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Destinies

Edited by **JAMES BAEN**

THE SCIENCE FICTION MAGAZINE

ALL NEW!
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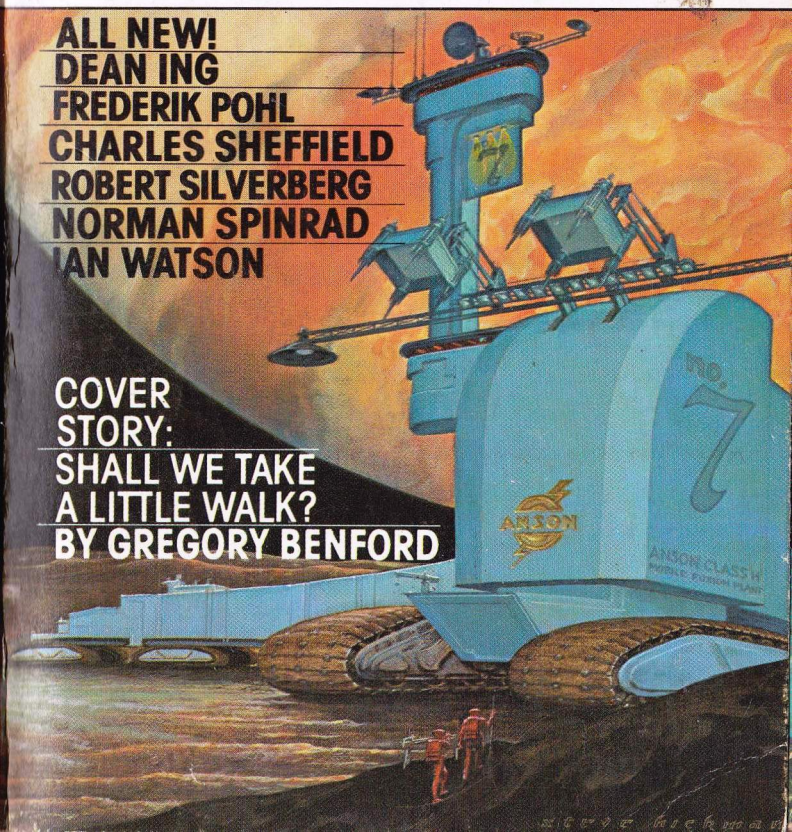
COVER STORY:
SHALL WE TAKE A LITTLE WALK?
BY GREGORY BENFORD



WELCOME

to this the Summer 1981 issue of Destinies. Our cover story, "Shall We Take A Little Walk" is by Gregory Benford, and it examines one of those magic moments when an era is transformed. The leading figures in the play are of course as heroic as ever. Also we have "Travellers," by David Drake, which suggests a way chrononauts might both pass for natives and enjoy the benefits of a higher technology. Ian Watson takes on the Deity, such as It is; Richard Sean McEnroe takes a look at some *really* interactive gaming (look for Rich's newest novel coming soon from Ace); Eric Vinicoff shows us the true poignance of the endless carving away at the Space Program; and, last but far from least, Kevin O'Donnell Jr. makes you shed a tear or two, for Emily.

On the non-fiction side, it couldn't have worked out better: Robert Silverberg examines the mechanistic basis of human behavior in "Humans as Machines: the Ideas of Edward O. Wilson," and James Hogan comes right back with "Mind, Machines and Evolution," which looks at the possibility of machines that act like people. Also Fred Pohl tells how to make a living predicting the future, and Dean Ing continues his lessons on how to survive it. . . .By the way, Dean was able to afford to do the research for the *Nuclear Survival* series only because it forms the basis of his blockbuster new novel, just delivered to Ace, *Systemic Shock*.

Next issue Charles Sheffield gives it to you with both barrels. In the cover story, "Summertide," he takes the concept of the skyhook, on which he shares a literary patent with Clarke, one step beyond. Then, in concert with Japanese astrophysicist and Aikido instructor Yoji Kondo, he takes the subject of Astronomy *several* steps beyond. You'll be amazed at what could be seen with a ten-mile-wide orbiting optical telescope; what the *big* stuff will do is boggling. Plus, of course, we'll have our usual *potpourri* of everything interesting, by our usual team of sf's greatest. See you then.

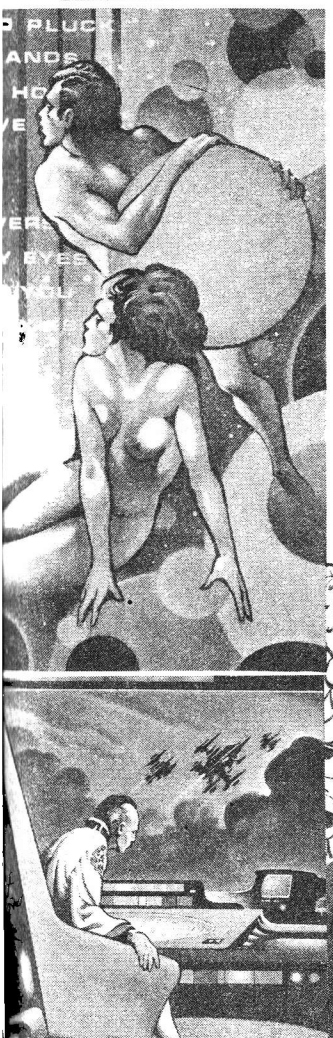
—Baen

TABLE OF CONTENTS

FICTION

SPECULATIVE FACT

Destinies



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SHALL WE TAKE A LITTLE WALK?

by Gregory Benford

No man is a hero to his rival— but Yuri was special!

Salutations! I am asked to recall certain events of my youth. This recording is made solely for historical purposes; any commercial exploitation is forbidden by the Laws covering the Plentitude of the Artifact.

The distant time I shall describe will seem odd indeed, to those not schooled in such matters, so the Hosts have asked me to permit a cerebral tap. I am told this will enable this ferrofax to plumb my dim, distant past directly. Delicate magnetic fields will probe the ancient cells of my cortex and coax forth the Matt Bohles who still lives on there.

Yet another wonder! The Historiographers have many tools. I need hardly point out, I hope, that the tap is yet another device we have gained from the Plentitude.

Before the tap begins, I remind you that my youth was spent on a Ganymede vastly different. As our shuttle ship dropped toward the surface, the young Matt Bohles gazed down upon blue ice, and frost that clung to the poles. At the equator was a thick belt of bare brown rock. Rivers sliced across the vast plains, cutting through the rims of ancient icy craters. The carved valleys were choked with a pale ruddy fog, and naked peaks jutted above them.

The Ganymede atmosphere building had just begun. A group of us was sent down for both relaxation and training. We had been in the orbiting laboratory—the Can—long enough. Sadly, Jupiter exploration was being cut back. There was open competition for the remaining permanent posts. Soon the *Argosy* would sail for Earth, and those who did not qualify would go on her.

There was only one position open in my area. Several contested it. In particular, Yuri Sagdaeff.

Yuri I can recall with ease, without the tap. He was beefy and tall. He swaggered. He had narrow pig eyes and a perpetual little smirk, as if . . .

No, no, I fear some of the old emotions still stir in me. Let me merely say that Yuri and I were in competition, and Yuri was making it easy to let the matter become personal. Yet the luck of the draw assigned us to the same Walker. We were ordered to carry out routine maintenance on the automatic stations dotting Ganymede. We were to spend cramped weeks together.

I . . . ah, but I see the engineer with his coils and lattices, beckoning. The tap should begin . . .

—glittering blue sprinkling of light—

—crunch of boots on pink snow—

Suited, I walked through the scattered ceramic buildings of Ganymede base. The Walker squatted on its six legs, seven meters off the ground. Ruddy light

shone through the big, curved windows of the bubble on top. I could see the driver's seat through the largest one. Beneath, almost lost in the jumble of hydraulic valves and rocker arms, the entrance ladder was folded down.

The Walker was bright blue, for contrast against the reddish-brown dirty ice. Beneath the forward antenna snout was a neatly printed *Perambulatin' Puss*. Everybody called her the Cat.

"Morning!" I recognized Captain Vandez's voice even over suit radio. He and Yuri walked up to the Cat from the other side of the base. I said hello. Yuri made a little mock salute at me.

"Well, you boys should be able to handle her," Captain Vandez said. He slapped the side of the Cat. "The ole *Puss* will take good care of you as long as you treat her right. Replenish your air and water reserves at *every* way station—don't try to skip one and push on to the next, 'cause you won't make it. If you fill up at a station and then go to sleep, be sure to top off the tanks before you leave; even sleeping uses up air. And no funny business—stick to the route and make your radio contacts back here sharp on the hour."

"Sir?"

"Yes, Bohles?"

"It seems to me I've had more experience with the Walker than Yuri, here, so—"

"Well, more experience, yes. You have taken her out before. But Sagdaeff practiced all yesterday afternoon with her and I have been quite impressed with his ability. He has more overall experience, as well. I think you should follow his advice when any question comes up," he said impatiently.

I didn't say anything. I didn't like it, but I didn't say anything.

Captain Vandez didn't notice my deliberate silence. He clapped us both on the back, in turn, and handed Yuri a sealed case. "Here are your marching

orders. Follow the maps and keep your eyes open."

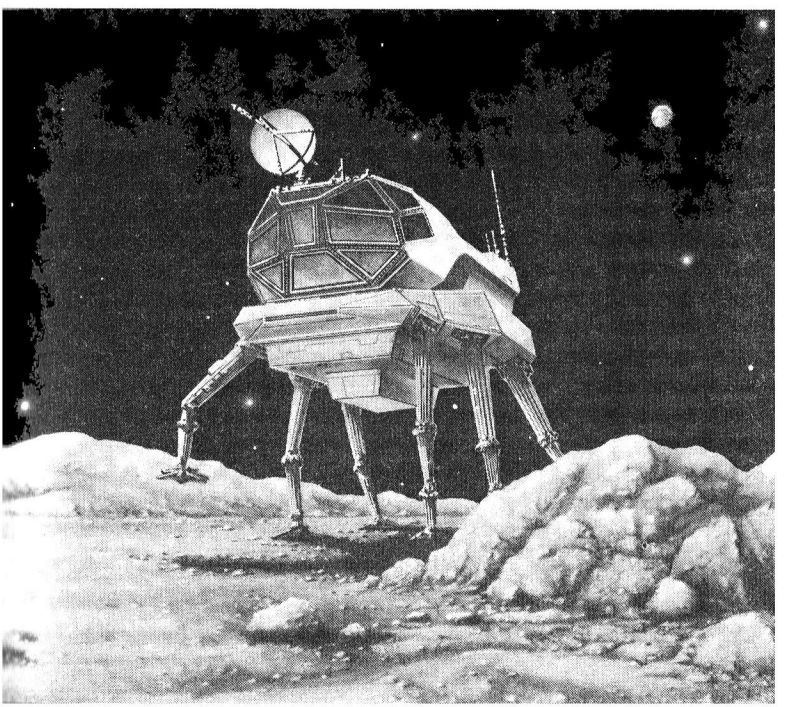
With that he turned and hurried away. "Let's move it," Yuri said, and led the way to the ladder. We climbed up and I sealed the hatch behind us.

This would be home for the next five days. It was crammed with instruments and storage. There were fiber optics in the floor so we could check on the legs. Sunlight streaming in lit up the cabin and paled the phosphor panels in the ceiling.

We shucked our suits and laid out the maps on the chart table. I took the driver's seat and quickly went through the board check. The lightweight nuclear engine mounted below our deck was fully charged; it would run for years without anything more than an occasional replacement of the circulating fluid elements.

"Why don't you start her off?" Yuri said. "I want to study the maps."

I nodded and slid over to the driver's place. I



clicked a few switches and the board in front of me came alive. Red lights winked to green and I revved up the engine. I made the Walker kneel down a few times to warm up the hydraulic fluids. It's hard to remember that the legs of the Cat are working at temperatures a hundred degrees below freezing, when you're sitting in a toasty cabin. It can be dangerous to forget.

While I was doing this I looked out at the life dome rising in the distance. I could pick out people sledding down a hill, and further away a crowd in a snowball fight. A scramble like that is more fun on Ganymede than on Earth; somebody a hundred yards away can pick you off with an accurate shot, because low gravity extends the range of your throwing arm. We don't have anything really spectacular on Ganymede in the way of recreation—nothing like the caverns of Luna, where people fly around in updrafts, using wings strapped to their backs—but what there is has a lot of zip.

I engaged the engine and the Cat lurched forward. The legs moved methodically, finding the level of the ground and adjusting to it. Gyros kept us upright and shock absorbers cushioned our cabin against the rocking and swaying.

I clicked on the Cat's magnetic screen. The life dome area has buried superconductors honeycombing the area, creating a magnetic web. As the Cat left the fringes of that field, we needed more protection from the steady rain of energetic protons. They sleet down on Ganymede from the Van Allen belts. A few hours without protection would fry us. Cat's walls contained superconducting hydrogen threads carrying high currents. They produce a strong magnetic field outside, which turns incoming charged particles and deflects them.

I took us away from the base at a steady thirty klicks an hour. We cast a shadow like a marching

spider on the slate-gray valley wall. Jupiter squatted square in the middle of the sky, like a striped watermelon.

"By the way, that little maneuver back there didn't get you any points with Vandez," Yuri said dryly.

"What?"

"Skip the crap. Listen, you try to undermine me again and I'll take you off at the knees."

"Ummm. Just seemed to me that if you don't know much about Walkers, you shouldn't be running one."

"What's to know? I picked up the whole thing in a few hours practice. Here, get out of the seat." He waved me away gruffly.

I stopped the Cat and Yuri slid into the driver's chair. We had reached the end of the valley and were heading over a low rise. Here and there ammonia ice clung to the shadows.

Yuri started us forward, staying close to the usual path. The whole trick of guiding a Walker is to keep the legs from having to move very far up and down on each step. It's easier for the machine to inch up a grade than to charge over it.

So the first thing Yuri did was march us directly up the hill. The legs started straining to keep our cabin level, and a whining sound filled the air. The Cat teetered. It lunged forward. Then it stopped and died.

"Hey!" Yuri said.

"Shouldn't be surprised," I said. "She's just doing what any self-respecting machine does when it's asked to perform the impossible. She's gone on strike. The automatic governor cut in."

Yuri said something incoherent and got up. I took over again and backed us off slowly. Then I nudged the Cat around the base of the hill until I found the signs of a winding path previous Walkers had left. Within fifteen minutes we were in the next valley, its hills lit with the rosy glow of the sun filtering through a thin ammonia cloud overhead.

We made good time; I did most of the driving. We stayed overnight at way stations. They were automatic chem separators, pulling water and ammonia molecules apart to make air plus useful working gases. I took care of the hoses, filling A and B and C tanks while Yuri took local samples and kept the Walker in shape.

Our route ran through the old Nicholson Region. We wove through wrinkled valleys of tumbled stone and pink snowdrifts, keeping an eye open for anything unusual. Ganymede was a huge snowball, steadily tugged by Jupiter. The tidal effects stir the slush interior. The churning fluids inside push the surface. Great slabs of frozen ice and ammonia slide over each other, trying to compensate and never getting it right: ice tectonics. They grind and butt and send shuddering quakes rippling all through the moon.

Ganymede is heating up. It's not all ice, of course —billions of years of meterorites have salted the crust, and there was a lot of rock to start with. Otherwise, we'd melt the whole world.

We avoided the areas near the fusion plants. The big ones burn hell-for-leather; you get flash floods and churning rivers. The warm water carries heat to neighboring areas and they melt too.

There's a limit to the method, though. If you're not careful, your fusion plants will melt their way into Ganymede and get drowned. Ganymede is a big snowball, not a solid world at all. It's mostly water. There's an ice crust about 70 klicks thick, with rock scattered through it like raisins in a pudding. Below that crust Ganymede is slush, a milkshake of water and ammonia and pebbles. There's a solid core, far down inside, with enough uranium in it to keep the slush from freezing.

So the fusion plants don't sit in one place. They're

big caterpillars, crawling endlessly outward from the equator. Their computer programs make them seek the surest footing over the outcroppings of rock—only they run on tracks, not feet. We saw one creeping over a ridgeline in the distance, making about a hundred meters in an hour, sucking in ice and spewing an ammonia-water creek out the tail. It carried a bright orange balloon on top. If it melts its surroundings too fast and gets caught in a lake, it will float until a team can come to fish it out.

A few decades and there will be a thick atmosphere. A few more and there'll be a Hilton, and it'll be time to move on.

Things got worse with Yuri. He rubbed me the wrong way. He was big and clumsy and the cabin was small. Worse, he was careless.

The third day, we went out to check a sensor package. It monitored ecochanges from the melting. Something had made it stop sending.

When we got to within hiking distance Yuri and I went out. The Walker couldn't scale the steep grade.

We came up on the sensor and the trouble was obvious. A fist-sized chunk had lodged in the collector, probably thrown there by some distant shifting among the hills.

Yuri bent over to investigate. He slipped in the gravel and collapsed on the sensor station. The collector, antenna, trinet spokes—they all snapped off. "Asshole!" I shouted, leaping forward. It was too late. He had ruined it.

He swore I had run into him and made him slip. He was lying, of course. I might have nudged him, but it was nothing.

So we had to fetch parts. And strip down the sensor. And install a lot of new stuff. And check it out. We fell a full day behind schedule.

That made Yuri even more surly. We snarled at each other when we were in the Walker. Outside, we tried to divide up the jobs so they could be done alone. We had a lot of recon work. Sensors are set up high, where sudden gully-washers won't catch them. When a fusion cat passes, there's not much warning. If the just-melted slush finds a brand new path, you'd better be out of the way.

The third time Yuri went out he came back empty-handed. He couldn't find his package. I walked out to it with him.

"You know, I remember this spot," I said. "We came by here last year. The package is right around this ledge."

"Well, it's not here now." We were standing by a shelf of yellow rock with boulders scattered around.

"What did the map say was wrong with it?"

Yuri looked around impatiently. "It stopped transmitting a few months ago. That's all they know."

I turned to go. "Well, there's—wait a minute. Isn't that a Faraday cup?"

I bent down and picked up a little bell-like scrap of

metal that was lying in the dust. "One of these is usually attached to the top of a sensor pack."

I looked at the nearest boulder. It must have weighed a ton, even a Ganymede. "I bet I know where our package is."

We found one other piece of metal wedged under the edge of boulder. I hiked back and got a replacement package. It took a while to set up. This time we put it away from any overhang.

Getting the package's radio zeroed in on the base was a little tricky, since we were down in a low trough and had to relay the signals from base through the Walker's radio at first. It took a big chunk out of the day. The next package to be checked was a long walk from our planned way station for the night. We elected to leave it for morning, but then I got restless and said I would go out to the site myself.

Jupiter's eclipse of the sun was just ending as I set out. I took a break to watch the sun slip out from behind Jupiter. Suddenly the planet had a rosy halo; we were looking through the outer fringes of the atmosphere. The Can was a distant twinkle of white I walked along a stream bed and in a way it was like early morning on Earth—as the sun broke out from behind Jupiter things brightened, and the light changed from dull red to a deep yellow. Everything had a clean, sharp look to it. The sun was just a fierce, burning point and there were none of the fuzzy half-shadows you're used to on Earth. Ganymede's man-made atmosphere was still so thin it didn't blur things.

I felt a *pop*. I stopped dead. I stood still and quickly checked my suit. Nothing on my inboard monitors. My lightpipe scan showed nothing wrong on my back. Suit pressure was normal. I decided it must have been a low/energy micrometeoroid striking my helmet: they make a noise but no real damage.

The micrometeoroid was probably some un-

charged speck of dust, falling into Ganymede's gravity well. If it had been charged, the superconductor threads woven into my suit would have deflected it. Superconductors are a marvel. Once you run a current through them, they keep producing a magnetic field—forever. The field doesn't decay because there's no electrical resistance to the field-producing currents. So even a one-man suit can carry enough magnetic shield to fend off the ferocious Van Allen sleet. And inside the suit there's no magnetic field at all to disturb your instrumentation, if the threads are woven in right. The vector integrals involved in showing that can get messy, especially if you don't know Maxwell's equations from a mudpuddle. But the stuff works, and that's all I needed to know.

When I found the sensor package it needed a new circuit module in its radio; the base had guessed the trouble and told me to carry one along on the walk out. That wasn't what interested me, though. This particular package was sitting in the middle of a seeded area. Two years ago a team of biologists planted an acre of micro-organisms around it. The organisms were specially tailored in the Lab to live under Ganymede conditions and—we hoped—start producing oxygen, using sunlight and ice and a wisp of atmosphere.

I was a little disappointed when I didn't find a sprawling green swath. Here and there were patches of gray in the soil, so light you couldn't really be sure they were there at all. Over most of the area there was nothing; the organisms had died.

