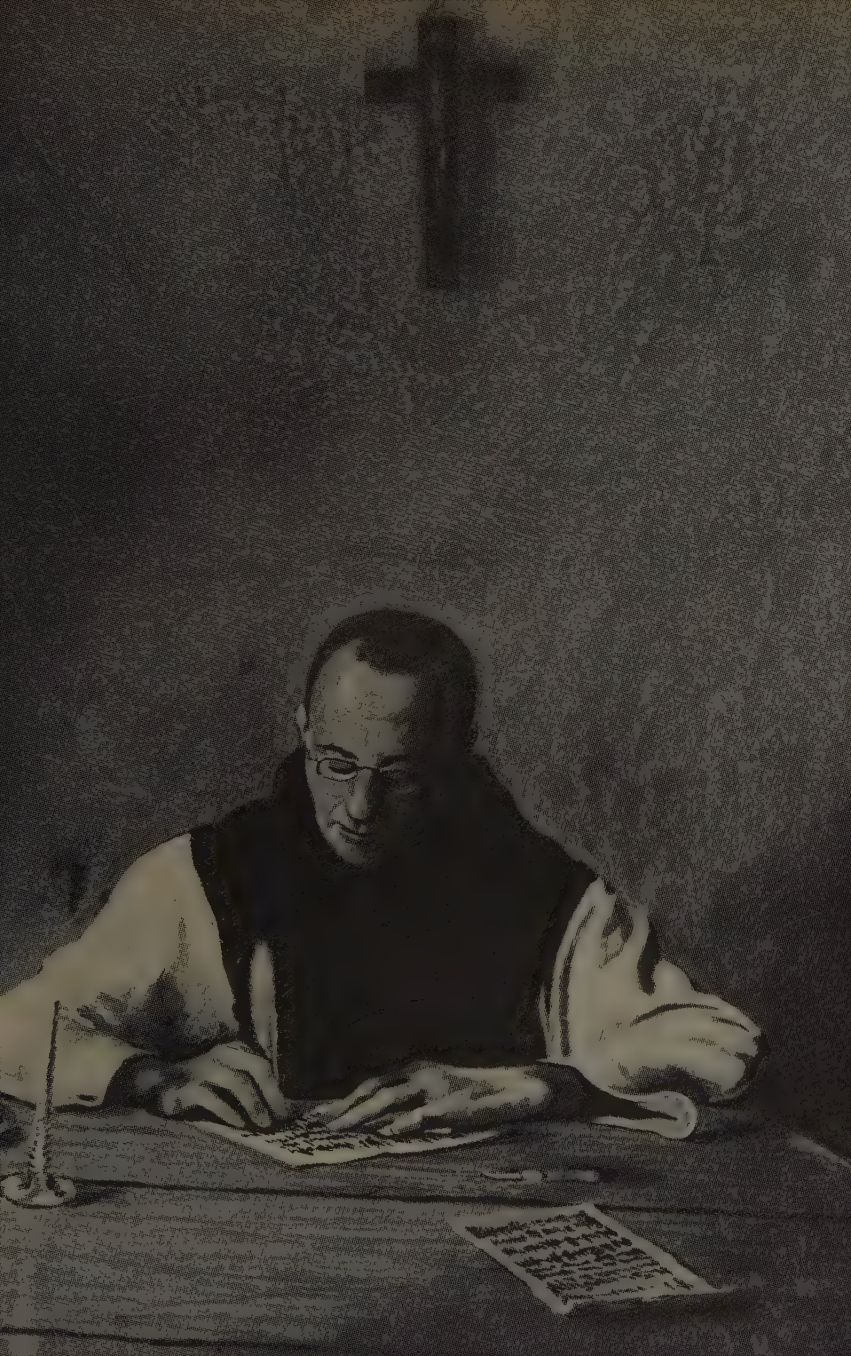
"What I find significant is the way Dietrich always refers to the aliens."

"If they were aliens, and not ergot hallucinations."

"All right," he said impatiently. "*If* they were aliens. He always calls them 'beings,' or 'creatures,' or 'my guests,' or 'travelers.' Never anything supernatural. Didn't Sagan once say that alien visitors would be very careful not to be taken for gods or demons?"

She snorted. "Sagan was an optimist. The ability to cross space doesn't make anyone wiser or more ethical. I remem-





ber, though, what he said *would* be convincing evidence of alien visitors."

"What's that?"

"A set of plans for some sort of high-tech hardware." She smiled at him and set her tea cup down on the table. As she did so, her eyes fell on the sheets spread out there. Printouts of her plans for the chronon detector. And the illuminated capital. She froze. Her throat felt tight. "Oh, my God!"

"What?" He jumped up.

"I don't believe it. I don't believe it." She grabbed the illuminated capital and waved it in his face. "Look at it. Vines and leaves and Trinities? That's a circuit diagram! Those are Josephson junctions! Tom! Hernando and I built this circuit only last week!"

Tom felt it run through him like a shot. Could it be true? He watched Sharon leaf through the printouts on the table until she found the one she wanted. She laid it side by side with the illuminated capital.

He looked over her shoulder. Were they the same? The illumination was all twisted, like a real vine, not laid out geometrically. He tried to compare them topologically, by matching the leaves and knots and berries with the arcane nucleonic symbols. Almost. There were some differences.

"Garbled in transmission," said Sharon. "That hookup is impossible," she pointed. "That's a shorted circuit. Those two should be reversed . . . wait a minute." She traced the vines with her finger. "Not all of it's garbled. A generator, not a detector," she muttered. "See there? And there? It's part of a generating circuit. It has to be. Part of their stargate. Damn!"

She had reached the bottom of the page.

"What is it?" he asked.

"Part is right. It's not complete." She frowned and walked across to the pillow sofa and threw herself into it.

Tom picked up the sheets, feeling oddly disappointed. He looked at them, trying to see what Sharon could see. It made no sense to him. "Too bad they didn't leave a complete set of plans," he said. "Then you'd know what to do."

She stared back from the other side of the living room. Tom could see her framed in the kitchen archway. "But I already know the only thing that matters."

"What's that?"

"That it can be done."

III

Freiburg-im-Breisgau has no aerodrome, so I met Tom and Judy at the Hauptbahnhof on Bismarkallee, where the magnetic train slid up from Frankfurt-am-Main. We took the Bertoldstrasse streetcar to Kaiser Joseph Strasse and walked from there to the hotel on Gerberau. I pointed out all the sights like the worst of tourist guides. Tom had seen it all before, of course, but it was new to Judy.

When we walked through Martin's Tor, she commented on its storybook appearance. The Dukes of Zähringen had founded the Freiburg in 1120, the first of the established "free towns," and this gate had been standing a century in the walls of the Old Town when Pastor Dietrich had befriended certain

travelers. The wind from the Höllental was cool, a sign that summer's end was near.

After settling them in their rooms (separate, of course), I took them to lunch at the Römischer Kaiser. We gave our full attention to the meal. No one else on earth cooks like the Schwarzwalders. Even our department store mannequins are portly. Not until the waiter had delivered the streussel did I allow the conversation to turn to business.

Tom wanted to leave for the Forest immediately. I could see the eagerness in him, but I told him we would wait for morning.

"Why?" asked Tom. "I want to see the site myself." Judy waited patiently, saying nothing.