The trouble with being an optimist is that you get to expect too much. The fact that *anything* could live out here was a miracle of bioengineering. I shrugged and turned back the way I had come.

I was almost halfway back to the Cat when I felt an itching in the back of my throat. My eyes flicked down at the dials mounted beneath my transparent view

screen. The humidity indicator read zero. I frowned.

Every suit has automatic humidity control. You breathe out water vapor and the sublimator subsystem extracts some of it before passing the revived air back to you. The extra water is vented out the back of the suit. You'd think that if the microprocessor running the subsystem failed, you'd get high humidity.

But I had too little. In fact, none.

I flipped down my rear lightpipe and squinted at my backpack. Water dripped from the lower vent. I checked my—

Dripped? I looked at it again.

That shouldn't happen. The suit should have been venting water slowly, so it vaporized instantly when it reached the extremely thin atmosphere outside. Dripping meant the relief valve was open and all my water had been purged.

I called up a systems review of my side viewplate, just below eye level inside my helmet. From the data train I guessed the humidity control crapout had been running for over half an hour. *That* was what had made the popping noise. And I had written it off as a micrometeoroid. Wishful thinking.

I stepped up my pace. The tickle at the back of my throat meant I might have suit throat. That's the coverall name for anything related to breathing processed air. If you get contaminants in the mix, or just lose water vapor, your throat and nose soon dry out, or get irritated. A dry throat is a feasting ground for any bacteria hanging around. If you're lucky, the outcome is just a sore throat that hangs around for a while.

I puffed along. In the distance I could see the faint orange aura from a fusion caterpillar. The rising mist from its roaring fusion exhaust diffused the light for tens of klicks. Blue-green shadows in the eroded hillsides contrasted with the gentle orange flow. Suddenly Ganymede felt strange and more than a little

threatening.

I was glad when the Cat came within sight. It was backed up to the way station. I clumped up the ladder and wedged through the narrow lock into the cabin.

"You're late for chow," Yuri said.

"Hope I can taste it."

"Why?"

I opened my mouth and pointed. Yuri looked in, turned my head toward the light, looked again. "It's a little red. You should look after it."

I got out the first aid kit and found the anesthetic throat spray. It tasted metallic but it did the job; after a moment it didn't hurt to swallow.

I broke down the humidity control unit in my suit. Sure enough, the microprocessor had a fault. I took a replacement chip slab out of storage and made the change. Everything worked fine.

I was surprised at how much Yuri could do with our vac-dried rations. We had thin slices of chicken in a thick mushroom sauce, lima beans that still had some snap in them, and fried rice. We topped it off with strawberry cream cake and a mug of hot tea. Pretty damned elegant, considering.

"My compliments," I said. I got up from the pullout shelf that we used for a table. The room began to revolve. I put out my hand to steady myself.

"Say!" Yuri shouted. He jumped up and grabbed my arm. The room settled down again.

"I—I'm okay. A little dizzy."

"You're pale."

"The light is poor in ultraviolet here. I'm losing my suntan," I said woozily."

"It must be more than that."

"You're right. Think I'll go to bed early."

"Take some medicine. I think you have suit throat."

I grinned weakly. "Maybe it's something I ate." I

jerked on the pull ring and my foldout bunk came down. Yuri brought the first aid kit. I sat on the bunk taking off my clothes and wondered vaguely where second aid would come from if the first aid failed. I shook my head; the thinking factory had shut down for the night. Yuri handed me a pill and I swallowed it. Then a tablet, which I sucked on. Finally I got between the covers and found myself studying some numbers and instructions that were stenciled on the ceiling of the cabin. Before I could figure out what they meant I fell asleep.

The morning was better, much better. Yuri woke me and gave me a bowl of warm broth. He sat in a deck chair and watched me eat it.

"I must call the base soon," he said.

"Um."

"I have been thinking about what to say."

"Um . . . Oh. You mean about me?"

"Yes."

"Listen, if Captain Vandez thinks I'm really sick he'll scrub the rest of the trip. We'll have to go back."

"So I thought. Which will lower our performance ratings."

"Do me a favor, will you? Don't mention this when you call in. I'm feeling better. I'll be okay."

"Well—"

"Please?"

"All right. I don't want this journey ruined just because you are careless." He slapped his knees and got up. "I will make the call."

"Mighty nice of you," I mumbled. I dozed for a while. I was feeling better, but I was a little weak. I thought over our route. The next way station was a respectable distance away and there was only one sensor package to visit. We would have to spend our time making tracks for the next station—which was just as well, with one crew member on the woozy side.

"Yuri," I said, "check and be sure—"

"Bohles, you may be sick, but that doesn't mean you can start ordering me around. I will get us there."

I rolled over and tried to sleep. I heard Yuri suit up and go out. A little later there were two faint *thunks* as the hoses disconnected from the way station. Then Yuri came back in, unsuited and sat in the driver's chair.

The Cat lurched forward and then settled down to a steady pace. I decided to stop worrying and let Yuri handle things for a while. I was feeling better every minute, but another forty winks wouldn't do any harm. I let the gentle swaying of the Walker rock me to sleep.

I woke around noon; I must have been more tired than I thought. Yuri tossed me a self-heating can of corned beef; I opened it and devoured the contents immediately.

I passed the next hour or so reading a novel. Or rather, I tried. I dozed off and woke up in midafternoon. There was a lot of sedative in that medicine.

I got up, pulled on my coveralls and walked over to the control board. "Walked" isn't quite the right word—with my bunk and the table down, the Cat resembled a roomy telephone booth.

I sat down next to Yuri. We were making good time across a flat, black plain. There was an inch or so of topsoil—dust, really—that puffed up around the Cat's feet as they stepped. The dust comes from the cycle of freezing and thawing of ammonia ice caught in the boulders. The process gradually fractures the Ganymede rock, breaking it down from pebbles to shards to BB shot to dust. In a century or so somebody will grow wheat in the stuff.

Some of the soil is really specks of interplanetary debris that has fallen on Ganymede for the last three billion years. All over the plain were little pits and gouges. The bigger meteors had left ray craters,

splashing white across the reddish-black crust. The dark ice is the oldest stuff on Ganymede. A big meteor can crack through it, throwing out bright, fresh ice. The whole history of the solar system is scratched out on Ganymede's ancient scowling face, but we still don't know quite how to read all the scribblings. After the fusion bugs have finished, a lot of the intricate, grooved terrain will be gone. Regrettable, maybe—the terraced ridges are beautiful in the slanting yellow rays of sunset—but there are others like them, on other moons. The solar system has a whole lot more snowball moons like Ganymede than it has habitable spots for people. Just like every other age in human history, there are some sad choices to make.

Yuri sidestepped a thick-lipped crater, making the servos negotiate the slope without losing speed. He had caught the knack pretty fast. The bigger craters had glassy rims, where the heat of impact had melted away the roughness. Yuri could pick his way through that stuff with ease. I leaned back and admired the view. Io's shadow was a tiny dot on Jupiter's eternal dancing bands. Jove's thin little ring made a faint line in the sky, too near Jupiter to really see clearly. You had to look away from it, so your side vision could pick it out. There was a small moon there, I knew, slowly breaking up under tidal stresses and feeding stuff into the ring. It's too small to see from Ganymede, though. You get the feeling, watching all these dots of light swinging through the sky, that Jupiter's system is a giant clockwork, each wheel and cog moving according to intricate laws. Our job was to fit into this huge cosmic machine, without getting mashed in the gears.

I yawned, letting all these musings drop away, and glanced at the control board. "You do a full readout this morning?"

Yuri shrugged. "Everything was in order last night."

"Huh. Here—" I punched in for a systems inventory. Numbers and graphs rolled by on the liquid display. Then something went red.

"Hey. Hey. B and C tanks aren't filled," I said tensely.

"What? I put the system into filling mode last night. The meter read all right this morning."

"Because you've got it set on A tank. You have to fill each independently, and check them. For Chrissakes—!"

"Why is that? Was that your idea? It's stupid to not combine the entire system. I—"

"Look," I said rapidly, "the Cat sometimes carries other gasses, for mining or farming. If the computer control automatically switched from A to B to C, you could end up breathing carbon dioxide, or whatever else you were carrying."

"Oh."

"I showed you that a couple days back."

"I suppose I forgot. Still—"

"Quiet." I did a quick calculation, we'd used some already—and on our present course—

"We won't make it to our next station," I announced.

Yuri kept his eyes on his driving. He scowled.

"What about our suits?" he asked slowly. "They might have some air left."

"Did you recharge yours when you came back in?"

"Ah . . . no."

"I didn't either." Another screwup.

I checked them anyway. Not much help, but some. I juggled figures around on the clipboard, but you can't sidestep simple arithmetic. We were in deep trouble.

Yuri stepped up the Cat's pace. It clanked and bounced over slabs of jutting purple ice. "I conclude," he said, "that we should call the base and ask for assistance.

I frowned. "I don't like to do it."

"Why? We must."

"Somebody will have to fly out here and drop air packs." There's always some risk with that because even Ganymede's thin air has winds in it. We don't understand those winds yet.

Yuri gave me a guarded look. "An extra mission. It would not sit well with Captain Vandez, would it?"

"Probably not." I could tell Yuri was thinking that, when the report came to be written, he'd get the blame. "But look, the real point is that somebody back at base would have to risk his neck, and all because of a dumb mistake."

Yuri was silent. The Walker rocked on over the broken ground. A pin thick ammonia stream flowed in the distance.

"You may not like it," he said, "but I do not intend to die out here." He reached for the radio, turned it on and picked up the microphone.

"Wait," I said. "I may . . ."

"Yah?"

"Let's see that map." I studied it for several minutes. "There, see that gully that runs off this valley?"

"Yes. So what?"

I drew a straight line from the gully, through the hills, to the next broad plain. The line ran through a red dot on the other side of the hills. "That's a way station, that dot. I've been there before. We're slated to check it in two days, on our way back. But I can reach it by foot from that gully, by hiking over the hills. It's only seventeen kilometers."

"You couldn't make it."

I worried over the map some more. A few minutes later I said, "I *can* do it. There's a series of stream beds I can follow most of the distance; that'll cut out a lot of climbing." I worked the calculator. "Even allowing for the extra exertion, our oxy will last."

"Yuri shrugged. "Okay, boy scout. Just so you leave me enough to cover the time you're gone, plus some extra so a rocket from the base can reach me if you crap out."

"Why don't you walk yourself?"

"I'm in favor of calling the base right now. But I'll wait out your scheme, if you want, right here. I don't like risks."

"Look, if we report this, it'll kill both our chances of staying on."

Yuri studied me sourly. "Probably."

"I don't want to ship Earthside. It's shit-awful back there."

"Uh huh. But I like dying less."

"You're just a coward, you—"

"Cut that crap or I'll break you in pieces, Bohles."

I caught myself barely in time. I felt a quick surge of energy and I knew what would happen next. But you don't have a brawl inside a Walker, not if you ever want to use it again. So I unclenched my fists and said, "Okay, a truce. Until this problem is solved. Then, by God, I'm going to kick your face in."

Yuri grinned. "I'd love to see you try. But don't let me detain you any longer—" He gestured to the hatch.

"Maybe if we—"

"Those are my terms, Bohles. If you go, you go alone."

I could see he meant it.

The cold seeped into my legs. My suit was fighting off the outside chill, but it was near the end of its reserves.

Pink slabs of ice, gray rock, black sky—and always the thin rasp of my breath, throat raw from coughing. My helmet air was thick and foul. I stumbled along.

My beautiful plan hadn't worked. The footing was pretty bad, and some of the stream beds were

choked with runoff—boulders, gravel, slippery ice ponds. A fusion caterpillar must have passed nearby since the last orbital photos.

So I had spent hours struggling over jumbled terrain. Yuri had listened to my complaining, and offered to call the base. But I was damned if I'd get pulled out of it now, and blow any chance of staying out here. My rating was going to stay high, even if I had to bust ass.

That's what I kept telling myself.

But for the last few hours the confidence had trickled away. I didn't want to say anything to Yuri, but things were looking bad to me. If he knew how tired I was, he'd call the base and all my sweat would have been wasted. And beyond that, the little bastard would have the satisfaction of pulling me down with him, even though it was his mistake with the tanks, all because of his stupid—

Gravel slipped under my boot. I lurched, twisting my back. A lance of pain shot through me. A small landslide eroded away my footing. I regained my balance, grabbed at a rock and heaved myself up the steep hillside.

My breath was ragged and I was sweating. I longed to wipe the salty trickles away from my eyes. Just wait a few minutes, I knew, and the suit would evap them. Sure. But the waiting took forever.

I worked my way up the side of what looked like a sand dune. Everything around here was broken and jumbled. The ground slanted the wrong way. I kept my orbital position fix updated, so I knew I was going in the right direction. But the map was useless.

The stones and sand gritted against my boots, slipping away, robbing me of balance and speed. I toiled up the incline, angling across the face of it. A few rocks were perched at the top, sheltering purple patches of snow.

I reached the summit panting, and looked down.

It was a cube.

I squinted at it. A big slab of ammonia ice had melted further up the ridgeline. The runoff had washed this way, scraping and gouging its path. Where the gully turned, a pile of boulders had collected. At the base of the pile, resting almost flat on the stream bed, was—

It moved.

No—there were yellow flecks swimming deep in the milky stone face of it. Turning. Glinting. Catching the wan sunlight and throwing it back at me in intricate patterns.

I frowned. Something—

I stumbled down the raw face of the hill, toward the gully.

The cube was a lattice. It formed frames for shifting lines that were buried deeper. Perspectives moved and formed and swirled and reformed. I squinted at the images, seeking to make sense of them.

They were hard to follow. I looked away, beyond the gully.

A broad swath, cut by recent streams, stretched into the distance. I could make out the bright blue and red of the way station. Its signal phosphor winked yellow. I could reach it within an hour. And there was enough oxy left.

Something drew my eyes back to the thing in the gully.

I felt suddenly cold. A prickly sensation rippled over me.

I peered closer. And saw—

—a vast space of darkness, with firey pinpricks wheeling as they flashed and tumbled and danced, green and blue and orange—

—a thing of quivering lines, plunging out toward me—

—and dissolving into a rhythm of billowy masses, clouds scratching a ruby sky—

—shiny surfaces, flexing bright and slick—

—scribbles in black, then in yellow—

—a running animal, so quick there was only the impression of lightning motion, a flash of brown skin—

—rotting pinks and greens, a stench of age—

—encrusted light—

—hair like snakes—

—explosion—

—I looked away, breathing deeply. Each second a layer shifted deep inside the thing and I saw something, something—

I made myself turn and start down slope. The important thing was to get to the way station. The important thing was the air. The Walker. The job.

I tramped on, my mind swirling with impressions, questions, strange shifting emotions.

I could not help looking back. But I marched on.

—but wait, wait, no—

—just a moment longer, please—

—to feel the first time again, I never suspected—

—oh but—just a short time—so bright—I—no—I—

—ah—

—yes, yes, I suppose I do see. It cannot go on for long, there are other needs, yes, but . . . Oh yes . . .

I am sorry. It has taken a few moments for me to recover from the tap. I had not suspected its, its power, and the vivid sense . . .

Can it be true that our youth is so colored? So gaudy? So purely intense? Without the haze of reflection that experience brings?

In a way, I hope not. I sincerely hope not.

For to go through one's last days knowing that they were filmed over so, that the true world stretches fine and firm, solid and brilliant, but forever beyond your true grasp . . . That would be too much.

I now see why the good engineers do not allow

widespread use of the tap.

And especially, use by ones such as me. As old as me . . .

But let me return to the subject that draws us together. The Artifact.

We know how it came to be there, of course. My first guess was very nearly correct. For a long time it had been buried in the vast ice fields of Ganymede. Once, long ago, it stood above the surface. But the slow grinding and thrusting of ice plate tectonics submerged the Artifact. It was not crushed. It withstood enormous pressures.

A fusion catepillar passed near. Ice melted. A random flow swept the Artifact free. And changed human history, forever.

If you will consult the Historiographers, you will find virtually all early discussion of the Artifact focused on its artistic merit. A curious notion arose: that it was a purely aesthetic construct, a work of art and no more.

I see looks of disbelief. But it is true. In those distant days there was a clear division between Art and Science—two concepts we now know to be mere illusions, and not even symplifying illusions, at that.

The earliest—and clearest—clue was obvious, even from the first: I could take my eyes from it only with difficulty. This proved true of everyone who gazed upon its infinite surfaces.

That constantly emerging, forever raw surface. That was the essential fact. The Artifact is in a sense stonework, and in a sense it is totally artificial, constantly remaking itself into new compounds, new substances, new forms and logics. Each basic unit is neither pyramid nor cube—the two most often observed forms when closely inspected—but in fact is a ragged, shifting thing of points and angles. Its molecular structure is dictated by the atomic structure, and that in turn comes welling up out of the

particles themselves, as the laws governing them change with time. The electro-weak interaction forms and reforms with spontaneous fresh symmetries, hidden variables. The strong force is awash in the same sea.

Thus the Artifact is at basis a recapitulation of the laws which have governed, do now govern, and will govern, the universe. When the universe was young, the laws were young. We see them, deep within the Artifact. Logic and mathematics can burn bright, living through their brief days. Then they sputter out. From them arises the Phoenix of fresh logic, spontaneously broken symmetries, young particles which spill into the welcoming matrix of a consuming universe.

Inward goes time. Outward comes the layered, changing order of the world.

Oh, sorry. Those last two sentences are a part of our litany; I was supposed to keep this discussion free of religious reference.

As I said before, you must remember that these recollections, lodged so deep in me, are from a very different time. Ganymede did not churn with winds. Humans could not walk the surface without a suit. Even the monalayer cap over the top of our air, holding in the precious molecules except where the huge holes permit spacecraft to pass—even this commonplace was not imagined, then.

So the thinkers of that time decided the Artifact was an artistic object. A complex one, granted, but "merely" artistic.

The second generation of thinking about the Artifact discovered it was a scientific relic. The Artifact contains the varying laws of the universe. We know that the electro-weak force, for example, will fade away within three billion years. Then a new force will emerge. New particles. A new form for the relativity theory.

Once men believed that fields created particles. This is so. But there are also things—I hesitate to call them fields—which create *laws* . The laws of the universe are dictated by these, these entities. And the Artifact is such an entity.

. . . Or perhaps it is only a record of that entity.

Which leads us to the third view of the Artifact.

Only a decade after the discovery of the artifact did the effect become apparent. A small community had grown up around the site. Then a town.

No one would willingly move away. No one.

When the city reached a quarter of a million souls, something had to be done. But there was no way to pursuade the researchers to leave. Anyone who saw the Artifact felt a magnetic pull toward it. A desire—to embrace, to witness, to watch the infinite interplay of its surfaces, its truths . . .

So the final truth became apparent. It is a religious object.

And perhaps . . . well, perhaps it is more. Perhaps it is rightly the object of religion itself.

For it contains the very laws of the universe. Despite the fact that the Artifact is enclosed *in* the universe, perhaps it is not *of* the universe.

Bur perhaps I stray too far into theological theory. Let me return to my role here today, which is not that of a priest—though that I am—but as an historical witness. I should mention the one other interesting event of that distant day.

I reached the way station. Got the oxy, and rescued poor Yuri—who was quite frightened by the time I returned. Not that he ever thanked me, of course.

We marched on, through a series of valleys, and reached the Artifact. Our intention was to study it further, make recordings, and report in full to our base camp.

Something bothered me about the Artifact when I

saw it again. You can look up my old faxes. There you will see a curious mottled pattern on the surface. A rippling of light, glinting like mica. Shifting. It formed concentric circles, like a great eye. I noticed that no matter where I stood, the eye was always centered on me. On us.

I stood at a distance, focusing the recorder. Yuri was as rapt as I. He walked closer.

I was fumbling with the recorder, so I did not see what happened next. He approached the eye, I suppose. When I next glanced up, he was reaching out to touch it. The rings of sparkling light were centered on him.

Then—His hand touched the surface. Joined the surface. And at once was in and of it. He did not move.