"Because Eifelheim is deep in the forest," I said. "It will be a long drive and a hike, even if we can locate the site quickly. You will need a good night's sleep to recover from the jet lag." I took another bite of my streussel and put my fork down. "And another reason, *meine Freunde*. Monsignor Lurm will be joining us once he has received the bishop's permission. I have not, *natürlich,* told him what we expect to find."

They glanced at each other, puzzled. "What do you mean?" asked Tom.

Sometimes my friend is a little slow. "It is a Catholic cemetery, *nicht wahr?* You did not come all this way only to look. Surely you will want to exhume the grave and see who, or what, is buried there? For that we need the permission."

Tom laughed and looked embarrassed. Americans are in too much of a hurry. A single fact is worth a volume of deductions. Best to plan carefully how to find that fact. Tom would have had us on site sooner, but without a shovel.

Monsignor Lurm met us outside the hotel the next morning. He was a tall, gaunt man with a high forehead. Dressed in a faded bush jacket, only his collar revealed his calling.

"*Na, Anton, mein' Alt,*" he said, waving some papers. "I have them. We must pay the proper respect and disturb nothing but the one grave. Personally, I think Bishop Willi will be more than happy to bury this Dracula nonsense." He looked at Tom and Judy. "That's something. To bury it we must dig it up!"

I winced. Heinrich was a virtuous man, but his puns were surely earning him many years in Purgatory. I also felt guilty at deceiving him regarding what we hoped to do.

"Permit me," I said. "This is my friend from America, Tom Schwoerin, and his assistant, Judy Cao. Monsignor Heinrich Lurm."

Heinrich pumped Tom's hand. "Doctor Schwoerin. It is a great pleasure to me. I much enjoyed your paper on the gene frequencies of the Germanic tribes. It clarified greatly the routes of their ancient migrations. A good thing for you that my ancestors dropped their genes everywhere they went. Eh?"

Before Tom could respond to this latest *bon mot,* I interrupted. "Heinrich is an amateur archeologist. He has excavated many ancient Swabian villages from before the *Völkerwanderung.*"

"You're *that* Heinrich Lurm? The

pleasure is mine. I've read your reports, father. You are no amateur."

Heinrich flushed. "On the contrary. Amateur comes from the Latin *amare*, to love. I do archeology for love. I am not paid."

He had rented two Japanese pickup trucks. Two men with drooping moustaches waited by them, talking quietly. There were picks, shovels, and other paraphernalia in the bed of the first truck. When the men saw us coming, they climbed into the bed of the second.

"I think there is an old logging road that will take us close to the site," Heinrich said to me. "It cannot be too far a walk from there. I will drive the first truck. Anton, you take the second. *Fräulein* Cao," he turned to her. "You may ride with me. Since I am celibate, you will be safer that way." He grinned at me, but I pretended not to notice.

We took the Schwartzwald-Hauptstrasse into the mountains, turning off at Kirchzarten. The road began climbing as we drove into the Zastiertal. I rolled the window down and let the cool mountain air blow into the cab. In the back, the workmen laughed. One of them began singing an old country song.

"Too bad Sharon couldn't come," I said.

Tom looked at me. "No. She's working on another project. The one I told you about."

"*Ja,* the circuit diagram. That was the most remarkable thing of all. Never again will I look at a manuscript illumination in the same way. Think, Tom. Could you or I ever have recognized it for what it was? Let alone what it meant? Pfagh." He waved his hand. "Never. And Sharon? Would she ever have thought to look at it? Medieval manuscripts? No, physicists do not do such things. Only because the two of you were together could it ever have happened the way it did."

Tom looked out the window at the trees whipping past. "I know. It was the wildest sort of coincidence. Who knows what else may be out there, lying in archives and libraries, unrecognized because the right people haven't looked at it, or haven't looked at it in the right way? Things for which we've found safe, acceptable, *believable* explanations?"

A few kilometers past Oberreid the road became rough and I paid all my attention to the driving. The Feldberg loomed high on our right. Shortly, the Monsignor honked and his arm jabbed out of the leading truck, pointing left. I saw the old logging road and honked back to show I understood. I pulled the floor shift to put us in four-wheel drive.

Heinrich drove like the lunatic he was. He seemed unaware that the surface under him was no longer paved. Our truck bounced and shook and I wondered if we would lose the two workmen in the back. I silently praised the Japanese quality control workers who had helped make our shock absorbers.

The sun was already high when we reached the area where Eifelheim had once stood. There was no sign of it. I had copies of the satellite photographs in my hand, but close up things looked different. Nature had reclaimed its own, and the trees had had centuries in which to grow. Tom looked around bewil-

dered. Where had the village square been? Where the church? We might have gone past the place entirely, except that the American soldiers had thoughtfully left their empty beer cans behind.

Heinrich took charge with the ease of long practice. The rest of us fell quickly into the roles of his assistants. But then, he was a field man and we were not.

From among his equipment he took a transceiver of the kind the airlines use. In a few moments, he had signals from the NAVSTAR satellite pinpointing our location on the photograph. He made a mark on the photo and pointed with his pencil. "The church must be buried under the cruciform mound, a few meters that way. The graveyard is most likely to the rear of the chancel, though it could be to the side also."

We found the mound and split into three teams, each searching the ground in a different direction from the chancel end. It was not long before one of the workmen, Augustus, found what might have been a headstone, smashed to rubble. We could not be sure. Perhaps they were natural rocks. We resumed our search.

Judy found the grave. I saw her on my right when she stopped and stared down at the ground. She did not call out, but only stood quietly. Then she crouched down and I could not see her through the brush.

I looked around. No one else had noticed. They continued to pace forward, searching. I made my way across to where she had been and saw her kneeling next to a sunken and broken stone. Soil action had already swallowed the lower half of the stone, but it had sunk at such an angle that the face of it had been partially protected from the elements. Its outlines were obscure, barely visible.

"Is this it?" I asked quietly.

She gasped and sucked in her breath. She turned and saw me and visibly relaxed. "I think so," she said. "It's the one the soldiers found." She held up a cigarette butt to show how she knew. "The inscription is nearly illegible, but near the top I can make out '. . . H-A-N-N-E-S S-T-E—' "

"Johannes Sterne," I said for her. "John from the stars. The name he was baptised under." I looked at the face. The features were indistinct. How had the soldiers ever noticed it? Was it the face of a monster, at all? Or was some harmless burgher resting here, about to be disturbed by a bizarre chain of misunderstandings? "Do you realize how many graves there must have been?" I said. "And this is the one we find."

"I know. I'm scared."

"Scared? Of what?"

"When we dig him up. He won't be the right shape. He'll be something . . . wrong."

I didn't know how to answer her. Whatever the shape, it would be wrong in one sense or another. "Gus found another stone," I told her. "So did Heinrich. Both were smashed. Tom thinks that when the Plague swept through here the neighboring villagers came and destroyed the gravestones. Yet this one—presumably the one that most frightened them—wasn't touched. Why?"

She shook her head. "There is so much we do not know and never will

know. Where did they come from? How many were there? Were they explorers or commuters? How did they and Dietrich establish communication? *What did they talk about?"* Her face, when she turned it up to me, was on the verge of tears.

"I imagine," I said gently, "that they talked about going home and the great things they would do when they got there."

"Yes," she said more quietly. "I suppose they would have. But those who could have told us are long dead."

I smiled. "We could hold a seance and ask them."

"Don't say that!" she hissed. Her fists, clenched tight, pressed on her thighs. "I've been reading their letters and journals and sermons. They don't feel dead. They feel alive, like I know them. Anton, *most of them were never buried!* Toward the end, who was left? They must have lain on the ground and rotted. Pastor Dietrich was a good man; he deserved better than that." There were tears on her cheeks now. "As we were walking through the forest, I was frightened that I would see them, still alive: Dietrich or Joachim or one of the villagers or—"

"Or something horrible."

She nodded, silently.

"That's what frightens you, isn't it? That you are a rational, secular, twenty-first century woman who knows that aliens would look different and smell different and yet you would run screaming like any medieval peasant. You are afraid you would act like Fra Joachim."

She smiled a faint, small smile. "You are almost right, Doctor Zaengle." She closed her eyes and sighed. *"Hãy cu'ú giúp tôi. Cho toi su'ć manh.* I am afraid I would *not* act as Pastor Dietrich did."

"He shames us all, child," I said. "He shames us all." I looked around at the tall oaks and the wildly beautiful mountain flowers. Perhaps Dietrich had had a fine burial after all.

Judy took a deep breath and dried her tears. Then she said, "Let's tell Tom and the others."

Heinrich gave directions for the dig. "After so many years the coffin will have disintegrated. Everything will be filled with clay. Dig until you find wood fragments. Then we will switch to the trowels."

Gus and Seppl, the other workman, began digging out a little ways from the grave. Because the remains would have sunk over the years, they would have to dig deep. They wanted the sides of the hole to slope inward so they would not collapse.

It was already late afternoon when the digging began, but Heinrich had come prepared with gas lanterns to work into the evening. There were also tents and bedrolls. "I would not want to try and find my way back in the dark," he said.

It was only when the evening sun was setting that we discovered how the soldiers had noticed the face. The light streamed through a gap in the trees, striking the stone and throwing the carving into stark relief. Gus and Seppl were busy diging and did not see it, but Heinrich was stooped just beside it. It was a mantis's face, and it wasn't. The eyes were large, bulging, and multi-faceted. (They would have been yellow, I knew.) There were lines that might have been antennae, or whiskers, or something

else entirely. Instead of insectlike mandibles, there was a mouth of sorts. Judy grabbed my arm. I could feel the nails dig into my skin. Tom was rubbing his mouth nervously.

Heinrich paused in his work and stared at the stone without speaking. It was obvious that this was no weathered distortion of any conventional face. It was a demon. Or it was something very much like a demon. Heinrich turned and looked at us, gauging our reactions. Already the sun had moved and the face was fading. "I think," he said, "perhaps I should take a rubbing."

The moon was a ghost riding through the treetops when Seppl finally reached wood. The gas lanterns hissed and sputtered, creating a shifting circle of brightness embedded in the darkness of the forest. Judy was kneeling by the edge of the hole, her eyes closed, sitting on her heels. I didn't know if she was praying or sleeping. I could barely see the heads of the men in the pit.

Tom came and stood next to me. He had Heinrich's rubbing of the alien face in his hand. *Hans,* I reminded myself. *Not "the alien" but Johann Sterne. A person. One who died a long time ago, far from home, in the company of strangers.* What had he felt near the end, when all possibility of pretense had been lost? What emotions washed through that alien mind?

Tom pointed to the sky. "Full moon," he said. "The wrong time to dig up Dracula's grave." He tried to smile to show that he was joking. I tried to smile to show him that I knew. I shivered. It was cooler in the mountains than I had thought it would be.

Sepp called out and we all jerked like puppets. Judy came alert and leaned forward expectantly. Tom and I walked to the edge of the hole and peered in.

Sepp and Gus were standing to one side while Heinrich dug in the clay with a hand trowel. There was something shiny and smooth protruding from the earth. It wasn't white like bone, but yellow and brown. He dug around it and removed it, earth and all. He sat back on his haunches and scraped at it patiently with a putty knife, cleaning it, his own face set as solidly as any carved in stone.

He knows, I thought.

Gradually a face emerged. Gus gasped and dropped his shovel. He crossed himself hastily, three times. Sepp remained calm. He watched with narrowed eyes, nodding solemnly, as if he had always known the soil of Eifelheim would yield unearthly fruit.

It was a skull, and not a skull, and no earthly mind had ever sat within it. Soil chemistry had been at work on it, but our worms and bacteria had, for the most part, found it unpalatable. The eyes were gone, of course, and gristle hung in the two enormous sockets set on either side of the head; but whatever had served him for skin was still largely intact. It was almost like a mummy's head.

Heinrich held it out and Judy took it. Tom stood behind her, studying it over her shoulder. Heinrich climbed from the pit and sat on the edge, his legs dangling in the hole. He took a pipe from his pocket and lit it. "So, Anton. Now will you tell me what I have gotten myself into? I have a feeling Bishop Willi will not like it."

So I told him. Tom and Judy added details. Tom's attempt to explain the physics of hypospace only confused him. I think Tom was confused as well. But the rest Heinrich accepted quietly. He had dug up the skull himself, hadn't he? He looked out into the surrounding forest.

"There will be the remainder of the skeleton, of course; and others as well. You say there were several of them. And out there?" He pointed with his pipestem. "What? Shards of metal or plastic, rotted or decomposed under the living soil. Perhaps an engine or a control panel, shattered and rusted. Now that we know what to look for, finding it will be straightforward. There is much work to be done. Don't forget the cries of fraud and hoax that will surely be raised. We will need to bring others up here; tell Bishop Willi and the University people."

"No."

We all looked at Judy in surprise. She still held Johann's skull in her hands and Gus, his initial fright over, was peering at it curiously, eyeball to eyesocket. I was proud of our two workmen and their reactions. It seemed a good omen.

"What do you mean?" Tom asked her.

"You know what they'll do, don't you? They'll dig him up and wire him together and hang him behind bullet-proof plastic so tourists can gawk at him and children make nasty jokes and laugh. It isn't right. It isn't." When she shook her head, her whole body shook.

"That's not true, Judy," Tom said gently, putting his hands on her shoulders. She twisted her head around and looked up at him.

"Let them gawk and let them joke," he said. "Oh, we'll take measurements and holographs and chip off some cells for the biologists to wonder at. Then we'll make plaster casts of him and hang those. The originals? Well, those we'll keep safe from harm and someday—I know Sharon will help—someday we will find out where he came from and take him home. Or our children's children will."

Heinrich nodded, his pipe sending filigrees of smoke toward the sky. Sepp still stood in the pit, leaning on his shovel. He had his hands folded over the top of the handle, looking up where the stars shone through the canopy of the trees; and his face was a mixture of wonder and eagerness the like of which I had never seen before.

I know where the path to the star lies. The gate opened once, a long time ago, and a few wayward travelers suffered a lonely death. Then it closed. But before it did, two creatures reached across the gulf and touched. They didn't flee and they didn't fight, and because they didn't they left the gate open, just a crack. ■

● If at first you don't succeed, try, try again. If that doesn't work, look for a better solution.
Kelvin Throop III

the reference library

By Tom Easton

Ranks of Bronze, David Drake, Baen, $3.50, 320 pp.
Closed System, Zach Hughes, Signet (NAL), $2.95, 223 pp.
Jerusalem Fire, R.M. Meluch, Signet (NAL), $3.50, 332 pp.
In Other Worlds, A.A. Attanasio, Bantam, $2.95, 211 pp.
Hardwired, Walter Jon Williams, TOR, $15.95, 352 pp.
Forsake the Sky, Tim Powers, TOR, $2.95, 217 pp.
Tesseracts, Judith Merrill, ed., Press Porcepic (235 Market Square, 560 Johnson Street, Victoria, BC V8W 3C6, Canada), $9.95, 292 pp.
Eye, Frank Herbert, Berkley, $7.95, 335 pp.
Cascade Point and Other Stories, Timothy Zahn, Bluejay, $15.95, 416 pp.