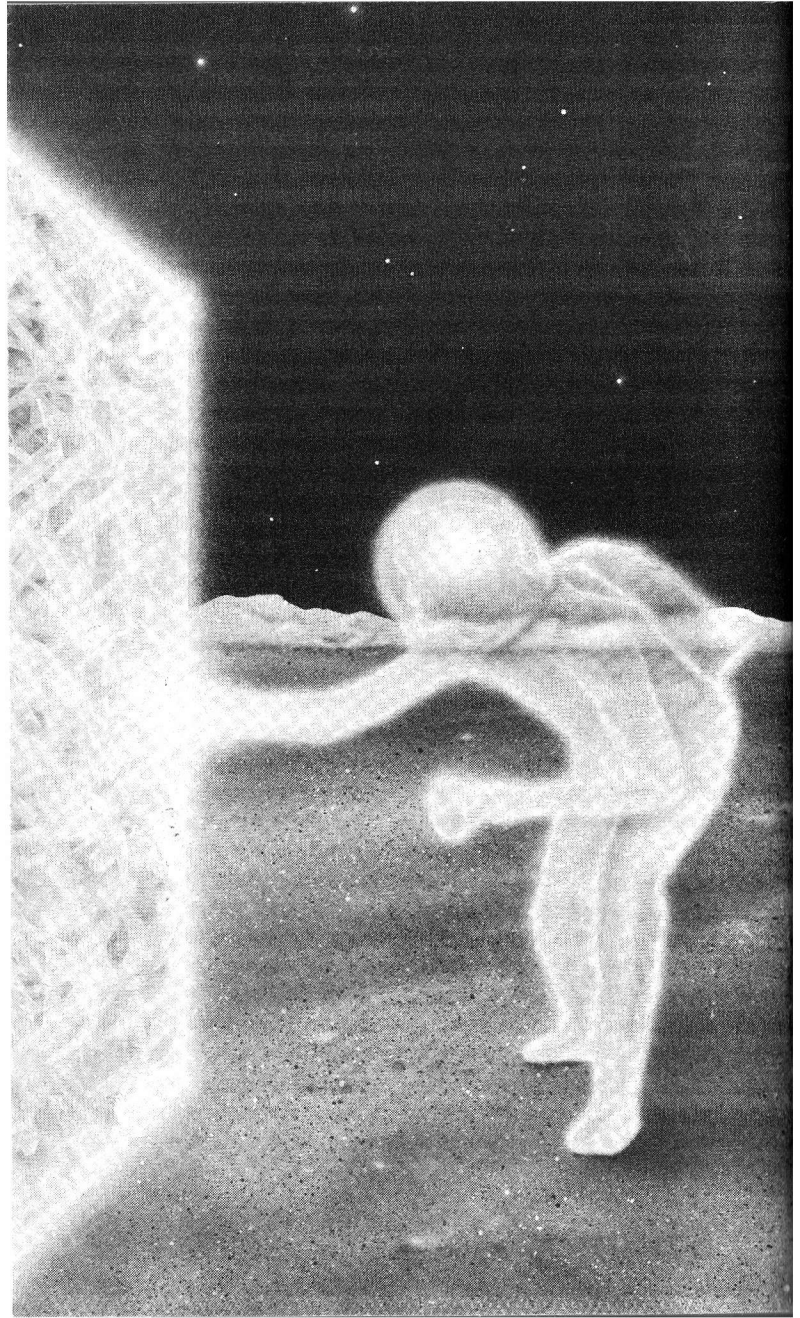
Quickly, a wave seemed to pass out of the Artifact. It ran up his arm, changing the dull suit skin to a flashing rainbow of colors, like an alive quartz. The wave washed across his back. Over his helmet. Down into his legs and, finally, to his boots. He was a stony figure, glinting, with moving facets deep inside.

I froze. Slowly, slowly, Yuri leaned forward. He made no sound. Not a word. His arm went into the eye, up to the shoulder. Then his head nodded forward, as if welcoming what was to come. And he was in up to his shoulders. The Artifact drew him in, the barrel chest and waist and then the legs. Finally, as the boots, too, oozed into the eye, I remembered the recorder. I took a stat. It is the only record I have of the event.

I was deeply confused. Perhaps I still am, to this day.

The eye vanished, to be seen no more. The Artifact returned to the guise you see today. Never once in the years since has it given any hint of what it did that day.

How should we think about this event? True, the



Artifact swallowed a human being. But when we consider all that it might be, and all that we have learned from its endlessly rippling surface—

Such moral issues I leave to others. Since no other person has been absorbed by the Artifact, the question is rather distant from our researches. Some hold that, since the Artifact may be here to follow the evolution of the universe, or supervise it, then perhaps it merely collected Yuri, stored him for use, as fresh information about the working-out of the evolutionary laws. Perhaps. Perhaps.

I am not concerned with such speculations. When I remember those antique years, one final outcome irks me. I should confess it, for as a disciple of the Artifact, I cannot speak falsely of it, not even a falsehood of omission.

As you approach the Artifact—now mounted on transparent beams, so all surfaces are visible, and the cameras may record each nuance—there is a small plaque. It is old. It recounts the date I first stumbled upon that fresh gully. Other, later dates are given as well—such as the founding of the Temple and the enactment of the Plentitude. My name appears, as the discoverer.

Each day, as I go to my labors, I pass by that little plaque. My eyes involuntarily rise, past the insignificant mention of my own name. Up, to the enormous statue which looms over the leftmost portal. It is a massive tribute to the Martyr of our following, to the sacrifice exacted by the Artifact.

And gazing at those huge features, accurate right down to the superior smile and the narrow little eyes—gazing at them, I know deep within myself that despite the serenity which should come from the Artifact, and all my years, I still hate the bastard.

—Gregory Benford

HUMANS AS MACHINES:

The Ideas of Edward O. Wilson

by Robert Silverberg

"This notion of the high merit and ultimate perfectibility of the human race has a broad spectrum of adherents, ranging from philosophical humanists of the gentlest sort at one end to hard-eyed Stalinist-Marxists at the other."

There has rarely been much reward in telling people things they don't like to hear. Copernicus was the first to grasp the notion that the earth travels around the sun, and not vice versa—a humiliating concept, if you are capable of being humiliated by the knowledge that our planet isn't the crown of creation. But he was a timid man who sat on his theory for decades, and finally published it in such a cautious way that hardly anybody took offense. When Galileo demonstrated, a century later, that the Copernican theory was no mere hypothesis but the actual *truth*, he was silenced by the Inquisition.

The Inquisition, luckily for Charles Darwin, had lost much of its clout by the middle of the nineteenth century, when he proposed his theory of natural selection—an idea that led inescapably to the realization that humans and apes are descended from a common ancestor. But that gave people the idea that Darwin was saying that we were only monkeys, and the storms of outrage blustered over the reclusive scientist for the rest of his life. Just as pre-Copernican astronomy offered the pleasing thought that Earth is the center of the universe, pre-Darwinian biology postulated mankind as qualitatively different from the humbler creatures of the world. It was once customary to divide living things into the Plant Kingdom, the Animal Kingdom, and the Human Kingdom—which led Darwin to remark, "If Man had not been his own classifier, he would never have thought of founding a separate order for his own reception."

In our time a secular belief in the unique nature of mankind has replaced the old theologies, but the essence is the same: that we are a special kind of critter, not merely superior to other life-forms but fundamentally different. Our difference allegedly lies in our possession of the means to create and transmit *culture*, our body of knowledge and belief and technique, by means of which we shape and reshape

our world and our society. This notion of the high merit and ultimate perfectibility of the human race has a broad spectrum of adherents, ranging from philosophical humanists of the gentlest sort at one end to hard-eyed Stalinist-Marxists at the other. (It was Stalin, remember, who sponsored the Lysenkoist school of genetics, which rejected most post-Darwinian theory in favor of the idea that enlightened government control was the most effective way of directing the workings of heredity.)

The most unpopular thinkers of recent decades have been those who have gone against this prevailing belief in human qualitative distinction, thus poking H. sapiens ego just as Copernicus and Darwin did. For example, the behavioral psychologist B.F. Skinner has argued that free will is an illusion and that in humans as in laboratory rats all social behavior is the outcome of conditioning—positive or negative "reinforcements" supplied by alternations of reward and punishments. Fifty years earlier, Freud arrived at a very similar conclusion using an entirely different body of experimental evidence and a wholly dissimilar vocabulary. Both men have been subjected to vigorous criticism and no little abuse. Freud's ideas have won favor in the most liberal circles and have been attacked by all totalitarian governments; Skinner's ideas are anathema to liberals and have been conspicuously employed by totalitarians; yet both theories boil down to the same underlying concept, which is that human beings are programmable entities and that the patterns of our lives are governed by our programs. Another lonely crusader of ideas was the sexual researcher Alfred Kinsey, whose indefatigable questioning produced the unsurprising but somehow controversial news that most human beings seek and find "outlets" for their sexual drives with a zeal that puts rabbits and orang-utans to shame. And for the past decade and a half the physicist William B. Shockley has doggedly insisted that

contemporary progressive social policies are leading to a degradation of the human genetic stock by encouraging the overbreeding of the least fit—a reasonable-sounding Darwinian view that has touched off fireworks partly because of Shockley's uncompromising belief in the inferiority of the black race and partly because his ideas call into question the most compassionate humanitarian trends of the last two hundred years. That food stamps, aid to dependent children, and free clinics for the poor are contributing to the genetic destruction of the human race is a disagreeable and painful concept to consider, and, like most messengers bearing bad news, Shockley is not getting a friendly greeting.

And now an entomologist from Harvard, Alabama-born Edward O. Wilson, has drawn the lightning down upon himself by attempting a synthesis of many post-Darwinian ideas that he calls "the science of sociobiology." The basis of his philosophy is a single simple idea: that in all living things, including *Homo sapiens,* social behavior is a function of genetic programming. Which is to say that everything we do—the kinds of governments we invent and the sort of religions we prefer, our sexual *mores* and our foreign policies, the way we dress and the fables we tell our children, the songs we sing and the jokes we find funny—are all the product of one overriding imperative, the drive of the species to continue itself through reproduction. Whatever social trait serves this drive is reinforced through the reproduction of those who bear it, and becomes established in the life of the species; whatever is anti-survival or non-survival is sooner or later discarded as biologically useless. To some, this is a monstrous ideology, bleak and mechanistic and dismal, robbing us of all volition and all purpose. To others, Wilson's ideas constitute a calm, sane, pragmatic view of humanity's place in the cosmos, a reasonable and plausible and paradoxically *hopeful* theory that could provide us

with the conceptual tools for surviving our own self-destructiveness.

(I think I should, at this point, offer a statement of my own biases. I have no doubts about Copernican astronomy, regard Darwinian selection as obvious truth, find Freud profound though Freudianism no more effective than other contemporary religions, believe Kinsey was a useful antidote to hypocrisy, feel edgy about Skinner but don't question the power of operant conditioning, think that Shockley has an important message but wish he hadn't muddled it by singling out one race as naturally inferior, and am neither personally offended nor philosophically outraged by Wilson's concept of human beings as elegant machines. I dislike chaos, try to take a systems approach toward comprehending the incomprehensible, and keep my ego out of my intellectual processes as much as I can, though not as much as I'd like. I think it's quite all right to regard oneself as a machine provided one is at least allowed to think of oneself as a very good machine, with a fair range of choice-functions that give some illusion of independence of action.)

There are, at present, two primary sources for the ideas of Edward O. Wilson. His magnum opus, *Sociobiology*, appeared in 1975—an encyclopedic and magisterial tome of 697 quarto pages closely packed with type. Since Wilson's field of professional expertise is entomology, *Sociobiology* is based extensively but hardly exclusively on his studies of insect societies. But in the elaboration of his theories Wilson ranges through the entire kingdom of animal life up to and including the higher primates, and in an epilog of some thirty pages arrives at *Homo sapiens*, declaring, "Let us now consider man in the free spirit of natural history, as though we were zoologists from another planet completing a catalog of social species on Earth." (I think this posture of Wilson's is an

extraordinarily valuable one, allowing him to strip away as much as is possible the vanities of anthropocentrism, and it is useful in examining his thought to see him throughout as a quizzical and serene visitor from Outside.)

Sociobiology is immense, dense, and—although Wilson is a clear and concise writer—a daunting project for the casual reader, especially one without much mathematical training, although I will testify that it's possible to skip the tougher graphs and equations without losing the essence of the thesis. Far more accessible, but lacking in the wealth of substantiating material that makes *Sociobiology* so significant a scientific work, is Wilson's controversial and exhiliarating brief popular account of his ideas as extended to the human realm, *On Human Nature* (1978). That one makes a good starting point. It is a startling and provocative book.

In the opening lines of *On Human Nature* Wilson sets out positions that would have had him burned at the stake in Galileo's time:

"—if the brain is a machine of ten billion nerve cells and the mind can somehow be explained as the summed activity of a finite number of chemical and electrical reactions, boundaries limit the human prospect—we are biological and our souls cannot fly free. If humankind evolved by Darwinian natural selection, genetic chance and environmental necessity, not God, made the species." He finds this a stark and unappealing proposition—but sees no way around it.

Having disposed of divine providence on page one, Wilson goes on to deal with free will:

"—no species, ours included, possesses a purpose beyond the imperatives created by its genetic history. Species may have vast potential for guidance and mental progress but they lack any immanent purpose . . . or even an evolutionary goal toward which their

molecular architecture automatically steers them. I believe that the human mind is constructed in a way that locks it inside this fundamental constraint and forces it to make choices with a purely biological instrument."

Mechanistic—brutal—anti-humanistic—

Yes. Wilson knows that. He is a sensitive and cultured man who admires Yeats and Mozart more than he does Attila and Hitler. Quite likely he would prefer to offer a more flattering view of humanity. But his examination of the biological evidence gives him no choice. The late John W. Campbell once suggested that the only opinion that really counts is "the opinion of the universe"—that is, the way things really are, not the way we would like them to be. Edward O. Wilson believes the opinion of the universe about the human race to be that we are animals like any other, very clever animals but subject to the same laws as the ants, the crocodiles, and the chimpanzees. One can see this as a harsh and narrow philosophy, or, as I tend to think, as a rational one, offensive to the ego only as Copernicanism or Darwinism offends—and a philosophy that still leaves room for striving and achieving.

He does step freely on toes. Most philosophers would agree, in this secular age, with Wilson's contention that "each living form can be viewed as an evolutionary experiment, a product of millions of years of interaction between genes and environment." But many find him guilty of reductionism when he asserts that the capacity for culture, the one great factor supposedly setting us apart from the "animals," is itself a trait evolved by natural selection, and that our culture differs in degree rather than kind from those of our fellow creatures.

Citing the work of Jane Goodall and others with chimpanzees, he shows that they have a complex culture themselves, and asserts in a nicely science-

fictional way that "by conventional evolutionary measures and the principal criteria of psychology *we are not alone, we have a little-brother species.*" (Italics mine.) This may shock those who are still fighting the battle against Darwinism but is not unduly disturbing to most others. But Wilson's training in entomology leads him to a funnier and more unsettling argument. From the anthropologist George P. Murdock he borrows a long list of traits indicative of human culture (such as bodily adornment, calendar, cooking, cooperative labor, ethics, folklore, food taboos, language, law, luck, personal names, surgery, tool making, visiting, weather control, etc.) and counterpoints it with a similar but not entirely identical list of his own making that is indicative of *insect* culture (including antennal rites, body licking, calendar, cooperative labor, ethics, food taboos, language, larval care, law, mutual regurgitation, soldier castes, surgery, tool making, visiting, weather control, etc.) He makes insects seem quite human—or, as his critics would have it, he makes humans seem rather like insects. According to your own degree of tolerance the juxtaposition of the two lists is exciting or outrageous, suggesting as it does that civilization is not a thing limited to humans or even to hominids.

Natural selection, to Wilson, is at the root of everything—even culture. Darwin and his successors showed plausibly that when genes carry useful traits (physical strength, heat or cold tolerance, superior intelligence, speed, keenness of senses, or whatever else meets particular external challenges) the bearers of those genes tend to reproduce more readily than those who lack them, giving those genes increased representation in the next generation. Wilson's extension of this in sociobiology is that the organizations of society arise and endure because they, too, serve genetic needs. Those societies that practice contra-survival cultural traits (total chastity, for

example, or ritual starvation at puberty) tend to vanish quickly; those whose cultural features promote survival tend to survive. It seems reasonable enough. Mankind's institutions, says Wilson, become established because they meet genetic needs, because they favor reproduction; and if seemingly irrational institutions survive despite lack of readily apparent genetic value (religion, pair-bonding, homosexuality, altruism) then he suggests taking a second look in order to figure out what need they must serve. Thus sociobiology is offered to us as a linking of a cluster of "hard" sciences—biology, genetics, biochemistry—and the "soft" social sciences. It is a synthesis that provides a rigid substructure—the opinion of the universe—for disciplines that until now have been troublesomely subjective in construction.

In his search for supporting evidence Wilson ranges far and wide, often brilliantly, sometimes questionably. Some of his arguments are essentially self-evident: the incest taboo, for instance, as a protection against deleterious inbreeding, or warfare as a way of improving a group's genetic fitness. Inevitably he touches on areas that are as sensitive today as Copernican astronomy was in the seventeenth century or natural selection in the nineteenth. The question of race, for one: if behavior is linked to genetic drives, then are race-linked patterns of behavior a sign of genetic superiority? It would be easy enough to use sociobiology as a racist tool by claiming that white colonial imperialism demonstrates the superior adaptability and survival power of Caucasians. It would be just as easy to show that the cultural traits currently impelling non-whites to reproduce faster than most white cultures prove the long-term genetic superiority of the non-whites, since they now seem the ones most likely to inherit the Earth. Wilson, obviously mindful of Shockley's difficulties, skirts the whole issue in a surprisingly per-

functory way by declaring, "It is a futile exercise to try to define discrete human races. Such entities do not in fact exist." Since he then immediately proceeds to discuss cultural differences between Chinese-American and Caucasion-American infants, the effect is one of cop-out: plainly Wilson does not want to make himself vulnerable to accusations of racism for fear of losing his forum, as has happened to Shockley.

On the question of male-female politics, though, he is more forthright. Citing the undeniable universality of male domination in human history, Wilson declares that "modest genetic differences exist between the sexes" and that this divergence is usually widened by cultural sanctions and training to place the men in charge and turn the women into chattels. Evidently the subordination of women had some genetic value for human society, he thinks, or it would not have been so consistently and widely practiced. (Opponents of Wilson call this circular reasoning; adherents regard it as rational analysis of the evidence.) In our society, at least, male domination is under attack and appears to be retreating, which Wilson acknowledges by calling it an "inconvenient and senseless" surviving relic of our prior genetic history. But despite this nod to current feminist ideals he does manage to leave the impression that the overthrow of traditional sex-role distinctions in our society might just be an aberrant departure from the long-term biological imperative.

The theme of altruism and self-sacrifice calls forth some of Wilson's most interesting ideas. Obviously the warrior who dies valiantly in battle, the youngster who drowns saving his struggling playmate, and the priest who takes a vow of celibacy have all removed themselves from the continuing gene pool. Where, then, is the genetic advantage in such behavior? And why, for that matter, has it not long ago

been bred out of the species?

Because, Wilson says, self-sacrifice protects the immediate gene-pool if not the actual genes of the sacrificer. The warrior dies in battle for the sake of his brothers and sisters and cousins and nephews and nieces; the hero who gives his life for another is probably aiding someone genetically rather like himself; the priest, though not a reproducer himself, gains through his renunciation of sex the moral stature from which he exhorts his co-religionists to reproduce more fervently; and so on. Astoundingly, Wilson even sees genetic value in homosexuality. Homosexuals, he says, freed from parental duties, have traditionally been able to play the roles of seers, shamans, artists, and keepers of tribal knowledge. Thus they have enriched the tribe and enhanced its survival. As for the non-disappearance of the genes of non-reporducers, Wilson has a simple explanation: most of one's genes are also found, in other combinations, in one's close kin. By furthering the survival of the tribe in general, one keeps one's own genetic heritage in circulation, if only by proxy. (He is willing to suggest that the predisposition toward homosexuality—and toward heroism in battle—is genetic, though he does not minimize the role of cultural determination. The basic Wilsonian point, though, is that genes determine culture.)

In developing his ideas Wilson is unable to avoid mechanistic metaphors. "The newborn infant is now seen to be wired with awesome precision," he says, recounting the ten billion neurons of the brain, the billion sensory elements that feed the central nervous system, the integrating centers of the eyes, and so on. "This marvelous robot," he says, "is launched into the world under the care of its parents. Its rapidly accumulating experience will soon transform it into an independently thinking and feeling individual." Then come the traits of social behavior—language,

ego awareness, love, family feeling, and all the rest. Is this all part of the machinery too, encoded in the genes, inexorably preordained? Is that all we are—nature's fanciest wind-up dolls?

To some degree, yes. We enter the world with all sorts of genetic clockwork ticking in us, and it determines our lives to a great measure. Piano lessons alone don't make a Horowitz; specific neuromotor abilities, and minor anatomical features like length of fingers, figure into it. Einstein had the wrong genetic program to be an adequate fullback; Muhammad Ali's circuitry did not equip him for the world chess championship; Karim Abdul-Jabbar would be a failure as a jockey. Apparently there are genetic programs governing schizophrenia, homosexuality, and left-handedness, and each of these traits can cause difficulties for their possessors if they live in a society where the opposite is the norm. Genes, then, not only decide our skin color, our bodily structure, and our ability to digest certain proteins, they tell us what we will do for a living, who we are most apt to find sexually attractive, and how well we will drive our cars. Is that so? Is there no way to circumvent genetic determinism?