David Drake, despite his fondness for violence, has shown a capacity for thought. It remains, though apparently deliberately inhibited, in **Ranks of Bronze.** He gives us a pornography of violence, in which a Roman legion, defeated by the Parthians and sold as slaves to interstellar traders, must wage low-tech war against low-tech aliens of every conceivable variety. If damaged, they are promptly repaired; they are, in fact, immortal. But they are slaves, and after a millennium or two, they decide they want to go home.

Natch, the answer is to rebel and take over the starship which ferries them from war to war. (Sound familiar? Like maybe Poul Anderson once told a similar tale?) And there the story stops, with the Romans in the catbird seat and Earth waiting on the horizon. A sequel seems inevitable.

Amid all the thud and blunder are buried several comments on the legionaires' reactions to the idea of war as a spectator sport, with them as the actors. They don't like it. There is also an intriguing contrast between the honor of

the soldier and the lack of same of the commercial traders who rule them, which makes me wonder whether Drake and Mike Resnick might not do well to get together and compare notes on the commercial pressures on SF writers (see last month's column).

There are two reasons why you might enjoy this book: 1) You *like* blood. 2) You like to watch a writer argue with himself about his own work. If neither applies, spend your money on something else.

Zach Hughes's **Closed System** is unabashed space opera. Pat Howe, owner and operator of a heavy space tug, accepts a strange assignment. He will take legitimate drugs to Taratwo, trade for jewels, pick up a passenger, and bring her back to Zede II. On the trip out, he falls in love with the star of a movie given him by his employers. On Taratwo, he meets the star, for she is his passenger. She is also the apparent consort of the local kingpin, and as they flee they must dodge warships. And then Pat succumbs to a mysterious illness.

He recovers, of course, as heroes must. He delivers his passenger and collects his pay. But all is not well. The authorities accuse him of deleting a large chunk of his voyage tapes, which could cost him both his license and his ship. Investigation of a secret memory cache in the computer reveals what was on the deleted tapes, and the hunt is on. Pat must go where his ship went when he was ill, deep into the galactic core, to find a hidden planet, a secret weapon, and imminent war. He must find as well his favorite actress and learn something of the deceptions love can serve.

If *Closed System* were a wine, I would advise you to drink it now. It will not benefit by spending another year in the bottle, for letting it age would not make it any more likely to leave a lasting impression. Yet it is a good enough wine. The bouquet is unpretentious, but it leaves a solid feel in the mouth, and one cannot ask more of a *vin ordinaire*.

"Hey!" said John Silbersack, the new SF editor at NAL. "Rebecca Meluch's books have been unfairly overlooked by reviewers. Yet she is one of those rare SF authors whose four novels have sought out a readership without benefit of the old boy's network. We'd like to see her work get the attention it deserves and I'm writing personally to encourage you to take a fresh look at these books and consider them for review."

Okay, John. Meluch's first was *Sovereign*, 1979. Then came *Wind Dancers*, 1981, and *Wind Child*, 1982. The latest is **Jerusalem Fire**, and with luck your new ad campaign for it and the older books will bear rich fruit for both NAL and Meluch. And maybe what I'm about to say will help.

When your package arrived, I decided to give Meluch a chance. I had read, but not reviewed, the *Wind* books when they first came out. Now I reread them, and I found *Wind Dancer*'s tale of Aeolis's natives, bioengineered to have three lives (one humanoid, one animal, one wind) and surviving the destruction of their civilization ten millennia ago in their wind form, quite effective. The mechanism of the destruction —a microorganism that lives by reducing any form of carbon to lampblack —wouldn't work, and the wealthy humans who have taken over Aeolis for its land—in an age of star travel—are unlikely at best, but the conflict between the aliens and the humans is well drawn. The best part of the book is the relationship between rich-girl Laure and her

bodyguard East, which leads directly into *Wind Child*, though at the cost of cheating the reader with the sudden revelation that Laure is a wind-human hybrid who can talk to Aeolis' natives.

Meluch made most of her mistakes in *Wind Dancers*. By *Wind Child*, they are background, givens, and this book is far more logical and hence even more effective. Laure and East discover that Earth's military has devised a weapon to kill the winds of Aeolis. When they rush off to give the warning, Laure is assassinated, and their adolescent son Daniel must take over their mission. On the way, he acquires a charming alien sidekick, Tavi, survives adventures, and matures. He also succeeds in restoring their world to the Aeolian natives.

With *Jerusalem Fire*, however, Meluch's writing reaches a new level of ambition and maturity. She lays out enough hints early in the story to let the reader guess her hero's past, which she reveals only late in the tale. Her aliens also lack mystery, for there too she gives away too much too soon. But the novel is still excellent.

Long after a collapse of interstellar civilization, we have the ascendant Na'ids, ideological mongrels who believe that the answer to human conflicts lies in aggressively hybridizing the species' fragments into a single race and its religions into a single faith. Their missionaries are conquering warriors, fanatical in their obedience to the dogma of human supremacy. They exterminate aliens as "rodent control," and they slaughter to bring all humans under the Na'id banner. And their greatest general is the Caucasoid throwback, Shad Iliya.

The great war is for control of Jerusalem, as is usually the case with crusaders. Shad Iliya takes the city with great bloodshed and is so sickened by what he has done that he flees the Na'ids, taking the name of "Alihahd" ("He left") and becoming their greatest enemy. He is not a killer, but a saboteur and a rescuer of refugees from the Na'id yoke, and his success ends only when his ship is shattered. Rescued, he winds up on the strange world of Iry, whose aliens, despite their apparent primitiveness, have some very technological weapons, a highly sublimated violent streak, and an extreme tolerance for others. There, his soul comes close to destroying him. In time, though, he heals, and when the Na'ids finally track him down, he is able to redeem himself in several crucial ways.

Meluch began by defining her characters—very well—largely in terms of banter. Now the key to her characters is pain, and her effectiveness is orders of magnitude better. *Jerusalem Fire* is a novel with both action and depth. If Meluch continues to improve as she has done in the last five years, she will master suspense as well as character and plot, and she will become a wondrous writer indeed.

A.A. Attanasio told us the kind of story he likes to write with his first novel, *Radix*—weird and wonderful—and he does not let us down with his second, **In Other Worlds**. It is as weird and wonderful as anyone could ask, and it has the advantages of smaller size and greater control and accessibility.

The tale begins when Carl Schirmer begins to tingle, glows, and vanishes in a burst of incandescent light, leaving his apartment bathroom a charred ruin. He comes to within the body of a sentient lake, an eld skyle, in a bubble of physical normality within the black hole at the end of time. He is there because his host had once cast a spore back into time; incorporated into Carl's body, it caused his incandescent journey into the

future, where Carl's novelty (in essence) could serve the eld skyle as food.

Drained of novelty and released, Carl finds that his new world is one of forested lumps of rock immersed in a sea of air and linked by gravitic pathways along which people can fly. Humans, however, are only one of the several sorts of people around. There are also the zotl, who hunt humans and feed on their pain.

Once Carl has acclimated, the eld skyle gives him his mission: He is to return to Earth, armed and armored by the Rimstalkers, obtain 3.5 tonnes of pig manure, and ship the manure back to the eld skyle, whose ecological metabolism needs adjustment. He must, however, watch out for the zotl who will follow him to conquer Earth, and he must take care never to lose a drop of blood, for his blood contains spores of the eld skyle that can, if they reach other humans, ship them too to the end of time, and too many arrivals will swamp the eld skyle.

Attanasio fleshes out these bare bones with the aid of Carl's friends on Earth. He has to leave them behind when he makes his initial journey, of course, but he meets them again, even though the Earth to which he returns is not quite the one he left. He rescues his writer friend, Zeke (who has intuited virtually all of Carl's adventures to date) from an insane asylum, sets up the drunken Caitlin and her enticing daughter Sheelagh for life, fights off the zotl, and sheds enough blood to make him very intriguing to the government. More than that I dare not say for fear of spoiling your fun.

I suspect the eld skyle stands for the writer, who requires periodic infusions of the earthiest of matter, whose food is novelty, and whose spores, cast to the winds of the cosmos, can bring new souls to the writer's trade. My suspicion is reinforced by Zeke's role in the tale, but the clues are not blatant and I may still be way off base. Read the book for yourself, and see what you think.

With **Hardwired**, Walter Jon Williams joins the ranks of the "cyberpunks," those writers who look to a grittily decandent future when people of all sorts plug themselves into computers to control machines, manipulate data, shape the world, and blow their minds. Williams, however, offers something more than adventures in computerland. For him, the brain-computer link, mediated by neurotransmitters, is but one thread in an intricate social tapestry. The decadence is there, expressed largely in Williams's vision of widespread abuse of bodies and neurotransmitter-based drugs, but there is a strong sense of desperation behind it. There is also a strong, active plot, premised on Earth's role as a bigger-than-ever Tangiers of the sort spy novelists have made a myth of our time.

The world's biggest corporations have gone into orbit and proclaimed their political independence of Earth in the infamous "rock war." Earth's nations, including a Balkanized America, are the exploited, second-rate victims of neocolonial imperialists. And its people are both mad and envious. We see the envy very clearly in the assassin Sarah, who dreams of lifting herself and—especially—her weakling, prostitute brother into orbital heaven. Yet though she does what her masters demand, she is treated without honor; the bomb intended for her smashes her brother instead, and all the money she has saved must go to heal him.

Cowboy, the wartime jet jockey who now runs orbital contraband across North America in armored ground vehicles,

shows us the anger. As he realizes that the lords of space are in command of the underground *and* the overground, manipulating both for their own benefit alone, he resolves to turn the tables. He meets Sarah, they are betrayed on a contraband run, they make their way to his base in the West and become lovers, and they find methods with which to strike back. There is intrigue with the aid of Reno, the man who has been absorbed into the world's computers. There are financial plottings with Albrecht Roon, the fallen villain who wants to regain his position as head of the worst of the orbital corporations. There are home-built fighter jets, piloted by the hopeless survivors of the last war's forces.

There are even attacks on landing shuttles that send them and their cargoes—a viral cure for a disease manufactured in orbit—crashing to the ground. The book thus could not be more apt for a 1986 marketplace, for it reminded me of my own speculations when the *Challenger* blew—Might it have been sabotage? A Libyan with a small rocket, or even a sniper rifle? I'm sure the publisher must have been tempted to put a shuttle crash on the cover; it is to his credit that he did not.

Tim Powers seemed to burst full-blown upon the SF scene with *Anubis Gates*. I was thus a mite surprised to find his **Forsake the Sky** in my mail. This one first appeared in 1976 as a Laser Book (*The Skies Discrowned*). For 1986, Powers revised it, but it remains an early novel, a glimpse of the writer in embryo. And if it does not show his later power and richness of imagination, it does show his verve.

The premise is an interstellar civilization in such decline that swords are once more popular. A palace coup hurls young Frank Rovzar, a painter, into the world of thieves beneath the city of Munson. There, thanks to his native intelligence and strong sword arm, he rises to be king of the thieves and overthrow the usurpers.

Not great SF, but fun.

Judith Merrill edited her nineteenth anthology nearly 20 years ago. Her twentieth, at long last, is **Tesseracts**, a display of SF prose and poetry by Canadian natives and residents that is well worth seeking out.

A few of the contributors are familiar. Spider Robinson is here with "God Is an Iron;" Michael G. Coney with the absurd "The Byrds," William Gibson with "The Hinterlands," Phyllis Gotlieb with "Tauf Aleph," and A.K. Dewdney with the introduction to his *The Planiverse*. Most of the rest are new to American readers, some because they write in French, some because they rarely (to my knowledge) appear south of the border. Of the book's 32 selections, 17 appear here for the first time, at least in English. I especially commend to you Elisabeth Vonarburg's "Home by the Sea," a warm tale of human decline and replacement, and David Kirkpatrick's "The Effect of Terminal Cancer on Potential Astronauts," which shows us the ultimate global village and its impact on human drive. Of the rest, a few fail to impress greatly because they reprise themes that have been vastly overdone (e.g., Gerry Truscott's "Cee" and Lesley Choyce's "The Loneliness of the Long-Distance Writer") or because they tend to the excessively literary (e.g., Marc Sevigny's "The Train" and Gary Eikenberry's "Anthropology 101"), or both. However, not one is a dog, and you could spend your money in much worse

ways. With luck, a U.S. publisher will bring it out soon as a lower-priced, easy-to-find paperback.

Frank Herbert is gone, and his grandest creation, the world of *Dune*, has come to an end. Yet the work is not buried with the man, and his books will remain on the market for years to come, even if no more await their first publication. They are his legacy to readers everywhere, and his memorial.

One book in particular may serve as his best possible memorial. It's **Eye**, one more of Byron Preiss' Masterworks Editions, and if it lacks some of the personal touch of prior Masterworks, there is still an essay reminiscing on the making of *Dune* the Movie. There is also a walking tour of Arrakis, text by Herbert, art by Jim Burns, and a dozen stories drawn from three decades of writing. There is an excerpt from *Dragon in the Sea*, a couple of Jorj McKie saboteur yarns, and plenty more with which to remember Herbert.

Herbert's most distinguishing characteristics may have been his attention to detail and his depth of imagination. That was the secret of *Dune*'s appeal, and we see it again and again in this book. He was not a dazzling writer, given to stylistic or technological pyrotechnics, and in that way he was one with the Golden Age writers: Pohl, Williamson, Heinlein, et al. He was in love with ideas and their consequences, and he conveyed that love to us all, in the process helping to convert thousands to love of SF.

Timothy Zahn, like Herbert, loves ideas, but there is a difference Zahn seems to share with many modern SF writers—the ideas are smaller, of lesser sweep, though the events they inspire may sprawl over as vast an interstellar realm. This is a consequence of more attention to character, to individuals, to matters of soul instead of destiny, but it is nonetheless real, and I urge you to look at Zahn's **Cascade Point and Other Stories** for proof of my point. Here Zahn brings together fifteen stories. One ("Not Always to the Strong") is new; most of the rest, I think (there are too few credits), appeared in these pages, from "The Giftie Gie Us" and "The Cassandra" to the title story. Together, they give us, in Zahn's words, "five years of style development as I've slowly grown from semi-rank amateur to at least journeyman status in this field. . . ." ■

● It does not take long in terms of human history to *devise* a tool that soon becomes widespread. What takes time is learning the different contexts into which the tool can be fitted.