Some of the program is inescapable. (Einstein trying to make the backfield of the Steelers, for example.) Some is almost impossible to overcome. (Perhaps with supreme effort someone with an IQ of 74 might translate *Finnegans Wake* into Aramaic, but I doubt it.) Some is optional. (Homosexuals and their heterosexual siblings have much the same genetic makeup; predispositions of the genes sometimes yield to cultural pressures.) Some is reversible (Lefthandedness.) Wilson's point is that the machinery is there—that we are sent into the world as little ticking boxes, already equipped with a set of programs that will define how we are to function.

This sounds bleak, cold, and ugly to many people.

But I think it's possible to take a more positive approach to these ideas.

Wilson does not, after all, insist that we are inexorably bound on pre-programmed routes through life. Bees are. A male bee will never sign up for retraining as a worker; a queen bee will not abdicate and spend the rest of her life buzzing about the flowers. Bees (and ants, and sea urchins, and all other low-phylum creatures) are tiny packets of genetic information that are almost without choice in the conduct of their lives. Higher on the evolutionary scale a little scope for variant behavior does appear, but generally speaking all frogs, lizards, robins, opossums, squirrels, antelopes, and baboons spend their days in a rigidly preordained journey from birth through maturity, mating, and reproduction to death, doing nothing along the way that does not directly serve the cause of insuring the next crop of frogs, lizards, robins, etc. On the most fundamental level it is the same for us, Wilson asserts; but our lives are longer than those of most other creatures, our minds are more intricate, our options are greater, and while we get on with the processes of birth, copulation, and death we are able to decorate our lives with all sorts of ornamentation not available to simpler beings. (And all of *that* in some way serves the genetic cause too, says Wilson.) The behavior of an ant colony is pretty much the same, aside from adaptations to local climatic conditions, whether those ants live in Turkey, France, or Thailand. Turks, French, and Thais, though, are rarely difficult to distinguish from one another. Gazelles show no cultural variation across all of East Africa that we are able to perceive, yet the same territory has produced perhaps a hundred human languages and three times as many sets of religious beliefs, tribal folkways, styles of dress, and techniques of making music. And so on.

Wilson offers a metaphor borrowed from the late

geneticist C.H. Waddington: the course of a human being's development can be seen as a landscape descending from highlands to the shore and cut by ridges and valleys. The path of each genetically determined trait across this landscape is probabilistic. For some traits (eye color, for instance) there is only a single channel, through which the trait must pass as inexorably as a ball down an alley: if you have the gene for brown eyes, your eyes are going to be brown, and no negotiations possible. For other traits several pathways are available (handedness, sexual preference, vocational aptitude), and even though a genetic predisposition toward one channel may exist, parental or social pressure may easily guide one's destiny into another. And some traits (schizophrenia, perhaps) have so many channels that the outcome is nearly random. The difference between human beings and mosquitos, under this metaphor, is that mosquito genetic programming involves a series of one-choice channels, and a mosquito's entire lifeplan is fixed at the moment of conception, whereas we, setting forth on the meandering rills of gulleys of our journey, start with a cluster of genetic predispositions but have so many options along the route that the scope for variation is wide and the range of developmental pattern is rich.

Throughout *On Human Nature* Wilson expands and embellishes this fundamental concept with what seems to me great clarity, wisdom, and reason. In the vastness of *Sociobiology* he illustrates the workings of genetic determinism in our fellow animals with a mountain of fascinating data, and invites us to make the conceptual leap from termites and gibbons to human beings, insisting that we are all cut from the same fabric. Here, of course, is the sticking point for the anti-Wilsonites, who are often quite willing to accept termites and even gibbons as little machines while still maintaining that *we* are of another sort.

I think that Wilson's arguments are unanswerable, just as those of religion or the humanistic philosophies are: each depends on a specific world-view that has at bottom an act of faith. In the dispute over the geocentricity of the solar system, one need only trot forth the mathematical proofs and the supporters of Ptolemy must perforce withdraw, grumble though they may. But in such matters as the nature of human nature no such clear-cut proofs are available; Wilson must in the end fall back on the position that his brand of scientific materialism is "probably the best myth we will ever have. It can be adjusted until it comes as close to truth as the human mind is constructed to judge the truth." Its claim to supremacy, he says, is "that the laws of the physical sciences are consistent with those of the biological and social sciences and can be linked in chains of causal explanation; that life and mind have a physical basis; that the world as we know it has evolved from earlier worlds obedient to the same laws; and that the visible universe today is everywhere subject to these materialist explanations." It is the same position that rationalists have been taking for half a millennium, and while it sounds convincing to those who are willing to be convinced by it, it contains no irrefutable mathmatics capable of overthrowing a belief in the singularity of the human species or the freely exercisable will of the individual. Nor can Wilson's special contribution, the assertion that the human mind itself, however miraculous it may seem, is bound by the same mechanistic laws that govern the movements of the planets in their orbits and the ebb and flow of the tides, be "proven" in quite the same way that a study of Kepler's laws of planetary motion and an analysis of the observed positions of the planets in the sky will demonstrate the validity of the thoughts of Copernicus.

Yet Wilson's ideas are exciting and plausible. If

they amount to the notion that we are just machines, so be it. If we are machines, we can be repaired when we falter and our design can be improved where the need for improvement is manifest. And this, I think, is where Wilson's thesis becomes most frightening for the humanists.

There is no reason why a machine, especially as intricate a machine as we seem to be, cannot be self-repairing. Even Wilson's genetic determanism clearly allows an organism to carry a program that leads it to a self-repairing (i.e. gene-modifying) capacity. Through a properly planned system of artificial selection, or even through out-and-out direct laboratory reconstruction of genes, we ought to be able to turn ourselves into superfolk, a race of recombinant titans, and thereby eliminate the nasty little flaws that mar the efficiency of the human organism as presently operating.

After all, Wilson observes, human nature at present is "a hodgepodge of special genetic adaptations to an environment largely vanished, the world of the Ice-Age hunter-gatherer. Modern life, as rich and rapidly changing as it appears to those caught in it, is nevertheless only a mosaic of cultural hypertrophies of the archaic behavioral adaptations." Our patterns of aggression, of male dominance, of territoriality, of group discipline, and all the rest, he says, represent the heritage of ancestors who survived the challenges of the prehistoric world. Through our own cleverness (or, Wilson would say, through the efficiency of our survival machinery) we have neutralized most of those challenges; yet our programs keep directing us to fight them anyway. But if mechanistic principles of the origins of social behavior can be worked out, we can rejigger the machinery to eliminate the evolutionary time-lag—that is, once we know all the rules, we can breed a better race of humans, just as with simpler goals to fulfill we have already managed

to breed better (i.e. more useful) forms of wheat and cattle and racehorses.

Of course that leads straight to the Third Reich and its efficient racial policies, or else to Marxist genetics—two ugly totalitarian chasms, most of us would say. Wilson acknowledges this by noting that we still don't really know how to upgrade our gene pool and therefore we should not attempt any serious degree of human reprogramming "until such time as an almost unimaginably greater knowledge of human heredity provides us with the option of a democratically contrived eugenics." He has no illusions about the likelihood of a saintly committee of wise leaders setting up criteria by which higher ethical values can be established through modification of the gene pool. But by arguing cogently and passionately that there is a link between genetic patterns and cultural values, Wilson raises the spectre of just such a committee, saintly or otherwise, engineering a society of its own design by tremors of horror in most of us. (Also part of the machinery—the genetic program defending itself against tinkering?)

I think we ought not get too exercised over the aspects of Wilson's arguments that arouse emotional responses of this sort, and simply look toward the theory itself. It is not necessary to *like* a theory or to feel comfortable about its most extreme implications in order to accept its validity. Sociobiology, like Ptolemaic astronomy, is most threatening to those who have a vested psychological interest in existing cultural assumptions—sociologists who think that *they* know how everything works, religious believers who prefer their traditional structures, artists who choose to see the artistic act as a working out of mystic intuition rather than as a stochastic process. To all these people Wilson tries to offer comfort; he hopes only to improve our knowledge of society's origins, he acknowledges the power and racial value

of traditional religion, he sees art as a valuable interpretation of experience and codification of behavior. Sociobiology is not a replacement for any existing body of belief but rather, he thinks, an enhancement, a clarification. In the closing pages of *On Human Nature* he proposes a joining between science and the humanities that could almost be a prospectus for science fiction. Not since Hugo Gernsback has anyone offered so stirring and lyrical a rationale for scientific speculation as this climactic passage from Wilson's supposedly "brutal" and "mechanistic" book:

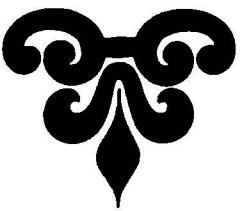
"We need to speak more explicitly of the things we do not know. The epic of which natural scientists write in technical fragments still has immense gaps and absorbing mysteries, not the least of which is the physical basis of the mind. Like blank spaces on the map of a partly explored world, their near borders can be fixed but their inner magnitude only roughly guessed. Scientists and humanistic scholars can do far better than they have at articulating the great goals toward which literate people move as on a voyage of discovery. Unknown and surprising things await. They are as accessible as in those days of primitive wonder when the early European explorers went forth and came upon new worlds and the first microscopists watched bacteria swim across drops of water. As knowledge grows science must increasingly become the stimulus to imagination."

This does not sound to me like the writing of a man who would lead us into a beehive society of genetic totalitarianism. What I hear in those words is an echo of H.G. Wells, perhaps, of Gernsback, of Campbell, of Robert A. Heinlein, of Arthur C. Clarke, of—well, insert your own favorite. I hear the voice of a poet of the scientific imagination.

—Robert Silverberg

A Letter From GOD

by Ian Watson




NOTHING ELS
OUT THERE
I DON'T HA
BILITY TO PLUCK
ILDISH HANDS
NLY HOP
SURVIVE
IFE
EAD UNIVERS
MY GODLY EYES
NTION TO YOU
GALAXIES
SUNS

Clearly, the Big Bang addled His Brains!

So at last I awoke, and saw my universe. Already I knew that something had gone wrong . . .

I shouldn't be able to tell you this. There oughtn't to be a single simple 'I' that can communicate with you. We should wear a myriad faces. We should be the Many-in-One, of which each conscious species in the universe is only the most fragmentary reflection—one single attribute of our high self, which is beyond self.

Instead, I awoke to a singleness of being which is far below that High Selflessness. I realized that I had been incarnated from out of my sleeping self quite

recently at a single point in space-time. It was the tug of that incarnation—that teasing of a portion of myself out of myself, into a particular shape for a while—it was that, coupled with something watery and oceanic, that had woken me a cosmic moment later. Like the footfall of an intruder in a darkened bedroom.

The bedroom wasn't entirely dark, of course. Galaxies and metagalaxies, crowded with suns, hung all over the place—a very big number of night lights, which was good.

Not dark. But it was empty. At first I thought it was entirely empty; and I shivered with dread at the absence of life.

To be sure, I *had* awoken—like an engine on a rather cold morning started, none the less, by a tiny trickle of charge from the battery. But the battery should have been fully charged—brimful with life-energy calling to me. And it wasn't; that tiny pulse was all I'd felt. I knew now how close I'd come to being in a cosmos where no life could ever have awakened me; and I knew how small and limited this present 'I' must therefore be.

It took a cosmic moment to locate the life that had awoken me. I was guided by a few more incidents of high consciousness from the same direction—high by your standard, pitifully weak by any other reckoning. I shouldn't have heeded the first tug. I should have turned over in my sleep, and slept through this cosmos till it collapsed! But in the vast silence that single note of life had sounded like a gong. Now that I was awake, I was committed to it; and because of this I was reduced to a single personal ego.

Of course, *you* had no idea that you were the one and only life-form to emerge in this cosmos. Oh you, with your proud arrays of radiotelescopes: tin ear trumpets harkening vainly for an alien message amid the mindless noise!

Like a vagabond who has precisely one match to light one piece of kindling to keep warm by, I directed myself towards you to cup my hands around that single prick of life-light, and nurse it with my breath.

Let me explain something about the creation of universes.

Your scientists have deduced that each successive cosmos springs into being by a random scattering out of 'superspace' of all the material of the previous one after it has collapsed. All the natural laws and physical constants of the previous cosmos vanish entirely, and new laws and constants spontaneously occur. But only certain laws and constants permit a habitable universe to occur—a universe where stars can form at all, and burn for a long time. The majority of universes must necessarily be lifeless ones. Either they last for too short a time, or perhaps no elements heavier than helium ever get the chance to form.

You know the game of pool, or snooker? You send the cue ball cannoning into a triangle of target balls and they all scatter in different directions, depending upon the cue ball's speed and spin and vector. If you had a completely frictionless pool table, the balls would carry on indefinitely, colliding and rebounding, till they all clunked into pockets—after a longer or a shorter time. (I bend the rules. I know.) Well, that first scattering of the balls is a bit—just a *bit*—like the first scattering out of superspace.

Contrary to your notion of random scattering, however, there is *a first deliberate shot* which send the balls of the cosmos flying, establishing the particular laws and constants of each universe.

And the Player? Myself. Or rather, the High Precursor of my present limited self. But it isn't quite so simple. The Player does not stand outside the universe. The precursor is the cue ball and the target balls and the cue as well, not to mention the baize of

space-time which the motion of the balls unrolls. At the instant of that first shot from which the cosmos springs, the precursor is torn apart, submerged into the spreading fabric of the game it has selected. Too, it must select angle and speed and spin such that during the course of the game, as the universe evolves, life of one kind or another will come into being: a cosmos of multifarious consciousness out of which—*by means of which*—that precursor will eventually awake and look around, with an awareness far beyond any of its billion tributory components.

A player usually has an opponent, too. Just so here, though in this case the Opponent is also part of the precursor. It is its anti-self—and that anti-self will also emerge, for unless there is a tension between God and anti-God the universe would be over in a flash. This is where the game gets really interesting.

This time, however, the precursor has miscued direly. The constants are off, the physical laws are wrong.

One world. One inhabited speck in it all—and that speck, I see now, a complete fluke! Not our favourite electromagnetic life—that's ruled out by the current constants—but protoplasmic life, preposterously chemically coded! Existing on a world perilously poised in a tiny habitable zone around a star that has been stable miraculously long! A world with a giant moon to draw tides upon the shore, and life upon the land. A world with an oxygen atmosphere which hasn't burnt up the life, but which on the contrary the life has learnt to breathe. And where did the oxygen come from, anyway? From life itself. Wild paradox. The odds against such life are vast even in an infinity of worlds.

I see the evidence of searing by a nearby supernova long ago. I see the hammer blow of a comet strike in your Late Cretaceous Period. I see the scars of the Ice

Ages—but somehow you escaped from the jaws of the ice calamity again and again, just as you avoided by a hair's breadth the runaway Greenhouse Effect of overheating.

I see how consciousness awoke, to awaken me—and how close it is to winking out again as you gobble up forests and food, fuel and fish.

The other consciousness, in your seas—which also, I see, conspired to awaken me—is already gone, turned into perfume and boot-oil, manure and pet-food by yourselves.

You have multiplied to starvation point and built sun-bombs to turn your world into a cinder. And here am I, awake, doomed to be cast in your image—since it is the one and only one available; so, if you all die, in this restricted image I shall hear nothing for almost ever after but the ticking of the quasars and the crackling of the barren suns.

You've flown to your moon, though, in tin cans. You've sent tin cans further out into the first few inches of that aimless deadness that stretches out all around you, everywhere.

And you're going to destroy yourselves. Would it destroy you, equally, to know that there's nothing else alive out there?

The only hope, as I see it from my hamstrung viewpoint, is for you to survive and spread out into the dead universe, to bring your own life to it, and in so doing to *change yourselves* into all the myriads of other life forms that are so sadly lacking.

I don't have the micromanipulative ability to pluck the ten thousand matches from your childish hands. My time should be aeons, my span whole galaxies! This attention to you is straining my Godly eyes!

How could this miscueing ever have taken place? Perhaps the sheer desolation everywhere else is somehow compensated for by the run of luck you represent. Perhaps this is a bravado universe.

Perhaps my precursor meant to cue a universe with no Opponent at all—since one and only one ball must run the course from first to last? A universe designed to fool the Opponent is surely also . . . a universe designed to fool myself!

Would a miracle, of the kind I think I can manage, not completely humiliate my one and only world?

I've made my mind up. I've decided, in an almighty break with tradition, to level with you people; to shake you by the scruff of the neck, to kick you in the ass—out into the galaxy, and into those beyond. (The exact details—the tin cans—I'll have to leave up to you.)

I don't, as I said, have the touch for dealing with individual scruffs of necks; I write large.

So I do just that.

I inscribe most of the foregoing as an open letter on a circular column ten miles high. (Which, to me, is rather like scribing a testament on a grain of rice. But never mind.) I plant this pillar down off the shore of your Florida, near where some of your tin cans take off, though not so closely as to be a hazard. Unfortunately, it does rather dwarf your Vehicle Assembly Building . . . No offence intended.

And I plant a second ten-mile column with a Russian text near Tyuratam Kosmodrome in your USSR.

I sit back, awaiting the cosmic exodus.

Perhaps ten miles is too high, even with your ingenuity—telescopes, balloons with cameras dangling from them . . .

It can't be, surely, that the letters are too large to be recognized as letters?

Well, it takes six weeks before the full text is released—by the Americans, the Russians following suit a few hours later.

The Russians promptly declare that I'm an im-

postor. According to them, my columns are the handiwork of an alien civilization bent on disenchanting you with the idea of galactic exploration by harping on the emptiness and the absence of life out there. With devastating cunning the Russians point out that on the contrary the sudden appearance of the columns proves that civilizations must abound. And these civilizations can't be too far ahead of Earth, either, or else they wouldn't be worried. They wouldn't stage this hoax of a letter from God, plainly an insult to human savvy.

I guess, pigheaded as it is, I should welcome this reaction—if it succeeds in uniting a squabbling world against an imaginary adversary in the sky; if it sets the starships flying.

The Americans, for their part, decide that if 'God' (best left undefined) can post a letter, equally they can answer it. They have great faith in the postal service. Up hum radio messages.

"This is the President of the United States of America speaking to the entity which identifies itself as God, in the sincere hope that you're listening. We appeal to you, on behalf of all the peoples of the Earth of whatever faith, to continue the dialogue you've begun. I'm suggesting no secret communications, but now that you've proved the extent of your powers perhaps radio will suffice? Now, we have some questions we all beg you to answer to elucidate your remark that the universe is the result of a 'miscueing'—and your other statement that no other life forms exist in the universe apart from ourselves. It's been suggested that this latter statement may simply be a compassionate, Godly way of making us value our own lives more . . ."

Around about this point in his radio speech, an awful double mishap occurs—so entirely coincidental that it seems utterly deliberate on my part.

The ten-mile-high column off Florida heels over in

the ocean. Falling, it slaps a tidal wave across most of the peninsula, destroying towns and cities—and incidentally all of the launch facilities at the Cape. And in the USSR the weight of their column triggers a fearful earthquake in a previously quiet seismic area, wrecking their launch site too. Shaken loose by the earthquake, that column also topples, hitting the ground with the force of an atom bomb. These two incidents, in their way, seem to me like a cruel recapitulation of the original miscueing of the whole darn cosmos—only this time I was trying to balance two cue sticks upright . . .

The Russians presently fire rather a large number of missiles out into space, to explode at random—but this cannot do me any harm, of course; I'm not of that nature.

The Chinese choose this moment of depleted Russian strength to attack with their own missiles. They get pretty thoroughly trashed in return, but the USSR is badly trashed too.

I look on, appalled at what I have wrought.

The Russian and Chinese survivors cry that the extraterrestial plot to ruin you all has worked. The Americans—and this is worse for my ego, now that I have one—accuse me of downright incompetence. By my own admission I set the universe up ineptly in the first place; now I've proved myself incompetent to have any further hand in it. (And I must honestly admit that this restricted 'I' which I am, does fall short of what I'd consider full Godly understanding . . .)

I withdraw from the tattered world, to lick my wounds for a century or two.

At the end of that century or two, the starships rise from Earth. They inch out, faster than light, into the heavens. Their crews burrow into dead worlds and the dead satellites of dead gas giants. They build

habitats. They begin to terraform some worlds so that people may walk upon the surface unprotected, even if it takes five thousand years.

Presently starships fly outward from these new worlds. The sphere of human penetration expands further and further.

I switch to high speed scanning. Millenia fly by, and now the starmen are constantly changing themselves into new and diverse kinds of beings: beings who can inhabit dead worlds without air or water, beings who can swim in gas giants, and coast through raw vacuum. Changing. A hundred forms. A thousand forms.

Like fleas they leap from the woolly spiral of the Milky Way across into Andromeda. They. *You.*

And you are all my Adversary. You are all my Opponent, now. You contribute nothing to my own expansion. Like my full capacity. None of you. But *you* aren't restricted.

You're hatching a multi-billion year scheme to survive the collapse of this cosmos and make it through intact into the next, differently-cued cycle of existence—to bring me to trial! Worse, to cue the next cycle yourselves so that it starts out right. I'm accused of Huge Frivolity, Negligence, and a Cavalier Attitude.

I hide from you all now in the deepest deeps between the metagalaxies—even if I am, in one sense, still everywhere. *I* hide: this 'I' hides from man.

But once this universe reaches its phase of maximum expansion and begins to contract again, I know that wherever I hide we'll all be rushed together in the end. Then you'll catch me, sure as eggs is eggs.

Cosmic eggs are no exception. Particularly when they're all in one basket.

—Ian Watson

MINDS, MACHINES, AND EVOLUTION

by James Hogan

ONE OF THE ODDER OF THE COMMON FALLACIES IS THE BELIEF THAT IF ONE CANNOT IMAGINE SOMETHING, THEN IT CANNOT BE.

If a 'machine' is any kind of system created by Man, and 'thinking' means all the kinds of mental activity we normally refer to when we use the word, will a machine ever be able to think?

I've chosen to use this somewhat loose and perfectly general terminology to avoid getting tangled up in the semantic irrelevancies that seem to typify so many of the debates one hears on this subject. A long philosophic treatise that I came across recently, for example, took ten pages or so to argue that a 'machine' is something that operates 'mechanically,'

i.e. according to fixed and unalterable rules implicit in its design, and another ten pages to deduce that 'thinking' could not be so described. Its solemn conclusion that thinking machines were therefore impossible on principle was not surprising nor particularly illuminating, since if somebody starts out by defining a machine as something that operates in a way the mind doesn't, he should expect it to lead to the deduction that a machine can't do things which the mind can. The flowery prose and the obscure technical terms used served only to conceal that the argument was stating the obvious, and in doing so missing the real point entirely.

History has taught repeatedly that it pays to be open minded, especially when the argument is over something or other being impossible or not. An open minded approach to this particular issue would be to ask the question: 'If a human brain is a system that can think, is there any reason to suppose that no other kind of system could be capable of doing likewise?', and if the answer was, 'No there isn't', to conclude that man-made thinking systems are possible until somebody proves otherwise. This, of course, is another way of asking if the mind can be adequately explained by the laws of physics as we know them and which would presumably govern the operation of any artificial system. If it can, then there's nothing in principle to prevent some other kind of system from emulating it; if it can't, we must conclude that the mind possesses something 'extra'—some fundamental, qualitative difference that sets it apart from all forms of man-made device (potential as well as existing) and makes it unlikely that its function could ever be duplicated. This, in my submission, is the crux of the whole Artificial Intelligence controversy. So which answer are we going to give to the question, and why?

An important part of living is being able to distin-

guish reliably between statements that are probably true and statements that probably aren't, and over the centuries our culture has produced a bewildering variety of systems of thought that profess the ability to guide us in making such decisions. The system that stands apart from all the others in a class of its own in its consistent ability to yield results that stand up to the *test* of *experiment* and make *predictions* that come true is the one we refer to as *scientific method*; the astonishing degree to which it has extended our understanding of the universe from galaxies and quasars through to muons and quarks, and the jetliners, TV sets, telephones, and electrical generators that we don't even notice all around us because we take them for granted all testify that it works, and works extremely well. So let's use that as our guide in trying to decide if there's anything unique about the mind, since beyond any reasonable doubt it's the best guide we've got.

One of the basic principles of scientific method is that an idea might be interesting, but there's no point in getting too serious about it unless there's some way of testing whether or not it's true, in other words, "Believe in something only when there's a good reason to." So there's nothing wrong with postulating that the world is carried on the back of a giant elephant if you want, but you'd better be able to show me the elephant. Another basic principle is, 'Don't go for a complicated explanation when a simpler one can account for all the facts'; in this context, 'simpler' means 'one that requires fewer assumptions'. Hence I'll accept that alien spacecraft might be visiting this planet, but lights in the sky aren't enough to convince me that they are; lot of other things that we're perfectly familiar with produce lights in the sky.

When we look inside the human brain we find atoms, molecules, electrical charges, chemical reactions, and all the familiar phenomena that go to make

up the rest of the universe. We also find exceptionally high levels of organization and complexity, and not a lot else. Are these factors alone sufficient to give rise to everything that we mean by 'mind'? Our first reaction might be to exclaim "No way!" because we find it impossible to imagine how anything like a mind could result from such simple and apparently unrelated elements, but when you think about it, such a response is really describing the limits of our imagination and saying nothing about the matter at hand at all. Science has shown time and time again that this kind of intuition can be a very unreliable guide when we venture into realms that lie beyond the ordinary everyday world of our senses. When Darwin's Theory of Evolution was published, many people opposed it on principle because they were unable to visualize how selective forces operating on large populations over long periods of time could transform inanimate matter into animate, and simpler species into more advanced ones. That didn't invalidate the theory, which today is substantiated by an overwhelming weight of evidence and no longer questioned seriously within the scientific community. And whose everyday intuition could have conceived quantum mechanics or Relativity?

So instead of reacting impulsively, let's apply our first principle and agree that there's no compelling reason at this point to believe in additional factors beyond the ones that are observed, and see if by thinking about the problem we can account for the mind in a way that is at least possible. If we can, then by our second principle there's no justification in introducing anything 'extra' since the simplest explanation available will have proved adequate.

A novel is an elaborate composition that can assume any of a virtually limitless number of forms, each of which might be perceived as embodying distinct qualities of 'sadness', 'passion', 'anguish', and so

on; similarly a symphony might be described as 'majestic' or 'somber'. Where, in such creations, do these qualities exist? At its elementary level every novel consists of letters drawn from the same, very limited, alphabet, and every piece of music of notes; but clearly it would be absurd to look for signs of happiness, sadness, and so on at that kind of level. But letters are assembled into words, and in combination become able to take on a whole new diversity of meanings which simple couldn't be expressed at the letter level; in the same way, words can be strung into sentences, sentences combined into paragraphs, and paragraphs built into novels just as notes, bars, phrases, themes, and movements go together to make the building blocks of symphonies. In each case the end-product is formed from an ascending hierarchy of components which increase progressively in complexity, and therefore in possible variety. At successively higher levels in such hierarchies, new orders of meaning and relationships emerge as properties inherent in the organizational complexity of a given level itself, which simply can't exist within the more restricted worlds of lower levels. Thus a single word can convey the notion of a simple object or action, but a sentence is needed to describe one object acting upon another one, maybe in a particular manner, time, or place. We see nothing remarkable in the observation that combinations of words can acquire depths of meaning and a variety of expression that transcends the properties of single words, and we feel no compulsion to invoke any magical or mystical agencies to explain it.

The same applies but to a far more striking degree in the field of biological evolution, which can be described loosely as the tendency for more complex systems of organization to emerge from simpler ones under the influence of selective pressures. Inorganic compounds assembled into larger, more complicated

organic substances which in the course of time evolved self-replication and progressed through single-celled organisms and multi-celled organisms to the advanced life-forms of today. Again we see a hierarchy of progressively increasing levels of organization and complexity, and at each new level new properties become manifest which exist only within the context of that level and which can only be described in terms that apply to that level; they cannot be described in terms of the properties of their components and still retain meaning although they are nothing more than a composite effect of those components. Thus the 'ruggedness' of an elephant or the 'cuteness' of a kitten can't be expressed in terms of the structures, spatial orientations, and chemical bondings of the molecules they comprise. Even if every single molecule were completely specified in the terms applicable to molecules, the resultant would still add up to a bewildering mass of numbers; it wouldn't add up to 'elephant', which is a concept expressible only in terms that apply many levels further up the hierarchy. In other words a single molecule doesn't possess a property of 'elephantness', but a large number of them, when put together in the right way, do.

Darwin's theory met with a lot of protest because many people refused to believe that the richness and variety of life could be fully accounted for by considerations like these. Some people today still do; they might be right too, but I find the principle quite acceptable, even if I am unable to visualize clearly every step and detail of the process, and conclude that there's no good reason to bring in any additional factors over and above those that the theory requires. And since they are nothing more than the same laws of physics that we see operating everywhere else in the universe, I feel on fairly safe ground.

Now if the result of allowing evolutionary proces-

ses to operate on simple starting materials for a billion years or so can be a physical form as intricate as the eye of an eagle or the airframe of a humming bird, is it so inconceivable that the nervous systems involved should have become capable of exhibiting behavior patterns just as impressive and in essentially the same way? If the laws of physics plus selection and nothing more are sufficient to account for the process of physical evolution that has resulted in higher forms of life, it seems quite possible that those same factors and nothing more could account for the process of behavioral evolution resulting in mind. And if we accept that an explanation along these lines *could* account for all the observed facts, then as we've already said there's no justification in wheeling in additional causes.

Survival is the name of the evolution game, and it's easy to see how such physical attributes as higher running speed, improved camouflage, and stronger jaws would enhance an individual's chances of survival and make it more likely for his genes to find their way into subsequent generations for further refinement. But it's not only what you've got but how you use it that matters, in other words an organism's *behavior*—how it interacts with its environment—is just as important for survival as its physical fitness, if not more so. Interacting with an environment consists of three basic operations:obtaining information from the environment, e.g. acquiring a visual pattern on the retina, processing and interpreting that information, e.g. deciding that the pattern represents a saber-tooth tiger coming this way fast, and initiating some action on the basis of that decision, e.g. running like hell. All of these operations are performed by the nervous system, and it isn't too difficult to see how major improvements in efficiency of the nervous system would confer enormous survival advantages and be rapidly reinforced in the evolutionary process. It's

interesting to note that in tracing the sequence that such major improvements could be expected to have followed, we see emerging many of the basic qualities that are essential to characterize that which we call 'mind'.

Primitive life-forms such as sponges evolved specialized cells that could respond to stimuli in the environment and trigger automatic responses that might, for example, improve the chances of capturing food. With things like jellyfish these cells developed into simple neural networks that could coordinate the movements of the whole organism, and in higher forms still these networks formed concentrations of neural tissue to apply more sophisticated processing techniques to the data gathered by the senses, which eventually became brains.

And here, just as with physical bodies, we see another example of a hierarchy of progressively higher orders of complexity taking shape. And just as was the case with novels and symphonies, we would expect that as each new level of complexity became added to the growing hierarchical onion, the units of information being processed would acquire new orders of meaning and interpretation that took on *symbolic* values progressively further removed from the raw data of pressure waves, tactile stimuli, and so forth impinging on the senses. Thus we see the beginnings of a mecahnism for assembling sensory data into symbols and symbols into a *conceptual world-model* inhabited not by aggregates of molecules, wavelengths, and momenta, but by personalities, objects, threats, rivals, allies, potential mates, and all the other factors that affect the well-being and survival of a high-level organism interacting with a high-level environment.

In combining symbols together to create progressively more elaborate world-models, the evolving brain would learn to synthesize a mental representa-

tion of the three-dimensional space around it and the objects within that space, and of the ways in which they interact with one another. If a primary criterion that determines whether or not an organism will be successful is its ability to protect itself in order to reproduce, a very important set of symbols for it to evolve within its model would be those that enable it to distinguish the self that needs protecting from all the other entities that come after "number one." We thus see the basis of a *self-image* as a mapping into the world-model of a particularly relevant portion of 3-D real estate.

And given the ability to manipulate conceptual symbols in a way that mimics the world as it really is, it doesn't seem such a gigantic step to go from there to being able to manipulate the same symbols into representations of worlds that *could* exist. This ability would enable, for example, the scenario of a possible danger to be played through in advance before it had become a reality, thus allowing timely action to be taken to avoid it with obviously improved odds in the survival stakes, or in a word the faculty of *'anticipation'*. And once we're in a position to play with models of worlds and situations that don't actually exist, we're surely well on the way to *imagination* and *creativity*.

This is all very well, but it won't do much to help somebody's survival prospects if he's so preoccupied with fond anticipations of his date tonight with the blonde who lives three caves farther along the valley that he fails to notice the tiger coming at him down the hill. In other words all this variety of complex activity within the brain requires some kind of 'overseeing' function to monitor what's going on inside it and make decisions about which functions need to be activated now and which should be suspended until some other time to ensure the most appropriate response to the demands of the real world outside. This

implies a need for a degree of *awareness* inside the brain of its own processes, particularly at the level of the higher-order symbols. When this is coupled to the self-image that we already have, it adds up to *self-awareness*, and do we really mean any more than that when we talk about *consciousness*?

And there we have it—all the qualities that describe what we refer to as 'mind' emerge as new properties that express themselves in successively higher orders of complexity, and at the lowermost level of the hierarchy we need nothing more than the familiar elements and laws of physics. The brain is without doubt the most complex system that we know, and therein—and nowhere else—lies the difference that makes it unique. That being so, there appears to be no reason in principle why another form of system of comparable complexity shouldn't be capable of exhibiting comparable qualities. Artificial intelligent systems ought to be possible.

A common objection to this claim is that man-made systems—computers for example—are necessarily 'machines' constructed from components that obey rigid rules and always behave in a fixed and predetermined manner. Even if a computer incorporates a few tricks to emulate decision-making or randomness, such 'flexibility' is there only because it was programmed to be there in the first place, and therefore it isn't really flexibility at all; in the long run the computer can still do only what it's programmed to do, nothing more and nothing less. It will always respond in exactly the same way to the same set of inputs (including any 'inputs' from internal randomness generators), and nothing that could qualify as 'thinking' could take place under such constraints.

This is certainly true of any of today's computers, but then nobody is claiming that today's computers think. Furthermore, this kind of objection fails to take

into account that precisely the same observation could be made about the human brain itself. At the microscopic 'hardware' level the brain is constructed from comparatively simple neurons which obey rigid rules and perform in a completely fixed and predetermined manner. If the sum of signals applied to a neuron's inputs exceed the threshold 'programmed' into it, the neuron will fire; if they don't, it won't. The neuron doesn't go through agonies of doubt or indecision trying to make up any microscopic mind about what to do in a given situation. At that level there is no 'mind', and the 'decision' is made quite mechanically according to fixed rules just like a "decision" generated by an integrated circuit chip inside a computer.

At the fundamental hardware level a computer is indeed composed of mechanical, deterministic components, but so is the brain. The fallacy in the objection lies in attempting to compare the brain's most complex, abstract properties, which are manifest only at its topmost level, with those of a computer's simplest, lowermost level. It's rather like saying that a tree-shrew could never evolve into Man because Man can build cities and paint masterpieces, and a tree-shrew is nothing but amino acids and proteins which are obviously incapable of such feats.

A good example of another very complex, inanimate system that's forced from large numbers of simple, totally mechanistic elements at its lowest level is the Earth's atmosphere. At its fundamental 'hardware' level it consists of countless gas molecules, every one of which interacts in a simple fashion with its neighbors in accordance with the fixed laws of thermodynamics, and at this level the response of a given molecule to a particular set of forces acting on it can be calculated precisely. But at the macroscopic level the resultant patterns of behavior appear as hurricanes, rainfalls, cloud banks,

and various other localized phenomena which in turn produce the global formations revealed by satellites, all of which acquire new domains of meaning inapplicable to molecules. We describe them in macroscopic terms like 'temperature', 'pressure', 'humidity', and so on, i.e. as *statistical* measures of the composite effects of huge numbers of molecules whose individual interactions can never be known with certainty. In the process we define a qualitatively new set of concepts and properties which lose the precision and predictability that characterize the lower-level operations and acquire an increasing degree of uncertainty and 'whimsical' behavior. And how much more true this is in the case of the vastly more complex system of the brain!

How true is it of computers?

Even the comparatively simple computer systems of today show the distinct beginnings of a hierarchical organization in which the information units being processed take on progressively more abstract and symbolic meanings as we ascend through higher levels. The hardware that comprises the lowest level leads a somewhat monotonous and uninteresting life shuffling binary digits to and fro according to its mechanical rules, but in the successively higher levels of 'software' activity that this traffic supports, the 'bits' are combined together and manipulated in the form of such entities as 'bytes', 'words', command strings, and data arrays to convey meanings in the terms in which computer programmers, not hardware circuit engineers, think. And above these levels the programming entities combine to produce 'records', 'files', screen formats, graphs on CRT screens and so forth, all of which reflect little of the qualities of computer hardware but relate directly to perceived aspects of the world of human affairs outside.

Now none of this is meant to suggest that what goes

on inside any of the computers built to date qualifies as 'thinking'. The way they operate is, however, analagous in an intriguing way to the mechanical, reflexive processes that must have characterized the earliest nervous systems, long before anything approaching 'mind' appeared. The parallel becomes even more intriguing when we note that, to a rudimentary dêgree anyway, the qualities of unpredictability and 'whimsy' that we insist on as indispensable ingredients of 'thinking' are already beginning to appear in advanced computer systems.

A large real-time system, for example—perhaps one for controlling the operation of an entire steel plant—would typically contain hundreds or maybe thousand of programs representing different tasks that need to be performed at different times and in different circumstances, and a specification of the priority relationships which enable the computer to decide which tasks are most important at any given moment and which can wait. Through thousands of instruments wired in from all over the plant the computer "senses" the continually changing conditions and modifies its operations to respond in an appropriate fashion, perhaps by suspending execution of one task to allow a higher priority response to a critical situation somewhere, or to activate lower priority 'fill-in' jobs at times when there's nothing more pressing to attend to. The result is a bewildering activity pattern of different programs all being started, interrupted, suspended, of interrupts nested within interrupts nested within interrupts, all interlaced with the operations of other programs keeping track of what's going on, and since this is all being 'driven' by unpredictable events unfolding in the outside world, it's impossible to say in advance what state the system will be in or what it will be doing at any particular time. If the system is in the form of a network inwhich messages are constantly being ex-

changed between the various nodes, a particular message might be broken up into separate packets of information that are routed via different paths to be recombined at the destination. The routing decisions would be made to optimize traffic flow and would depend purely on the conditions prevailing between the nodes at the time, and again it would be impossible to predict in advance which of the many alternatives open to it the system would adopt.

Hence it's not really true to say, even today, that a computer's response to the same set of input conditions will always be the same. The response will depend not only on what signals and commands are applied externally, but also on the system's internal condition, or 'state', at the time, and this in turn will depend on its earlier history, i.e. its 'experiences'. What is 'programmed in' is the *potential* to react to different stimuli in various ways without any preordained *macroscopic* pattern being defined. The resultant behavior pattern observed becomes a product of the system's interactions with its functional environment, and presents a striking parallel to the primitive processes that culminated eventually in the emergence of natural intelligence. As is the case with the human brain and the neural network of a jellyfish, the difference between an intelligent inorganic system and a contemporary computer appears to be simply a matter of degree and not anything fundamental in nature. Therefore I can see no conclusive reason to believe that a sufficiently complex mad-made system shouldn't think, and whether or not we would continue to call such a system a 'computer' is immaterial. For those who still argue that they could never imagine a computer being able to originate a knowledgeable critique of *Gone With the Wind,* my reply would be that reality is not limited by their imaginations; a jellyfish can't either (imagine it or do it), so does that prove that brains are impossi-

ble?

A fact of life well-known to system designers is that some of the requirements of a system will always conflict with each other, thereby necessitating 'tradeoffs' of some kind in the design process. If a system is designed to optimize one aspect of its performance all-out, it invariably pays heavy penalties in other directions which the designer selects to be least damaging to the purpose the system is primarily intended to serve. Thus a high-altitude interceptor excells in speed and maneuverability but doesn't have the range or load-carrying capacity of a freight transporter; a school bus is great for getting kids to school but wouldn't win many trophies on a racing circuit; the most reliable machines are never the cheapest, and so on. Systems designed to be general-purpose offer a compromise in being able to do a number of things moderately well without being spectacular at any of them (although I suppose you could say they excell in versatility). The human brain is undoubtably the most versatile and general-purpose system that we know, and offers a prime example of a system of the second kind. It can do practically anything to a degree, but its performance in any one area is limited and we supplement it with all kinds of specialized aids such as microscopes, telescopes, long-range communications equipment, and calculating devices, each of which can outperform the brain by many orders of magnitude in its own particular function, but is useless for anything else.

It could turn out that when we eventually build a system capable of versatility and generalizing abilities comparable to the brain's, we'll find that we have to sacrifice many of the features that we tend to associate with the highly specialized computers that we see today. Maybe our artificial intelligent system would find that it couldn't process astronomic calcu-

lations in seconds in the way that an IBM 370 or a CDC 7600 can, couldn't recall word for word a conversation that it had a week ago with somebody, and, unlike a simple 'machine', found that it had to wrestle with all kind of imponderables to make a decision about some course of action and even then couldn't say with certainty that it had made the right choice. In other words the process of evolving the higher level 'conscious' operations by which it manipulated the symbolic representations of the world around it could result in its becoming 'shut-off' from the low level hardware at which its mathematically exact and high-speed 'subconscious' activity is taking place.