Jerome S. Bruner

(continued from page 78)

lions of kilometers roll by, but stop your ship one second too late, and you'll have trouble finding your by-passed target.

Once you get to the target planet, you must search for a landing sight by orbiting the planet. This was a bit tricky since it seemed all-too-easy to go crashing into the planets. (Ooops!) And if you're on a planet's dark side you won't see the planet at all. I was right next to Mars once and I wondered where it was.

Eventually you'll receive an indication that you've located the landing sight. Landing is automatic, activated by simply pressing the "A" on the keyboard. Upon landing, you are presented with a picture displaying a suitable planetary terrain. (Birds and a lake on Earth, red rocks on Mars, etc.) And you are told to return to the comet to complete the mission.

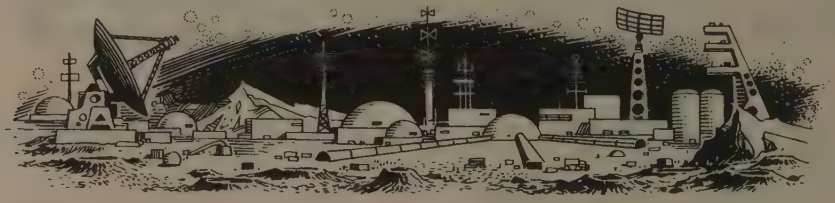
While reaching the speeding comet can be difficult, it's rather exciting to zero in on Halley from 5 million miles away and watch it gradually grow larger, as you correct your heading and aim right for it.

Now, you might be wondering, what do you do if you don't know your constellations. Mindscape thoughtfully includes a strip that displays all the relevant constellations so that, with a bit of judicious checking, you can find the constellation you should use for a directional heading. And, wonder of wonders, it gets pretty easy after a while.

Some knowledge of astronomy is helpful. My second mission directed me to land on a planet with no moons. No sweat, I thought, as I went to Mars and landed. Unfortunately, the game does not suffer fools gladly and I was told to go to a planet with no moons. (Mars has moons? Oh, well.) Venus wasn't too far away.

All the missions are timed, and after feeling like a 12-year-old at the steering wheel of a classic Corvette, you eventually learn to pilot your ship with some degree of expertise.

And, needless to say, a good deal of enjoyment. ■



● Some problems do not get solved, they only get older.

Dr. Chaim Weizmann

brass tacks

Dear Dr. Schmidt,

I know this is an issue that you probably are sick unto death about, but for some reason this morning as I ate my toast, it all came up again for me and I feel the need to put one last volley your way.

The problem of the treatment of women in *Analog*. The perceptions of apparently more than a few people is that *Analog* is not a sterling example of enlightened attitudes. I know that periodically I go so far as to tell myself I won't renew my subscription because some story is particularly offensive (coming from someone who usually buys three years at a time and has never cancelled a subscription in her life—well, perhaps you can see the extent of my distaste).

But what I want to put to you is this. A test. It's the one I used myself back when I was 18 years old and first started caring about this stuff.

Whenever you have a character who is female—*change the gender to male* and see how your gut reacts to the language. I guarantee you it will open your mind to what all these upset people are writing you about. Can you honestly say you would accept a 30-year-old man being called a boy—yes, yes, I know there are exceptions. I don't want to cloud the issue. Ninety-nine per cent of the time that women are called girls it would be impossible for a writer to naturally write the same sentence calling a man a boy.

My other analogy that helped me get my own act straight on this was to change the race and gender—and make the character a black male. Now how do you feel about calling him a boy? What got me started this morning on this was fantasizing that all the women in all your issues were black men, being denigrated by being called "boy" with

all the other Old South (actually, New South and more's the pity) speech mannerisms and attitudes thrown in for good measure. How many public and private organizations would be on your tail day and night? How long do you think you'd stay in business nationally?

Anyway—I had meant this to be a short note. I got carried away. But truly—will you try my test? Just on one story—a short one even. Listen to your gut reaction. *Can you accept a grown man being called a boy*. Then ask yourself why it's all right to call a grown woman a girl. The answer isn't very pleasant—I know from personal experience. It was and is a terrible battle for people, steeped in it since childhood, to make their way to full and responsible adulthood. Ask any woman. Ask any black.

GALE WALLIS

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The test you suggest is always worthwhile for an author to think about, and I explicitly recommend it. However, I can't insist that every story pass the test in exactly the way you want—partly because I'm unwilling to impose all my preferences on a story appearing under someone else's byline, and partly because doing so would make our overall composition more propagandistic than realistic. You and I might like to see society make that small a distinction between its attitudes toward men and women, but historically few societies have actually done so. I see no reason to assume that all future societies will either (though it would be nice to see more convincing portrayals of some that do). Writers might take that parenthesis as a suggestion; meanwhile, if a particular story bothers you, I'd suggest that you let the author *know how you feel. We'll cheerfully forward any letter addressed to any of our authors %* Analog, *380 Lexington Avenue, New York, NY 10017.*

I've discussed this problem (or complex of problems) in more detail in a recent editorial (Mid-December 1985), which I hope you'll read and consider carefully. I also recommend F.M. Busby's comments on that editorial in the May 1986 "Brass Tacks," which adds some eminently sensible advice for both writers and readers. Busby's letter in turn led to the following, containing still more thoughts worth careful (and cautious) consideration.

Dr. Schmidt:

F.M. Busby states ". . . both writers and readers should pay more heed to intent, and less to nitpicking about okay words." (Brass Tacks, May 1986)

How does a writer convey intent to a reader if not by the choice of words? How can a reader evaluate the intent of the writer if not by evaluating the connotation and the denotation of the words that the writer chooses?

Written communication does not provide the opportunity for questions, clarification, and other nonverbal feedback that is inherent in oral communication.

A writer has no way to convey either information or intent other than words, the organization of those words, and the media in which the words are published. The writer must therefore know the intended audience and select the words carefully to convey meaning and intent to that audience.

The reader seldom has anything other than a copyright date and the context in which the words are printed to provide clues concerning the author's intended audience. Occasionally (in a collection) an editor will provide the reader with supplementary information, but this is an exception.

For the most part, it is the words themselves which will guide the reader in forming conclusions.

D.J. ELDEN
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Santa Barbara, CA 93103

You make an excellent case for the importance of writers' thinking carefully about what connotations readers will see in their words—but readers have a concomitant obligation to be very careful about what connotations they read into words. In practice, the writer is not addressing a homogeneous "intended audience," but a hundred thousand individual readers, no two alike. The best he can do is try to anticipate how most of them will interpret what he says—and even if he succeeds with most, he will still run into exceptions. (If you should happen to get many letters in response to yours, you'll probably be astounded at how little some of them have to do with what you thought you wrote, even though you wrote it very well.) Readers need to be aware of this effect and make allowances for it. Before getting too upset at something you think an author implied, ask yourself if you're sure *he meant it that way. To borrow an example from the previous letter, "girl" (to a much greater extent than "boy") has long been in general use to refer to a young adult,* not necessarily with any pejorative connotations. *This usage may, as Ms. Wallis suggests, have historically sinister origins, and a good case can be made for trying to phase it out. But that hasn't been fully accomplished yet, and many people, unaware of "sinister origins," have used and still use "girl" with completely innocuous intent. It's wrong to assume that their motivations are at all similar to those of a Klansman saying "boy"—though writers should bear in mind that times have changed and some usages are no longer as widely or readily accepted as they used to be.*

I'd like to see more English courses (which presumably teach communication) stress the dual responsibility of writers (to say carefully what they mean) and readers (to read carefully what was written). Unfortunately, too many seem to do just the opposite on the reader's end. I've seen literature courses encourage and indeed require students to read the most outlandish things into a story or poem, sometimes to the express astonishment and dismay of the author.