This, after all, is just what has happened in the case of the human mind. Our neurons function according to precise and simple laws, but our conscious awareness does not extend down to that level. We think and communicate in terms of persons, places, ideas, and things with no knowledge of or need to understand the processions of discrete neural impulses being shuffled around in our brains or the chemical codes that the cells and organs of our bodies use to communicate among themselves in order to control temperature, blood pressure, respiration, digestion, and the like. At their own levels they communicate in their own languages, and we at our level as *conscious totalities* communicate in ours.

It's not difficult to see why evolution proceeded in this direction as it manufactured more and more complex brains. The simple act of raising an arm to comb one's hair requires the coordinated action of something like forty muscles, and even this is many levels of complexity up from the basic 'hardware' operations of discrete neural discharges. Such muscular sequences are triggered by fixed 'microprograms' that are 'hard-wired' into the nervous system and initiated by single high-level commands issued

at the voluntary, conscious level. if we had to follow every detail of such a sequence step by step to make it work, our brains would be permanently saturated with mundane housekeeping and unable ever to think about where the next meal's coming from, or what the animal coming down the hill is and if it looks mean and hungry. Delegating such chores to the subconscious level seems a good way of freeing up our more powerful conscious processing capacity for more valuable, survival-oriented activity.

Again the beginnings of the same kind of trend are apparent in today's computers. At the basic hardware level a discrete machine operation is controlled by a sequence of 'microcode' instructions embedded in the machine's design. Microcode is understood by and constitutes the 'language' of circuit chips and hardware design engineers. At a higher level a single 'machine instruction', expressed as a symbolic mnemonic, can trigger off a complete predefined sequence of microcode operations, and provides the basic unit in which 'machine language' programs are written; the machine language programmer does not have to understand microcode to write his program, or even be aware that it exists. Above this are 'high-level language' commands which trigger whole sequences of machine instructions, enabling a scientist, for example, to program a solution to an equation in mathematical terms without having to be a machine language programmer or know anything about machine instructions. And finally we come to the level of 'operating system' commands and 'user' commands at which whole programs and other functions that are meaningful in real-world terms that have no connection with computers *per se*, such as booking an airliner seat or checking a bank balance, can be used without the users needing to know or care whether what goes on behind the buttons is electronics, clockwork, or black

magic.

This makes a lot of sense. If every user of a computer had to understand microcode in order to obtain a payroll or play 'Adventure', the industry wouldn't sell many computers. Also, of course, it's difficult to see how they could be designed any other way, or any other type of complicated machine either for that matter. For any kind of system built from subsystems that are built from assemblies that are built from subassemblies that are built from components, the designers who produce the devices at each level become highly specialized with their own specialized languages, and pass their creations up to the specialists at the next level as a 'black box' accompanied by a specification of what goes in and what comes out; to use it you don't have to know in detail what happens inside. If an automobile designer had to be an expert on everything from engines to radios right down to having to design the transistors, it's doubtful if anything more complicated than a bicycle would ever get built. In other words it might turn out that one of Nature's basic tradeoffs is: 'Thinking big and thinking small are mutually exclusive'. (I never agreed with the saying about looking after the pennies; if you can look after the dollars, who cares about the pennies?)

Our intelligent computer might thus find itself intelligent at a level that precluded any awareness of exactly how its microcoding and various subsystem operations worked, just as we are unaware of what our neurons are doing or even that we have any. It might therefore be unable to access the levels of its nature at which fast, high-precision operations are executed, having sacrificed such specializations in return for versatility. So what would it do if it wanted to compute pi to a couple of thousand decimal places? Well, I guess it would have to build itself a computer or buy one. And that's another good reason

to suppose that by that time we'd be calling it something else.

Another good reason is that by that time we might no longer be building 'computers' as we understand them (i.e. electronics in some form packed into boxes of some form) at all. In recent years the science of microbiology has made enormous strides towards unravelling the genetic code and understanding in detail how the instructions carried in the structure of a DNA molecule are expressed in the macroscopic properties of the organism whose growth the DNA controls. Also we already manufacture simpler molecules to order as a matter of course, such as certain drugs which mimic the structures of neurotransmitters in the brain and anesthetics, to exhibit certain desired characteristics. So if we extrapolate this a step farther, is there any reason why, one day, a complete artificial DNA molecule shouldn't be designed and manufactured to specification to control the growth of a biological structure having any specialized capabilities we choose? Maybe this offers a far more efficient method of making high-density computers.

If such a structure were highly specialized and designed to do exactly what it's told to do and no more, fast, it would probably make sense to continue calling it a 'computer'. But suppose that it was designed to be not highly specialized at any perticular thing, but a fully general system comparable in every way to the human mind. It might not be designed as a fully developed adult mind of course, which has been shaped by years of experience and interacting with its environment, but perhaps as something more akin to an embryonic mind that had 'programmed in' the *ability* to learn and generalize, but which would then have to be taught from then on. An appropriate name for it would be: '*B*iologically *R*eproduced *A*rtificial *IN*telligence', which, since computer people de-

light in acronyms, would soon be abbreviated to "BRAINS." That would describe it pretty well and would save us from having to think up another word when we already have a perfectly adequate one. The use of upper and lower case would be sufficient to distinguish which kind had come from which origin.

I see no reason to suppose that this couldn't present an opportunity to end up with a 'BRAIN' that is a better brain than "brains." Nature is not the perfectionist that many people suppose, and evolution is full of dead-end experiments that got nowhere, compromises that were barely "good enough," and examples of better ways of doing things that could have been exploited if it were possible to back-track over a hundred million years or so and try again. The long road upwards from our distant pre-Devonian ancestors has no doubt left us with a long list of mental relics and traits that we'd be better off without, and it's not difficult to come up with some possible candidates for things we'd like to be better at but which were never selected for and reinforced strongly because they have become significant only within the environment that we have created and weren't really a factor in the environment that has predominated until very recently. We could, perhaps, do wonderful things for the IQ of the species, or maybe add in some bio-electronics to improve our long-range communications, or maybe our ability to think rationally under stress and adapt easily to new situations. In short it seems to offer a good opportunity to clear out a lot of junk that has been accumulating for something like a billion years and replace it with some improvements of our own choosing.

How is it that somewhere I've started talking about 'us' and stopped referring to artificial systems? Because I think we've reached the point of catching a glimpse of where all this could be leading. A brain like ours would need to be supplied with nutrients

and energy in the same kind of way that ours is, and being just as curious about the universe outside, would want to move itself around and take in information from its environment. Well, the human body provides an ideal 'support system' for doing all that, and if we've postulated genetic engineering taken to the point of growing better brains, why not go the whole hog while we're at it and grow an improved-model body to put it in as well? In other words we seem to have arrived at a much surer and faster method of improving our own species than shuffling chromosomes around randomly in games of sexual roulette and hoping for the best. (No, I'm not advocating doing away with sex!)

The evolution of a species is shaped by its environment, and Man's intelligence has become a significant, if not the dominant, factor operating in the environment in which we exist. Intelligence is now a part of our environment, and its effects are just as "natural" as any other part of it; I see nothing "unnatural" about guided, intelligent thought superseding random mutation and selection, and becoming the major force in determining the further path that evolution should take after the appearance of 'natural' intelligence in the picture. The spectrum of evolution began when raw atomic nuclei first formed and remained stable out of the cooling plasma of the Big Bang, and the appearance of life billions of years later in the still cooler conditions of planetary surfaces was just a significant milestone along the way that marked the beginning of a qualitatively distinct phase in an essentially continuous process. The emergence of intelligence was another such milestone, ushering in a new era in which new forms are produced not by chance variations on a theme but by deliberate design, and selection is performed by consciously applied choice instead of by blindly operating survival factors. Over the past fifty thousand

years or so, which is but the wink of an eye on the total evolutionary timescale, the results of the introduction of guided thought into the scene have been stupendous, and its potency to influence the shaping of the millenia ahead is surely awesome. I see nothing unnatural, distasteful, or repugnant in the notion that this same force should prove to be the dominant influence in transforming Man as we know him into whatever he is destined to become.

So perhaps one day a race of streamlined and enlightened beings of some form will look back on their distant ancestral cousins and see a similar comparison to themselves as we see with *Ramapithecus* or even *Stegosaurus*. What ambitions, hopes, aspirations, and visions of the future might motivate them I've no way of knowing, or probably even of visualizing. But I wish them well, and in many ways I envy them.

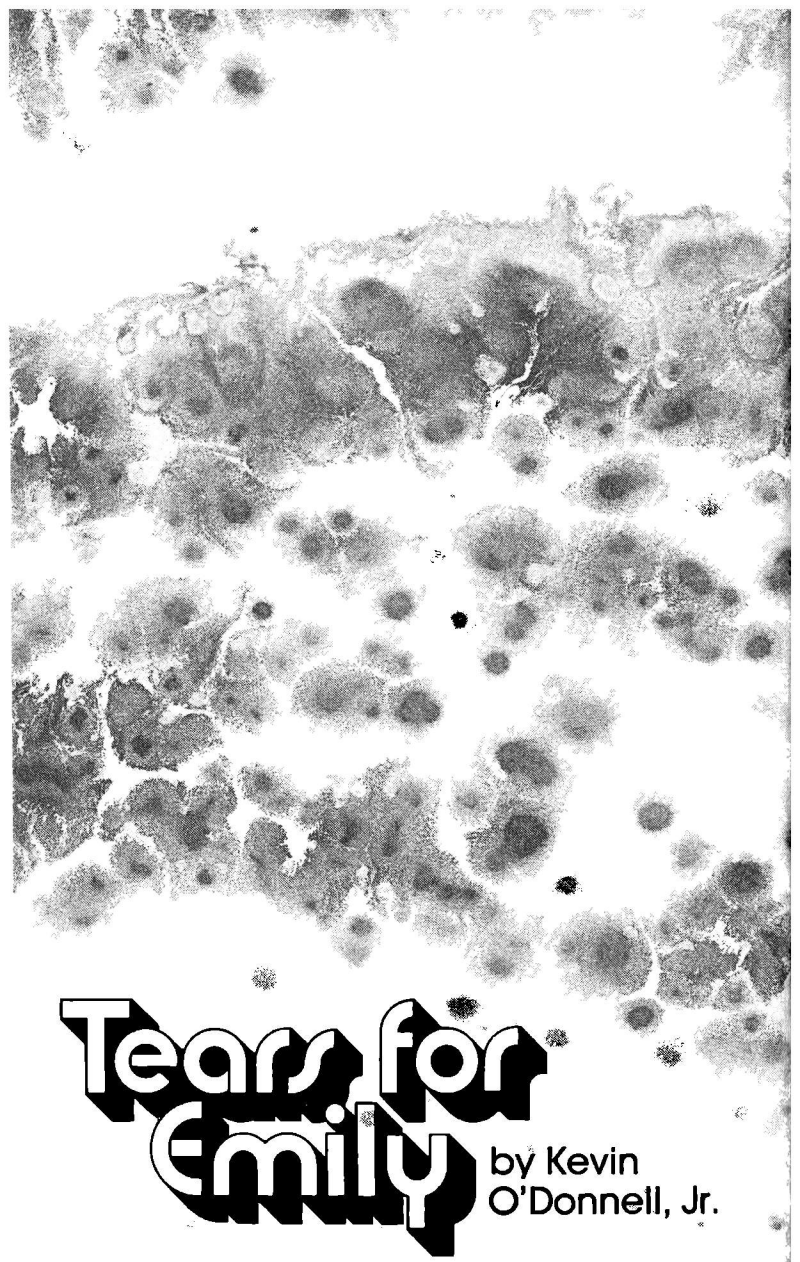
Pretend that long ago on the bed of a drying-up ocean that was left covered by pools of water, there lived a race of intelligent amoebas who built instruments that could see beyond the rim of their pool to find out what the universe outside was like. To their astonishment, they discovered that the universe consisted of countless other pools all very similar to their own, extending in every direction to the infinitely distant horizon.

"Is there some way we can explore those other pools?" the more curious of the amoebas asked.

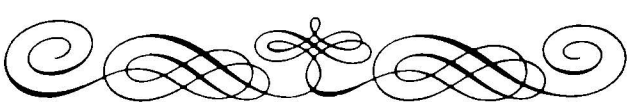
"Impossible!" the skeptics replied. "There's no way we could survive in the void between the pools. And even if there were, the distances are far to great to cover in a lifetime. We'll never travel to other pools."

"*We* won't," some of the more thoughtful said. "But we might evolve into something else that will."

—James P. Hogan


Tears for Emily
by Kevin O'Donnell, Jr.

LOVE ISN'T EVERYTHING, BUT WITHOUT IT YOU'VE GOT NOTHING. ABSOLUTELY NOTHING.



The lookout at the monitors said, "Cops!" That froze the dissident leaders in Emily Kenyer's apartment. Outside, brakes screeched. Silence: then a shotgun roared. Big Dan Higgins took charge. "Stay put. It's not for us; it's across the street."

He's got good instincts, Kenyer thought. *Cool-*

headed and sensible. I like that. I wonder how it jibes with his "modified anarchy," though?

"Emily, get the lamp by the window. Harry and Chelle fade, now; I'll meet you at the van later. Out the back, soft but righteous, you know?"

She moved across the living room while his two assistants slipped through the kitchen. His gaze tracked her like radar; she felt it even with her back turned. *Maybe you'll get your chance, Em,* she thought. *Make the most of it; convince him before he leaves town.* She pushed the button of the K-Mart lamp and darkness swallowed them all.

Red shimmers streaked the ceiling. She glanced outside. Below, sheriff's men crouched behind open cruiser doors; a spotlight white-washed the house across the street. "Dan, it's a foreclosure eviction."

"Dough, stash the monitors. Emily, is there a crowd yet?"

"Small—the cops are trying to break it up." Yet even as she spoke, T-shirted figures mushroomed around the fire hydrant. "Getting bigger."

"Folks," said Higgins, "I'd hoped we could get to know each other tonight, but let's be elsewhere when they come collecting statements. Anybody but me have outstanding wants or warrants? No? Good . . . Win and Martha, out the front, pretend you live here and want to see what's happening—then slip away." He shook hands with the middle-aged couple, patting each on the shoulder, then turned to Doug and the other Yale student. "Out the back, around to the right, come up between the two houses and make like nosey next-door neighbors. Gape, mingle, vanish. Got it?" At their nods, he shook their hands, too. "See you soon, okay?"

When the metal-sheathed door latched behind them, he faced Kenyer and Sheila McDermot. "Let's get the extra glasses out of here, and we'll be set. I carry, Sheila washes and rinses, Emily dries and puts

away."

Kenyer looked into his dark brown eyes. Bold and commanding, they irked her by taking for granted the obedience she granted only to those who shared her goals. And she wasn't yet sure about Dan Higgins: he'd used the bystanders too glibly, and gave a lot of orders for one who claimed to be a quasi-anarchist. "You're staying?"

Higgins ran a hand through his sandy hair. "I have to talk to you. Tonight." He scooped up the empties. "Come on."

Shrugging, she followed him into the kitchen, wondering not why she'd been singled out—every dissident passing through New Haven got in touch with her, sooner or later—but what he wanted from her. Money? Refuge? Trustworthy assistants? He wanted something. Everybody did. Even she.

She was willing to trade. She'd give what she could; she'd yield the present to insure the future (unless asked, "Who do we put on trial afterwards?" She'd never answer that one.) But she had to know, first, that whoever she aided was marching in the right direction.

In the sink, the water ran brown. McDermot took the remaining glasses from Higgins. "Em's right, Dan. You ought to split."

"We're safe for a while," he said.

Outside, a bullhorned voice ordered Irvine Gregory to throw down his weapon and come out. The shotgun spat Gregory's reply; glass tinkles broke the night.

Higgins clapped his hands. "That's telling them, Irvine!" His bulk filled the kitchen. He pressed against the formica-topped counter to get out of the way. "Do New Haven cops foreclose at night for a reason, or just for kicks?"

"Both," Kenyer said. McDermot passed her a slippery crystal tumbler. She dried it carefully; it was

part of a set. "The bastards time it for impact. You see your neighbor out on the streets at two a.m., it hits home."

"God, if I could just glitch some computers so it would happen to them—" He leaned towards the doorway like a compass needle drawn to a magnet. "Maybe I'll put Harry on it."

"Who is Harry, anyway, your man for all seasons? Last week he was doing a report for you on our Olin campaign, interviewed me for hours." She still thought the time spent recapping the activities of the Checkbook Coalition was wasted, and didn't keep her opinion out of her voice.

He chuckled; his sympathy ran warm and rich. "That's Harry, all right. He's a 20th Century Renaissance man—except that he has *no* aptitude for politics, of course. You have to let him do things his own way, but give him a problem, any problem, he'll bring you a solution you can 99.9% trust. We'd be nowhere without him."

Someone screamed, high and sharp, and all three tensed. The shriek cut off. Far away, somebody else coughed.

"Damn!" said Higgins, lips tightening. "I wish we were ready now."

"In the Olin campaign," Kenyer said, closing the cupboard, "we—"

"Your Checkbook Coalition?" He cocked his head and regarded her with interest.

"Uh-huh. We set up a phone chain. When they tried to foreclose on a member's place, we'd pull the chain. Two, three hundred people'd race over to occupy the house and stay until the cops gave up."

"Yeah, Harry said that, I thought it was great! But look, I have to be honest," he said, touching her shoulder lightly, "I didn't have time to read the whole report. Harry's nuts about detail, which is crucial when he's breaking me out of Leavenworth—"

An insight delighted her. "*That's* why you sent him away first."

Bewilderment showed on his face, but only for a moment. "Oh, yeah. I get caught, the movement gets a martyr; he gets caught, we lose our best tactician. Although," he said, studying her so closely that she had to step aside and hang up the dish towel, just to break his gaze. "Although, with people like you waiting in the wings, maybe now we could survive Harry's arrest."

"Thank you." She tried not to show how much that pleased her. "But is this what you risked hanging around to talk to me about?"

An explosion rocked the room; McDermot ran to the front windows to investigate. "A cop car's burning!" she called.

Higgins glanced at his watch. "Maybe fifteen minutes till those bozos get organized enough to shoo people away; we'll skip then. But first—" His eyes narrowed. "According to Harry, you say we should promise *not* to punish *any* of the crats." He jabbed a finger in the direction of the street. "Not even the bastards out there murdering Irvine Gregory. Why?"

"Because," she said, finally free to deliver the lines she'd been rehearsing, "a system born in vendetta dies of vendetta. Look at China, Iran—even Italy. It's reprehensible to punish people for being cogs in the machine you've supplanted. And by now the technique of establishing a revolution's legitimacy by savaging the old order is so trite that it won't work in America. It will only deepen resistance. That's why."

The stink of burned rubber seeped into the room. Higgins sniffed, and made a face. "Dammit, those are arguments! Why do you *feel* that way?"

She took a deep breath, and prayed that the explanation would make sense to him. "Because of my mother."

He frowned. "But she's not a crat. I know your father—"

"She's a victim."

His raised eyebrows told her to go on.

"My father travels a lot for the Defense Department," she began.

"I said, I know. That's something else we have to talk about."

"I thought it might be," she said, disappointed. A woman of talent and character, she knew she was more than a doorway to David Kenyer's attention, but it was difficult to convince strangers of that. Though she loved her father—even, at times, still visualized him as the looming giant who would tickle her toes, envelop her in huge furry arms, and answer any question at all—she hated him, too. She could not stop being his child, and she wanted to be herself. It was one reason she'd moved out. "What about in particular?"

"It can wait. You haven't told me how your mother got victimized."

He seemed sincere; she awarded him a mental point. "Well, he was out of town so often that she decided to start an ad agency. She made a name for herself in a couple of years. Then—"

A siren whooped once, then moaned down into silence. "Go ahead," he said.

"Well, a Federal Trade Commission inspector stopped in for the quarterly truth-in-advertising audit, and propositioned Mom. When Mom turned her down, she wouldn't issue the permit to place the next quarter's ads. Mom complained up and down the line; the inspector sued for 'defamation of a public servant.' Mom lost. The inspector owns the agency now. And Mom still owes half a million in damages. If she ever gets a job again—but no agency anywhere will touch an FTC enemy—the court's going to garnishee 75% of her take-home. So she gave up. She

became a housewife. She hasn't allowed herself to have an intelligent idea for four years."

"You sound bitter," said Higgins softly.

"Wouldn't you be? They ruined her!"

"At your mother, I meant."

She bit her lip. "Maybe I am. I know how badly she got hurt—some of the inspectors perjured themselves just to destroy her credibility—but I think she gave up too easily. That was her life. She should have fought harder."

"Not everyone has your intensity," he said.

"But it's symptomatic!" She clenched her hands and shook them. "There's two hundred fifty million people just like her, letting themselves get raped because in the short run, it's safer than fighting back. That's why I started the Coalition, to teach people how to fight back. To get them to take that first step."

"I admire your passion," he said, his eyes fixed on hers. "But you still haven't explained—*none* of all that explains—why we shouldn't punish the crats."

"Because, damn it anyway, the ads *were* dishonest. By FTC standards, at least."

"What?" He blinked, and stepped back.

"Don't you see? The system pukes up regulations it'd take a Talmudic scholar to decipher, and gives enormous powers to millions of petty bureaucrats, and—listen. Turn it around. By the book, my mother's ads were illegal, even though the inspector knew they wouldn't deceive anything smarter than a frog. The lie, though, is in the pictures—reshoot them, they cost forty or fifty thousand. Common sense says issue the permit anyway, but if the inspector does, she's risking her career, and why should she do that for nothing?"

He folded his arms. "You're justifying corruption?"

"No, damn it, I am not!" She wanted to shake him. "I'm saying, our system puts normal, weak

human beings in positions of terrible temptation—and for God's sake, we shouldn't devote the new system's energies to punishing people for being human! We should concentrate on designing something that won't create the same god damned situations."

"But you said this inspector perjured herself."

Exasperated, Kenyer said, "She had to! If she'd told the truth she'd have lost her job—and the way Mom was filing complaints, not taking Mom to court would have been the same as signing a confession. It's my whole point: the system is totally screwed up, we have to replace it, but we can *not* punish the people who didn't have the guts to do anything but go along with it!"

"Replace—not reform?" The question rang cool and aloof.

"Listen." She wondered if she were about to insult him, but decided to risk it. "You claim your income tax strike is intended to choke the government into submission, force it to reform itself—and I don't buy it. I don't think you do, either. Get ten million regulators to stop bleeding us by making it harder for them to pick our pockets? Uh-uh. Look across the street, damn it; it just makes them desperate!"

He nodded. A very slow smile stretched the corners of his mouth. "Harry said you were more a revolutionary than a reformer."

"Well, he's right about that," she said hotly. "But I'm not an ayatollah; I say, pardon them all and start over fresh, *tabula rasa*. It's the only way."

"In that case, you might be able to help us a lot." He reached for her hand; the gesture was surprisingly innocent. "Come on, let's get Sheila and split. I have a favor to ask you two."

"All right." But she quickly slipped free of his fingers. She had yet to decide if he were serious, or if his talk was only an excuse to get close. Too many revolutionaries spent more time seducing than sub-

verting; they were in the movement to stoke their self-esteem, not to cause change. She hated that type. Not that she objected to pleasure, but she had to be more than a body. She had a brain, and a heart as well.

Higgins pulled on his mask, a lifelike plastic sleeve that flattened his nose and rounded his jawline. He'd barely tucked it under his shirt collar when the doorbell rang twice, three times, insistently.

"Stay in the shadows," said Kenyer, crossing the living room. She swung open the door and caught her breath: two policemen stood there. "Y-yes?"

"Sorry to bother you, lady," said the one holding the rifle with the telescopic sight, "but we need your front window. The angle's better'n I can get from the ground." Without waiting for her to comment, he pushed his way past her. His companion hurried to open the window for him.

Raising a hand, she spun on her heel, wanting to shout "No—get out!" but she thought better of it when she caught the worry on McDermot's face. "You mind if I leave?" she said instead. "I don't want to be here when they start shooting back."

"No," said the sniper's companion, "go ahead—we'll close the door when we leave."

"Thanks." She kept her body between the cops and Higgins as the anarchist, face averted, walked into the hall. *He's so tall it probably doesn't do much good, but what the hell. Can't hurt.*

Before she closed the door, she heard the sharpshooter say, "Bill, see if there's any beer in the fridge." She gritted her teeth. And left.

McDermot had parked her car around the corner; the two women flanked Higgins and chattered as they walked, giving him reason to watch the sidewalk. The police and firemen stationed up and down the block

barely glanced at them. Yet Kenyer's stomach stayed knotted till they were in the car, anyway.

"God," he said, sinking into the '92 Datsun's back seat, "let's not do that again any time soon . . . Dan, what's this favor you want to ask us?"

"It's like you figured, Emily—I don't believe the tax strike alone is going to be enough to bring down the government. But what it *will* do is cause a cash flow crisis come November, and right about then the government will be very vulnerable. That's when we attack."

"With what?" she said disparagingly. "Where are our armies?"

"I figure for this area, you two will do just fine." He smiled broadly. "What we've got is better than a suitcase nuke."

Appalled, she stared at him. The car pancaked through a pothole, and threw her against the seatbelts. Oncoming headlights lanced into the Datsun. For an instant she imagined smoking rubble, and wanted to puke. "No—all those people—no!"

He recoiled, blinking, like he'd expected applause, not a slap. "What?"

Her hands shook; so did her voice. "How could you— I never met you before tonight, but from your books, your speeches, I thought I knew you and now— my God, *nukes?* No! You can't save the people by destroying them."

His jaw dropped. "No, wait, I'm not talking—" He reached inside his suit jacket and pulled out what seemed to be a microputer. "*This* is what we use. A T-SS Unit—a Tisser—and it doesn't kill *anybody.*"

Confused, now, she shook her head. The vision of mass death persisted, but Higgins had just said that it was all wrong. There'd be *no* death, no destruction . . . which made no sense: how could anything harmless coerce a government? *But if, oh what if, a magic*

wand to wave, no that's silly, there are no magic wands . . . Deliberately, she flattened the hope peaking out of the trough of horror. "Dan, you're talking gibberish."

"Uh-uh." He smiled again. "I'm talking genius—David E. Kenyer's."

"Dad?" She wanted to put disbelief into her tone, but couldn't quite manage it. Her father had created too many implausible artifacts for her truly to be surprised. "Somehow, it figures." Fitting, though, that his brilliance would help her abolish his world. "May I see it?"

He passed it over. "It's off."

She took it gingerly anyway, wary of placing her fingers near a button.

"You called it a T-SS Unit?"

"A Time-Space Separation Unit. Nicknamed the Tse-tse because it's like putting people to sleep."

"He never mentioned it, so it must be Defense Department. How did you—"

"You read about the terrorist attack at Fort Benning last year?"

She nodded and nibbled on her lip, suspecting what was to come.

He sighed. "It cost a million dollars and seventy-nine lives to take one bread-boarded prototype away from the crats field-testing it, but last month it paid off. Two of our guys finally made some sense of its programming. That's production model number one, there."

She blinked. "That raid cost three hundred lives."

"The rest were crats."

"Scientists, a technician, a photographer—people!" She thought him wrong not to show more compassion. "Listen, we count their dead like they were *our* dead. We *have* to. Otherwise . . . otherwise we lose our souls, Wyatt. We make an Iran, a Reign of Terror—"

"Nobody wants that—and that's where the Tse-tse comes in." Though the three were alone in the moving car, he lowered his voice—then chuckled at his instinctive precaution.

The rueful laugh restored some of her faith in him. Most rebels took themselves far too seriously. If Higgins didn't, he might be able to give more rein to the compassion she was sure he had—and would need.

"Look, your father designed the T-SS Unit so it wouldn't hurt anybody, but we've got to find out exactly how."

Now he had her off-balance. She shook her head. "You lost me."

"We know how to assemble it, we think we know what it does—but we don't know any of the theory. See, it eliminates things. I don't mean destroys. I mean eliminates: sic the Tisser on something and whoosh! the target's gone, completely, no sign of it left." He paused ostentatiously.

Amused, she took the cue. "Where does it go?"

"The name suggests another dimension, maybe. But we don't know that, or what side-effects it has, or anything else. It makes things disappear and reappear, too, later on. That's all we know. Are you close to your father?"

"He thinks so." She extended her hand for the weapon again. "But . . . there are tensions." It was very light, very plasticky. It looked cheap. Yet it awed her with its potential to equalize—and sickened her, too. "How does it work?"

"The GI model is more sophisticated. With this bootleg one, though, you use a first-corner indicator—" He pulled from the case what looked like a telescoping antenna; unfolded, it opened into the corner of a cube. "—and punch in how many meters it should zap from each tip: width, depth, and height, in that order."

"And then?"

"Then you press the 'subtract' button, and that—that volume you described is gone. Along with everything in it." He spread his hands, splayed his fingers. "Now what we—"

"Does it come back alive?"

His eyes wavered for a second. "Yes, but . . ."

"It dies quick?"

"No." He seemed surprised. "Paralyzed, yes, but only for an hour or two. Nothing more, but . . ." Looking retrospectively baffled, he puffed his cheeks, and blew air through his pursed lips. "There's something . . . you forget what you Tissed-out; you even forget that you did Tse-tse something . . . when we tested it, we thought we'd failed, because we couldn't see that anything had disappeared. One of our techs wondered if maybe the memories hadn't started off full—to work right, it has to store a huge string of spatial co-ordinates—so he cleared all the memories. And things came back."

Night wind whipped through the open window; she shivered. "What do you mean, 'came back'?"

"Well, actually, we had zapped things—but once they were gone, we couldn't remember that they'd ever existed. It wasn't till we brought them back that we recalled they'd *been* gone. Before, it was like they weren't missing because they'd just never been. As a final test, we took out the Mayor of San Francisco. Nobody noticed—no, that's not right; after a day or two, people started saying, 'Why don't we have a Mayor?' Not 'Where's the Mayor?' but 'Why don't we have one?' Honest to God, even when they looked it up they couldn't remember the poor guy. Until he came back, and *then* everybody said, 'Where were you?' "

"Why does it work that way?"

"God, Emily, if only we knew . . ." He slumped in his seat suddenly looked like what he was: a thirty-five year-old Oregon homeowner so fed up with taxes

and bureaucracy that he'd risked everything to force a change. "That's why we're trying to figure out some way to get answers from your father without tipping off the crats."

"He'll call them himself if you approached him . . ." She stared hard at Higgins, trying to decide if he was, indeed, the kind of person who should run things afterwards. *I wish the deaths of those crats bothered him more* . . . but he had that sense of humor, and she was sure she could make him see that there were already too many victims. "Would you like to get into my father's desk?"

His eyes widened. "Damn straight I would. Can you set it up?"

"Right now, in fact. Sheila—let's go to my folks'."

"On our way," McDermot said, and turned onto the Boulevard.

At Edgewood Avenue, Kenyer checked her watch, then tapped McDermot on the shoulder. "It's three a.m. Better drop us off here; we'll walk the rest of the way."

McDermot pushed a loop of blonde hair back over her ear, and looked at them curiously. "I can take you right to their door, you know."

"And Dad will hear your car, and lumber down, and . . ." She dug a cigarette out of the crumpled pack in her windbreaker pocket. "Can you see the introductions? 'Dad, this is Dan Higgins, Number One on the FBI's Hit List. Maybe you recognize him from tonight's facspaper?"

"With my mask on you can introduce me as anybody," said Higgins.

"Dan, that plastic face looks real good from five meters, but at handshaking range it wouldn't fool a baby. Take it off as soon as we get there." Aware that nervousness was making her chatter, she snapped on the lighter. The butane flame danced blue and yellow as it warmed the palm of her hand; the smoke felt

good so she held it in. "No, we can't drive up; Dad keeps his window open and some sounds wake him all the time: firecrackers, breaking glass, cars coming up the gravel . . . once we're inside, we're okay, though. The house is almost soundproof and Dad's a heavy sleeper."

"How about your mother?" McDermot asked, looking meaningfully from her twenty year-old friend to Dan Higgins. "Won't she wonder?"

"She's not home."

"I could have sworn I saw her at the store tonight."

"She's in Chicago, visiting Aunt Mae."

"Are you sure?"

"Listen, even if I'm wrong, even if she is home, you know her. She'll be vague and hospitable and a little relieved when I say, 'Nope, just popped in for a sweater 'cause the walk was getting chilly and your place was closer than mine." Then tomorrow I'll get a phone call about dating older men who are probably married." She stared, lips tightened, at the windshield's reflection of the cigarette ember. "That's your role, Dan—older man on the make for younger woman."

Higgins squeezed her shoulder lightly. "No trouble."

But McDermot seemed unwilling to be reassured. "What if she's home *and* if she recognizes him? What then?"

Kenyer dismissed the idea with a sniff. "*If* she got back early, there's about one chance in ten she even glanced at tonight's facs. Maybe one in a hundred that Dan's face'll ring a bell. Then she'll shake her head and accuse herself of being silly, because the man her foolish daughter brought home is wearing a suit, and everybody knows rebels are wild-eyed and smelly and carry machine guns under their T-shirts." Higgins snorted; she elbowed him. "Listen, you have to play it straight. She's living in a fantasy world, but

she's not dumb. If you act like anything but a late date with sex on your mind, she'll get suspicious."

"Of what?" he said.

"She won't make the rebel connection, but she'll think you're, oh . . . you're casing the place. You sweet-talked me into inviting you in so you could look around. Don't let her get going in that direction. The house is all she's got, and if she thinks you're threatening it—"

"I understand," he said. "I promise I won't ask where you keep your silverware, or if it's really a Ming vase on the mantel piece."

She chuckled, confident that things would go right. "Come on, let's go. Sheila, thanks for everything—let you know how it turns out."

"You do that," she said, releasing the brake. " 'night."

Companionably silent, they watched the tail lights jiggle through a stretch of pot-holes, then disappear around the corner. The night was still and clear; a sprinkling of stars glimmered through New Haven's haze. The moon filled in for the burnt-out street-lights. Somewhere birds called, and love-lorn fire-flies signalled their needs. "Nice lady," said Higgins at last.

"Isn't she? Come on, it's this way." Exhilaration put bounce in her step. It wasn't that this man could trigger bloody riots just by twitching his finger; that, if anything, depressed her. She couldn't respect power when it created victims. But his notoriety thrilled her, because proximity to it would make her important.

Dan Higgins scared the police, so his companions did, too. To the cops, whoever associated with the rebel had to be dangerous; housecats don't walk with tigers. At any moment a cruiser could wail up. And if that wasn't being taken seriously, nothing was.

"Dan. After the revolution, how are we going to

shut up the people who want to restore the bureaucracy?"

"Shut them up?" He stopped, and looked down at her. "We're not. That's what modified anarchy is all about—nobody shuts anybody up."

"Good." Reassured on that, she said, "What do you want Sheila and me to do? You never told us."

He looked into the night. Very quietly, he said, "While I'm in town, I'll be picking out targets for you two to zap at H-Hour. When the time comes—"

"What do you figure we'll take out first? With the Tse-tse, I mean."

"Police departments." Quiet, now, his low voice rumbled like gravel being stirred. A working street light tested the verisimilitude of his falseface; orange brilliance bounced oddly off the dyes in the vinyl. He started walking again. "Without obedient local police, the government's helpless. See, we pay taxes, ultimately, because cops have guns. But if there are no cops, no guns, then the crats can't force the money out of us, and they can't pay each other. And you know that those parasites won't work for nothing. The whole structure will disintegrate. Then—then, we will be free!" The shadow of his clenched fist beat on the pavement. "Free!"

She frowned. It seemed simplistic. "What about the Army, the National Guard?"

"If they come, we'll do the same to them—but remember, they'll have to donate their services, too—and somehow, I don't think they will."

Emily's instincts said it wouldn't happen that way. It never went as quickly, as cleanly, as the visionaries promised. Like rowers on a muddy pond, they thought thirty strokes and you're across, that's all there is to it, but she knew there was more. Beneath the surface, the blades had to slash: scattering fish, cutting weeds, stirring up muck. The leaders saw the hull skim the ripples; she saw the turbulence. And she

vowed, once again, to devote herself to saving the fish. "We're here."

He turned and looked. "Nice place."

Behind the sloping front lawn, the garage clung to the two-story, twelve-room house. In the half-acre backyard towered a climbable pine in whose resiny branches Kenyer had used to lose herself for hours at a time. The house had been her home for nineteen years. She loved it. Quietly, she said, "They raised the mil rate again last year. Dad said taxes were so high he had to unload it, but the best offer he got was only twice the tax bill."

"Is it in bad shape?" They walked up the drive, careful not to crunch gravel.

"No," she whispered, "it's in beautiful condition—but who can afford a big mortgage on top of $1200 a month property tax? It's not like you get any services—usage charge for everything, garbage, sewers, streets . . . The city has programs for everybody but the people who pay for the programs." She held a finger to her lips. "Ssh."

The thumblock remembered her touch, and let the door swing back into the dark entryway. A loose board creaked. Without switching on a light, she led him into the long, high-ceilinged living room, and closed its door. Grateful for the orange shag rug that absorbed their footsounds, she seated him at a roll-top desk. She flicked on its lamp.

He skinned off the falseface and wiped his cheeks—then stared at the desk in bewilderment. "Doesn't he use a computer?"

"Of course he does." She rested her hand on his right shoulder. "But it's voice-keyed, and you couldn't get into it. Besides, he sketches most of his ideas on file cards before he feeds them into the machine—says he can't think at a screen—and he keeps the cards in one of these drawers. Or in most of them; I mean, he has a ton of cards."

"Well—" Dubiously he pulled on a handle.

"Good morning," said a mellow but sarcastic voice from the door.

"Mother!" Emily gasped. Spinning, she shielded Williams with her body. "Did we wake you? I didn't realize you'd come home."

Sandra Kenyer's green eyes left Emily to touch on Higgins, then returned. Her hair was brown, long, and streaked with grey. The streak was chance; its retention, deliberate. She held herself with dignity, even when wearing the pink nylon gown whose ruffles brushed the floor. Crinkles around her mouth and eyes spoke of easy laughter. Tonight, her lips were compressed. "It's almost three-thirty, and yes, you did wake me. I flew in this morning. I thought you were burglars." She brought her right hand from behind her back. It clutched a small automatic. She looked at it, mouth puckering into a wry moue. "I was afraid I'd have to—"

"You can put it away, Mother," said Emily. She disguised her upwelling of relief. A shot would have sunk them. The police would have come, recognized Dan . . . "We're harmless. But why didn't you wake Dad?"

"I didn't think the burglars would wait that long." Her relief resonated in her voice. "So. How nice of you to drop by."

Emily restaged mentally the scenario she'd outlined in the car. "We were walking; I got chilly." She dropped her eyes and pretended to fidget.

"I see," said Sandra Kenyer knowingly. Her tone was either condescending, or embarrassedly casual. Clearing her throat, and glancing away, she said, "You know your father doesn't like you in his desk."

Before Emily could react, Higgins said, "Emily told me that, Mrs. Kenyer, but I had to have a sheet of paper. A line just came to me, and I have to get it down before I lose it. They come so laboriously, you

know, like children."

Though she found his fluency in falsehood disturbing, Emily kept her face blank, and watched her mother's sense of hospitality struggle with her protectiveness. Confusion won. "A line?"

"A line. Poetry. I'm doing a—" Appearing to rein in artistic enthusiasm by brute force, he said, "Anyway, I needed some paper, and didn't think Mr. Kenyer would mind."

"Dr. Kenyer," said the scientist's wife, but she seemed reassured. "Well, if you're trying to compose, would you like a cup of coffee, maybe some cake or cookies?"

Emily said, "Mother—"

"That would be very nice," said Higgins. "I'd like to polish this line before I leave, which may take an hour or more. Coffee would be perfect."

"It'll only be a minute."

"I'll help." Emily realized at last that Higgins wanted privacy and time to search the desk. She hurried to the door, uncomfortably aware of the oblong bump in her coat pocket. She couldn't take it off because her good housekeeper mother would hang it up, and maybe find the Tse-tse. She'd have to wear it a little longer.

Her heels tapped on the vinyl tiles in the corridor, finding and forming a syncopation with the swishes of her mother's slippers. After a moment she said, awkwardly, "Hey, Mom, I'm sorry we woke you—" She pushed open the swinging door and held it.

Sandra Kenyer grabbed Emily's arm and almost threw her into the kitchen. Sandra's teeth grated; her jaw muscles bulged. Her eyes had narrowed to slits of hostile emerald. While her hand plucked the phone off the wall and her fingers began to tap numbers, she hissed, "What the hell do you mean bringing a rebel into my home?"

"What do *you* m-m-mean?"

"I mean your 'date.' Dan Higgins a poet, pfah! His picture's all over tonight's paper; what did you think I was, blind? And letting him ransack your father's desk, I am so— Hello, Police? . . . Yes, I'll hold."

Emily saw what she had to do, but rebelled. *Why do I have to make her a victim? Dan*—She moved towards the door, hand in her pocket.

"And don't try to warn him, either, because I will shoot him. You could have cost your father his job, his reputation—hello? Yes, dammit, but hurry!"

While Sandra Kenyer glared at the phone, Emily took out the Tse-tse. *I'm sorry, Mom, I'll bring you back.* Her fingers shook with fear, urgency, and—already—self-loathing. *But I* have *to.* She pulled out the first-corner indicator and began prodding the keys. *On; 1 for width—*

"What's that?"