Yes, it is the words themselves that will guide the reader—along with a whole set of his own explicit or implicit assumptions. *The more of those he is conscious of, the better for all concerned.*

Dear Stanley Schmidt:

This letter concerns G. Harry Stine's August 1983 Alternate View column entitled "The Sky is Going to Fall," as well as the explosion of the space shuttle Challenger on January 27, 1986. If this letter gets printed, it will be months from now (I'm writing this four days after the event), and it will be interesting to see how things really turn out for the future of the US manned space program.

The shuttle explosion was very nearly the worst possible spaceflight tragedy any way it is examined. The shuttle's external fuel tank (the very large, central part of the unit during takeoff carring liquid hydrogen and liquid oxygen) exploded just over a minute after takeoff. Considering that this tank provides fuel for the twenty minutes or so (I don't know the exact time) that it takes to get into orbit, it was over ninety percent full when it exploded. This apparently caused complete destruction of the shuttle. The

disaster could only have been worse if it had crashed on land.

All seven people on board were killed, which is the highest number of deaths in any single spaceflight-related accident. One of these was a high school teacher, the first civilian or "ordinary citizen" to go into space, making the deaths even more tragic.

Since space shuttle flights had seemingly become so routine (this was the twenty-fifth flight), none of the three major TV networks showed the launch live. But within minutes of the disaster, all the networks were showing replays of the disaster, and they continued showing it all afternoon in between speculating on what went wrong. President Reagan postponed for a week his State of The Union speech scheduled for that night, and has made statements that the manned space program would continue once the cause of the accident was determined and fixed, and that more civilian volunteers will continue to go into space. Other officials have made similar statements, some also saying the shuttle will be replaced.

I have yet to hear a statement from any congressman or public official or in any news editorial that the manned space program should not continue. This is in contrast to Stine's Alternate View column, in which he states that the media and others will find much fault in the space program, and attempt to destroy it by swaying public opinion against it. While I haven't seen this happening, that doesn't mean it won't. Some hard questions about the manned space program will definitely be asked over the next several months and years. Despite positive statements just after the disaster, the manned space program is in serious doubt. Those of us who believe strongly in the future, that the future of mankind depends on the development of space, need to have the right answers—good, justifiable reasons why the US manned spaceflight is so important and must be continued.

BEN BRADLEY
2930 Lake Colony Drive Apt. 9
Norcross, GA 30071

The Editor,

An ancient Irish hero opted for a short and brilliant career instead of a long and insignificant life. The crew of the Challenger did the same. They are gone, but definitely they are not in the company of cowards.

JOHN P. CONLON
Newark, OH

Dear Dr. Schmidt:

The enclosed idea is popular with a lot of folks here and perhaps it will strike a chord with you. It seems unlikely that there is an unnamed 14,081-foot peak in the Sangre de Cristo mountains, but it is possible. There are other unnamed features there. There are something between 53 and 60 peaks over 14,000 feet in the state (the debate continues).

Perhaps the bill in the House to get the L5 Society to build a Challenger monument could be modified to include putting that Monument on Challenger Peak. It would be more fitting than putting it in a traffic circle in downtown D.C. Those people were exploring the unknown. Also the pigeons do not frequent Challenger Peak.

Speed is not essential on the feature naming effort as such matters have a very long fuse. The agency gets little enough mail that any outpouring of correspondence should suffice. It sure beats naming a feature after a dead politician. (see the change of the name of Mt. McKinley to Denali, an Indian name meaning The Great One).

Anyone going to such a monument

would have a chance to show dedication and perhaps a bit of blood, sweat and, yes, even tears. Eagles live there and you can see the stars ever so well. It is as easy to get to as D.C. and safer.

Thanks for your time.

DAVID H. HANNAH
Prexy Pikes Peak Chapter L5

The clipping with this letter described a movement to name a previously unnamed Colorado mountain "Challenger Peak." The matter may already be decided by the time you see this, but in case it isn't, the article suggests that anyone wishing to support this idea write to Donald J. Orth, Executive Secretary, U.S. Geological Survey Board, National Center 523, Reston, VA 22092.

Dear Stan,

I'd like to take a crack at David Brin's question: "How does one answer a question like that?" Or in essence, how do we measure nonhuman intelligence using tests designed by/for human intelligence and environment?

There is a universal test: survival. Intelligence is a survival mechanism, and if it doesn't aid in survival, it doesn't evolve. (The preceding, is of course, a statement of faith—disprove it and the whole argument goes out the window.)

The environmentalists wail and moan because so many dolphins are caught in tuna nets. Such stories have been very frequent in recent years. More to the point, they didn't decrease over time (except as the media lost interest, of course).

If members of an intelligent species with a communication system are being killed in large numbers, eventually one will escape by accident or design. That knowledge will be communicated to others, and the knowledge of additional escaping individuals will be added. Eventually most individuals will know how to avoid the danger. In the case of the tuna net, the knowledge needed is that one jumps completely out of the water at a certain time and in a certain direction.

Some of the people I have suggested this idea to over the years have come back with "But the nets are so fine that they cannot be detected with dolphin sonar." This is true, but human beings, at least, can stop from being killed even if they can't see the menace. Diseases and naturally occurring poisons, both gaseous and other, come to mind. In the case of the nets there would be other clues, such as the position of the boats and the strange behavior of the fish.

In short, the answer to David's question is: "because they don't survive in their environment as well as we do in ours."

BRIAN L. BURLEY
177 Main St., #295
Ft. Lee, NJ 07024

Your equation of intelligence and survival seems to me simplistic, to say the least, and I expect it to generate lots of heated response. But then, I suspect that's what you want—and the resulting fray should be interesting to watch. You provided the bait; the least I can do is hang it up.

Dear Dr. Schmidt:

Some thoughts on David Brin's editorial in the April issue: it seems to me that Brin has a valuable viewpoint for thought. I found myself in agreement with most of what he said, because it fits my own experience extremely well. Should we pass beyond the Doctrine of Otherness, as he suggests at the end? It seems to me that diversity of thought as a cultural phenomenon is a great force for protecting freedom as well as an important tool for scientific and philo-

sophical inquiry. In that respect, I think that we not only should be proud that it has become an American cultural tradition, but also thankful. At the same time, we need to be cautious and skeptical about the validity of some of these viewpoints which may arise. Without explicitly saying so, Brin warns at the end of his editorial about the dangers of accepting without critical analysis alternative viewpoints when he talks about how propaganda concerning the human relationship to the animal kingdom and the environment is wrong. In this case, Brin says the propaganda is a good thing, and he is right, but in other cases, like creationist propaganda, accepting too easily alternative ideas can cause the erosion of our intellectual landscape. I want to praise you for publishing Brin's essay. It is a very useful, thought-provoking piece of work.

CLINTON LAWRENCE

Rescue, CA

Dear Dr. Schmidt:

It certainly looks as though Mr. Lunan has a good answer to the Fermi paradox. I remember well the disappointment I felt when I learned of the long term effects of cosmic rays. Granted, they don't make space travel or colonization impossible. But when the smallest interplanetary ship needs perhaps a thousand tons of radiation shielding (and that's for a very claustrophobic one man ship), the threshold for private colonization of space is considerably raised.

Of course, all this is contingent on the non-replacement of brain cells. That's something which raises problems even for the ground bound.

Now, if the Daedalus project can depend on advances in robotics AI, and plasma physics, then I think I'm not out of line in expecting similar advances in biological engineering. I firmly believe that once we get a handle on biological engineering, we can make changes so that people won't need radiation shielding in space, except maybe during really bad solar flares. Not only would this make the ships faster, but major alterations in human physiology would also free us of dependence on gravity, and enable us to hibernate during long trips. All in all, a much better solution than lugging around megatons of rock. Start making your wish lists. I'm looking for this to happen within the next hundred years or so, and almost certainly before our first interstellar ship.

BRETT PAUL BELLMORE

8750 Burt Rd.
Capac, MI 48014

Dear Stanley Schmidt,

I enjoy my subscription to *Analog* and wouldn't be without it. While I don't always agree with your authors' viewpoints, I do enjoy the variety of ideas they provide. I know that science *fiction* is fiction, but an author is expected to do the proper research so that the fiction part of the story, even a minor element, can reasonably be extrapolated from the knowledge available when the story was written. I think Robert F. Young's story "Cousins" (April, 1986) shows poor research and I do think that you, as editor, should have questioned it. Let me quote: "The library has no aisles of books I can hide among. There are only naked cabinets of micro-films." The story is set sometime in the latter half of the 21st century. The Library of Congress is *currently* working with the private sector on preserving materials for the future with laser disc technology. Indeed, several reference works are already available from their publishers in CD ROM format. It will not be long before bibliographic databases, such as

those offered by DIALOG or BRS, will be available in this format. Cabinets of microforms (fiche or film) for the storage of most materials will be as common in the year 2000 as dinosaurs.

The second thing that rankled about this particular story was the portrayal of the librarian with a bun in her hair. Since the rest of the story does not seem to indicate that hair buns were all the rage of fashion in the 21st century, why perpetuate such an antiquated sterotype? I will admit that at national conferences of librarians, in scanning a group of 500 or so, I will spy three or four hair buns. I would suggest though, that librarians gave up their hair buns about the same time as the rest of the female population. Among the librarians I know personally, none has a hair bun, although several have beards.

KAREN FISCHER
President, Montana Library Association

Dear Mr. Schmidt,

I have come to expect this from you humans. I am referring to Spider Robinson's "The Mick of Time" in the May issue.

Do you really think that a race that can augment a puny being like Mickey Finn would not have provided themselves defense against as tiny a power as your nuclear explosives? I appreciated the blast, it relieved an itch I had below my left second leg.

The only reason I have not sterilized your sorry little green planet is that I am working with my relatives to help them develop into the superior species they are. They will soon replace you as leaders of the Earth, and I will enjoy watching you squirm under their magnanimous benevolence. Of course, they will never reach the level of even my great-great-great-clutch ancestors, but they will exceed your minuscule potential in only five or six years.

Oh, and Jake. I have had my protégés visiting your "Place." They especially enjoy the "throw the glasses in the fire" routine. Unfortunately, susceptibility to alcohol is a problem in superior races, as well as yours.

JOHN D. STANLEY
"The Beast"
Syracuse, NY

Dear People:

Spider Robinson is the best speculative fantasy writer on the planet. It takes balls to write about beings sixty times smarter than us, but it takes brains to write about someone skiing through a revolving door.

PHLIP PLUMLEE
1031 Wood Rd.
Oakford, Pa., 19047 ■

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Samuel Johnson, *The Idler* (1758)

a calendar of analog upcoming events

22-28 September
POLCON (Polish National SF conference) at Warsaw, Poland. Western fans encouraged to attend. Info: Richard Jasinski, 70 351 Szczecin, ul. Bol. Smialego 14/16, Poland.

31 October-2 November
WORLD FANTASY CONVENTION at Biltmore Plaza, Providence, R.I. Guests of Honor—Ramsey Campbell, Charles L. Grant, J.K. Potter. Registration—$45; NO memberships at the door (limited to 750 attendees). Info: 12th World Fantasy Convention, Box 3251, Darlington Branch PO, Pawtucket RI 02861.

31 October-2 November
NECRONOMICON '86 (Tampa SF conference) at Tampa Airport Inn, Tampa, Fla. Guest of Honor—Frederik Pohl. Registration—$10 until 1 October. Info: Stonehill S.F. Association, Box 2076, Riverview FL 33569.

7-9 November
SCI CON 8 (Tidewater area SF conference) at Sheraton Beach Inn, Virginia Beach, Va. Guest of Honor—C.J. Cherryh, Artist Guest of Honor—Mike Kaluta, Fan Guest of Honor—Marty Gear, TM—Allen Wold. Registration—$15 until 1 October, $18 at the door. Info: Sci Con 8, Box 9434, Hampton VA 23670. (include S.A.S.E.)

7-9 November
ORYCON '86 (Portland area SF conference) at Red Lion Inn, Portland, Ore. Guest of Honor—Edward Bryant, Editor Guest of Honor—Jessica Amanda Salmonson, TM—George R.R. Martin. Registration—$17 until 31 October, $20 at the door. Info: Orycon, Box 5703, Portland OR 97228. (503) 283-0802

14-16 November
WINDYCON XIII (Chicago area SF conference) at Hyatt Regency Woodfield, Schaumburg, Ill. Guest of Honor—Harry Harrison, Editor Guests of Honor—Donald and Elsie Wolheim, Artist/Fan Guest of Honor—Arlin Robins, TM—Marta Randall. Registration $15 until 1 November, $20 thereafter. Info: Windycon XIII, Box 432, Chicago IL 60690.

28-30 November
LOSCON 13 (L.A. SF confderence) at Pasadena Hilton, Pasadena, Calif. Guest of Honor—John Brunner, Fan Guests of Honor—Bruce and Elayne Pelz. Registration—$17.50 until 31 October, $20 at the door. Info: Los Angeles Science Fantasy Society, Inc., 11513 Burbank Blvd, North Hollywood CA 91601. (818) 760-9234.

27 August-2 September 1987
CONSPIRACY '87 (45th World Science Fiction Convention) at Metropole Hotel & Conference Centre, Brighton, U.K. Guests of Honor—Alfred Bester, Doris Lessing; Fan Guest of Honor—Joyce and Ken Slater; Artist Guest of Honor—Jim Burns, Special Fan Guest—David Langford Registration —Attending (until 30 September 1986)L25, $40, $A50; Supporting L10, $15, $A20. Info: ConSpiracy '87, Box 43, Cambridge CB1 3JJ, England, U.K. OR Bill & Mary Burns, 23 Kensington Court, Hempstead NY 11550 OR Justin Achroyd, 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

Items for the Calendar should be sent to the Editorial Offices six-months in advance of the event.

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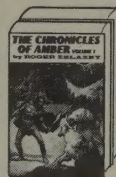

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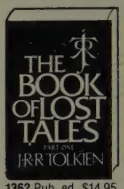

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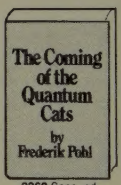

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