—1 for depth—

Still jamming the phone to her ear, Sandra Kenyer thrust her hand into her gown, grabbing for the automatic. The billowy nylon thwarted her grasp.

—2 for height—

"Emily, what are you—"

She pressed the indicator against her mother's suddenly struggling body.*—and '—' to eliminate!*

For a time measurable only in microseconds, she knew horror. Her memory was a rope of many strands, and in the instant, half their fibers faded away. Half her life disappeared. Half of herself died. She felt the loss and regretted her impetuousness. It was too much to throw away; she had to have it back, she had to have— she had to— she had— she— She ganwed on a knuckle and wondered what she'd lost. A *victim,* she thought faintly, *or something to do with love . . .*

She was alone in the kitchen, staring at the wall phone that had never had a receiver. A T-SS Unit quivered in her cold white hand. She couldn't under-

stand why she was holding it. It was Dan's, and it belonged with him. Shrugging, she tiptoed back to the living room.

He was still at the desk, rifling through its thousands of file cards without disturbing their precise alignment. Somewhere he had found surgeon's gloves, thin and green. His back stiffened as she entered; his head turreted. He exhaled his fright at the sight of her. "Geez, I thought it was your father."

"Dad? No. Once he's asleep, you could stage a rock concert down here and not wake him. Talk about heavy sleepers." She bent across him to set the Tisser on the desk. Deliberately, she pressed her breasts against his shoulder blades. "Did you find what you wanted?"

"No." He turned to take her hand, then winked. "Not in the desk, anyway."

Let him be grateful, she thought. *It'll give me leverage to help save the victims.* Because, of course, that was what she wanted more than anything. To protect the innocent. She smiled, slowly and sweetly. Avid for affection, for closeness and security, she lifted his insulated fingers to her cheek, "Like I said, once he's asleep he's dead to the world."

"Sounds good," As he stood, his gaze slipped away, to the framed photograph on the mantle. "Who's that?"

She twisted around in his arms and leaned back against him. A woman with green eyes stared at her. "I don't know."

"Oh." Clearly, he'd asked only out of politeness. "I thought it might be your mother."

"My mother?" She probed that notion, but it was like looking for a thirty-third tooth. "No, it's not. I thought you knew. I never had a mother."

And for no reason at all, she began to cry.

—Kevin O'Donnell, Jr.

ON BOOKS

by Norman Spinrad

One of the most promising writers to appear on the sf scene in recent years is being ruined.

One of the eagerly awaited publishing events in sf in 1979 was the publication of John Varley's second novel, TITAN (Berkley/Putnam.) Varley had made a huge reputation as a comer with a long series of short stories and novelettes set in a future in which humans had been forced off the Earth by alien Invaders and had built a series of weird and complex societies on the remaining bodies of the solar system and in space itself around the rings of Saturn. His first novel, THE OPHIUCHI HOTLINE, (Quantum), had been the apparent capper of this series, and continued the show of promise. His first collection of short fiction, THE PERSISTANCE OF VISION (Quantum), was hailed as the best single author collection of the year, if not the decade.

Then, in 1979, came TITAN, which, at this writing, has been nominated for everything, and has won the *Locus* Poll as best sf novel of the year. Which did not preclude it from being, in the opinion of this critic, not merely a turkey, but a turkey of a peculiarly pernicious sort.

The McGuffin of TITAN is this giant living "Ringworld" called "Gaea" orbiting in the vicinity of Saturn. I use the term "Ringworld" advisedly because only near the end of TITAN do we learn the thing is really an organism, and only this change makes the raison d'etre of the "novel" anything more than a "spin-off" from the concept of the Larry Niven novel. The "plot" of TITAN is what is euphemistically called "picaresque," which is to say an endless "quest" which serves chiefly to walk the characters through the landscape and leave us set up for the next episode in the series, namely WIZARD (Berkley/Putnam), just recently published in hardcover.

Well, after reading TITAN and while waiting for WIZARD, it was my feeling that a writer of great literary promise was in the process of having his career sabotaged by the currently all-too-common publishing pressure to embark on "series novels" at a

ridiculously early stage of development.

It must be remembered that MCA, which owns Berkley/Putnam, is heavily involved in tv production, as is Gulf & Western, which owns both Paramount and Simon & Schuster/Pocket Books, as is CBS which owns Fawcett, as is RCA, which is trying to sell off Random House/Ballantine. Now while I doubt very strongly whether there is direct pressure coming down from the lordly corporate home offices on the sf lines of any of these publishers, the karmic connection does seem to be there: things like Varley's TITAN-WIZARD—third episode-to-come series can best be understood as the literary equivalent of episodic television.

You have Gaea, the consistent setting of the series, which in tv terms would be the "standing sets" used in every episode. You have the concept of using a variation on something that was a previously successful show, namely RINGWORLD. You have the star of the series, Cirocco Jones (aka Rocky Jones, title character of an ancient Saturday morning tv sf series), who appears in all the episodes, and various guest stars, who appear and disappear from episode to episode. You have a script for each book which tries to be self-contained without having its own internal resolution, setting the audience up at the end for the next episode. You have familiar schticks which appear in the episodes, in this case the intelligent centaurs, the blimp creatures, the personification of Gaea as an irrascible old lady, etc. etc. If the Nielsens are good, it means you have captured an audience of regular fans who feel at home within the format.

Unlike episodic tv, however, you also have one poor single writer chained to his typewriter churning out this stuff, either for the run of the show, or until he croaks and the format is taken over by a stable, as in the continuations of Conan, Doc Smith, etc.

After I read TITAN and before I read WIZARD, it

was my feeling that one of the most promising writers to come into the field for many a moon was being literarily ruined by this commercially-tempting pressure towards literary television. How, you may ask, does this ruin a writer? Answer: by rewarding the development of bad habits. Plotting novels like episodes in a series is exactly the *wrong* way to go about writing real novels. Real novels have self-contained internal structures esthetically pleasing in and of themselves. Real *sf* novels create a universe entire each time out; the whole point of sf is the multiplexity of fictional realities. In real novels there must be at least the possibility that the "star" can die or become the villain or metamorphose under stress. But episodes in a series *can't* resolve themselves internally, can't create a new universe each time out, can't kill off the star, can't change the parameters or diverge from the series guide.

For a writer like Varley to be encouraged to write his second, third, and fourth novels as episodes in a series, was to stunt the growth of a major writer, was, to be brutally blunt about it, to turn a developing literary artist into an instant hack before he even had the chance to truely spread his wings and fly.

So I thought before I read WIZARD. Now I am not so sure. And after reading the stories in Varley's second collection, THE BARBIE MURDERS (Berkely/Putnam), I am even less sure. And after hearing that Varley was in the process of novelizing a screenplay based on his own novellette "Air Raid," I begin to suspect that Varley has been a willing collaborator in his own downfall, that this kind of stuff truely represents the highest level of his own aspirations.

Taken out of the series and read on its own, WIZARD is not merely a bad book, it is well-nigh no novel at all in any sense. We have the same settings, the same schticks, the same formless quest plot (here made absolutely overt as such), some guest stars at

least one of which will probably appear in the next and hopefully concluding episode. Worst of all, what we also have is the unstated assumption that anyone who reads WIZARD has first read TITAN. Rocky Jones, the star of TITAN and the title character of WIZARD is the star of this one too, if only because she *is* the title character. Plotwise she functions as the star but not as the lead character, being perceived as such only by referring back to TITAN, her story being told here at remove through other viewpoints. The settings and schticks work this way too—Blimps and Angels and Gaea-as-old-lady and etc. being thrown at the reader perfunctorily and achieving any story resonance at all only through their previous development in TITAN.

It has been pointed out by other critics that Varley in this series relies heavily on 20th century pop culture, using movies and tv shows of his own time as the main source for images describing the denizens and landscape of his future world. He "justifies" this by making Gaea, the creator of her own internal landscape, and creatures a fan of 20th century media, but of course what he is really doing is exactly what prime time episodic tv now does—referring to media images as a shorthand bypass of the need to create new and original ones that will move the reader or viewer in fresh directions. It is lazy and sloppy enough when shlock tv and film refers to other shlock tv and film, but when fiction starts doing it the gorge rises.

More to the point, perhaps, it clearly indicates that this stuff is written to be disposable; bought, read, thrown away, out of print, forgotten, and soon incomprehensible.

The remaining question is whether Varley is a writer of genuine talent who is being chewed up by the teeth of the commercial interface, and hence salvageable, or whether his early promise was an

illusion. THE BARBIE MURDERS makes one wonder. In the light of TITAN and WIZARD, a certain revisionism begins to uneasily surface. Varley's original reputation was made on a fairly long series of short stories which are *also* part of a series. The universe he created there was far more bizarre, creative, idiosyncratic, and biting than the Disneyland of Gaea (*his* image, not mine), and in the short forms he seemed more able to make each story a work of art entire. But THE BARBIE MURDERS, the second collection of episodes in this other Varley series, begins to suffer from "second season syndrome," becoming derivative of itself, referring to the created universe as if it were the real world, assuming in many of the stories too much knowledge of other episodes in the series, written with one eye on the Nielsens.

The jury on John Varley is still out. What he badly needs now, more than negative criticism like what he's just gotten, is one or more tough-minded editors who will demand fresh, new, challenging work instead of more slices of the same cheese. Either that or his own private rethinking of who he is, how much talent he has, how far he is willing to reach, and what he wants to be when he grows up. What happens to John Varley may turn out to be a litmus test of what will happen to science fiction itself in the decade to come.

WILD SEED by Octavia E. Butler (Doubleday) is billed on the jacket copy as a "prequel" (God help us!) to her "Patternist" novels. As Billy Martin kept saying to George Steinbrenner in that series of beer commercials, oh no, not again!

I wish I didn't know that WILD SEED is a "prequel" to anything. Because this is a very good novel indeed, it hangs together esthetically and formally all by itself, it has none of the flaws of sf as television, and it demonstrates that Octavia E. Butler is not

merely a writer of at least as great a potential as John Varley, but one who herein has already fullfilled a good piece of that potential by writing a novel with psychological depth, a formally satisfying resolution, real characters, new ideas, and a sophistication of insight and style sufficient to stand up and be counted in any company.

Doro is a strange African mutant; born into ancient Egypt, his many bodies die but his spirit is immortal. He changes bodies as casually as we change clothes, killing the personality within. He has lived a very long time as the story opens. He has been breeding generations of humans like prize cattle—in Africa and in the Colonial America of the period. He is alone. Anyanwu, the "Wild Seed" of the title, is another African mutant—long lived, but nowhere near as old as Doro. She is no killer or vampire, but she can assume almost any shape she chooses, has amazing recuperative and healing powers, and instead of breeding generations of humans like cattle, she has raised many families, whole tribes of her descendants to whom she relates not as an animal breeder but as a mother.

The novel is in part about this difference. It is in part a love story. It is in part about Doro's struggle to either retain the spark of humanity or get rid of it for good and all. It takes place in Africa and Colonial and post-Revolutionary America and spans a couple of centuries. All the technical problems—the settings, the timespans, point of view, even what science is necessary—are handled flawlessly. Not much else to be said. This is a very different sort of science fiction novel, excellently done, fascinating reading.

Now I am going to have to ferret our Octavia Butler's other novels and read them, including, alas, the ones that WILD SEED is a "prequel" to. Whether her earlier books are as good as this one is not really the point—WILD SEED is her latest and it represents a

major writer in full control of her powers. That it is a "prequel" to her earlier work, though, brings out the Jewish Mother in me. Please, Ms. Butler, let it be! You are far too good a writer to have to string all your novels out into an endless series. Your powers of sf conceptualization are far too unique and idiosyncratic to be straightjacketed by trying to fit all your work into a single consistent alternate universe. You are meant to be a creator of many alternate universes, not one. WILD SEED is a novel in a series and it is entirely successful on its own, and I admit it. I'm glad you wrote it. But when Ted Williams retired from baseball, he did it off a .300 season, and hit a home run on his very last at bat. He knew exactly when to move on.

GOLDEN VANITY by Rachel Pollack (Berkley) does not seem to be part of any series, and in fact I never heard of the author before, though I have been told she has been publishing short fiction for several years. What she has done here is somehow modernized and updated the kind of thing Robert Scheckley was doing so well in the 1950's. To attempt to summarize the plot of GOLDEN VANITY would be ludicrous. A ruthlessly capitalistic galactic empire has contacted Earth for the purpose of turning it into a Market World, a source of wage-slaves and spare organs, and a market for galactic junk trade goods. This has caused Earth's civilization to go totally bugfuck. The "Golden Vanity" of the title is the daughter of Jaak, one of the main exploiters from Center, who flees to Earth rather than be turned over to the loathsome Loper as payment of a debt by Jaak. Hump is the Earthman she falls in with. This is the basic situation. The plot involves aliens, Earth cultists, weird planets, fantasies as a commercial way of life, drugs, weird spaceships, etc. etc. ad infinitum.

GOLDEN VANITY is that true rarity, a successful

comic science fiction novel. *Not* an sf satire like THE SPACE MERCHANTS or a satire of sf like BILL THE GALACTIC HERO, nor even sf farce in the mode of Ron Goulart, exactly. Pollack takes the story more or less seriously, the characters have a certain depth, political and social points are being made, and there are quite a few interesting science fictional ideas. The novel works as a science fiction story, and on this level the outre realities depicted have a certain verisimilitude. Yet GOLDEN VANITY *is* comic novel.

It's remarkable how little of this stuff has been written successfully. Robert Sheckley's novels in this mode are perhaps the best example, with Kurt Vonnegut approaching it from a slightly more bitter point of view. It seems hard to create a big splash with this kind of thing, almost as hard as it is to write such seemingly effortless stuff. SF satire has been pretty common, sf farce less common, and this kind of "serious characterological humor" least common of all. It's a fine line that Rachel Pollack has walked successfully here, and what she has produced may be something that appeals not to the great sf mass audience nor to cognoscenti looking for heavy significance, but I like it, I'd like to see more of this kind of thing (though not a sequel to GOLDEN VANITY!), and it may very well be that Pollack will emerge as one of the few major comic sf novelists of the period.

THE HELL CANDIDATE by Thomas Luke (Pocket Books) is copyrighted in the name of Graham Masterton, neither of these names is familiar, it is not on the Pocket sf list, it is not exactly science fiction, but nevertheless. . . .

The premise of the book is quite simply what the title implies—Republican Presidential candidate Hunter Peal is taken over by the Devil. He undergoes a nasty personality change. He becomes imbued with strange charismatic powers. He becomes a sex ma-

niac. He gets the nomination. He is elected. Just as he's about to start World War III he is exorcised by the Pope.

Now admittedly this sounds like the plot for a pretty silly occult thriller. Furthermore, Luke makes the elementary mistake that no experienced sf writer would make of setting the novel in 1980, mixing references to Jimmy Carter and Ted Kennedy with an entirely fictitious cast of Republican contenders, thus obsoleting the book even as it is published.

Nevertheless, Luke, whoever he is, seems to know American politics inside out and upside down, can write knowingly and excitingly about it, and fits the occult material seemlessly into his hardbitten realistic narrative. And what makes the novel fascinating and more than a little frightening is the way the Santanic Peal gets elected.

He is able to conjure visions for his audiences during speeches. His first number is a rousing patriotic speech during which the masses, are transported to waving fields of golden grain over which roar hundreds of B-52s. His acceptance speech at the Republican Convention is enlivened by the spectral appearance of *Playboy* bunny types done up as the Spirit of '76.

The Satanic Presidential platform calls for confining the poor to ghettos between the rich central city fortresses and the middle class suburbs. For achieving crushing military superiority over the Soviet Union. For legalizing all forms of sex and plenty of it. For setting up friendly puppet governments in obstreperous Third World countries. For bringing back giant American cars. For recreating the pioneer gunslinging spirit of the Wild West. For invading Cuba, throwing out Castro, taking over the Middle East oil fields by overt force, and restarting the Viet Nam War to recapture our lost military pride by pounding the Commies into the ground with the full

ruthless might of our total military force as we should have done the first time.

Now bear in mind that this is the political program of the Devil and the ultimate Satanic purpose is to precipitate a nuclear war which will grind the human race into the dust for good and all. In the novel, the electorate eats it up like apple pie and cotton candy. And you believe that this is happening.

And I believe it *could* happen. I've lately mused that a Presidential candidate crazy and ruthless enough to spout unadultered racism, class warfare from the point of view of the middle class, up-front jingoism, gibbering hydrophobic anti-communism, military solutions to the energy crisis and other complex foreign policy dilemmas, sexual license, and atavistic nostalgia for the American supremacy of the Eisenhower era—to appeal, in other words, to the dark cravings and frustrations of the current mass unconscious—would sweep all before him and ride to the White House on a tidal wave of bile and hate, exactly as Hitler got himself *elected* Fuehrer of Germany.

THE HELL CANDIDATE lays out this thesis brilliantly, realistically, and convincingly.

Of course this *is* a novel of Satanic possession, and in the real world this could never happen and so forth and so on. . . .

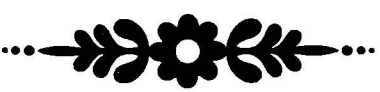
Uh . . . er . . . only a few days before I started writing this, Ronald Reagan got up on his hind legs before the Veterans of Foreign Wars and loudly proclaimed that it's time we got over our "Viet Nam guilt psychosis" and proudly realized that 50,000 Americans had given their lives in a just and noble cause, that America must achieve convincing military superiority over the Soviet Union. . . .

You don't suppose . . .?

—Norman Spinrad

"DEAR EDITOR..."

BY JAMES RANDI



Above all an editor must be deft,
making his changes without
disturbing the basic fabric.
And he must be invisible....

Mr. Hussain sat comfortably in the very expensive chair provided for visitors, a dark man against a very white and sterile background. The office resembled nothing so much as the inside of a refrigerator, relieved only by the striking presence of the recep-


DEAR EDITOR,
JANET AULISIO.

tionist, who was anything but cold, in the opinion of Mr. Hussain, who had not failed to give that matter much thought. Her wrap-around desk was liberally equipped with electronic wonders quite in keeping with the nature of the business conducted there.

Once more, Hussain took from his pocket the brief but very official note he'd received that very morning. Topped by the logo—an ancient hour-glass shape with a human hand pinching the stream of falling sand—it read, "The Director wishes to see you concerning your proposal." It could mean only one thing, thought Hussain. Acceptance. He was to be permitted to engage in one of the most important experiments ever conceived. There had only been six to date, and this one would make it seven. He'd heard that the agreed limit had been seven.

The near wall was relieved only by the large illuminated seal that stood out from it. Again, the hour-glass logo plus the text:

> Day 1, Month 4, Year 3460.
> Telkronics—dedicated to the technicians of the US Institute of Temporal Studies and their project: to judiciously insert among the series of events leading to the present moment, minimal and carefully chosen artifacts, thereby altering the Now Future to the benefit of Mankind.

Hussain's thoughts jumped back to his childhood, when the world had been agog over the discovery that had become known as Telkronics. Actual matter—at first only a few cubic centimeters of inert gases, then whole objects—had been sent back a few moments in time. An immediate drawback had become evident. The amount of energy needed to make the initial breach of the formidable time barrier had proven enormous, as expected. But to actually get the matter "across" that barrier required tens of gigawatts per gram, a figure that increased expotentially on a most

astonishing curve with each increment in mass. Of course, Nature had also written another clause into this hard bargain, requiring that the same curve apply to the amount of temporal displacement as well. The mathematics involved had frustrated schoolchildren for most of a generation.

After only a few tests had been made, the government had stepped in and established firm control of it all, for it became evident that any interference with the past was changing, in some degree, the present moment. Thus the office in which Mr. Hussain now sat, waiting his summons.

The paradox, so mulled over by his generation in every level of schooling, was familiar to everyone. There was no way of telling whether the desired effect of the experiment had been achieved! Of course, it was known that the actual transport took place. History books and other records proved that. But how different was the world of *today*? And different from *what*? A world that had—now—never existed? All that could be done was a difficult analysis of what might have been if the transfer had not been made . . .

And it was all housed in this small building. He knew that somewhere near was the desk-sized single unit that did the magic required. The nearly ridiculous security check he'd passed through to arrive at this point had verified his handprint, voice-print, mass parameters, iris patterns and DNA/gene specifics. He was Hussain all the way back to the nineteenth century, it told him. How reassuring.

The far door hissed open, and a man dressed like a school principal appeared in the opening, blocking sight of a similar white sameness behind him. He gestured to Mr. Hussain, who sprang up a little too energetically to follow him, somewhat alarming the receptionist, who was not accustomed to such improper less-than-sterile actions. Hussain gave her up as unattainable and followed the man through the

door. It hissed again in closing.

The man offered his hand to his visitor, reluctantly, it seemed to Hussain. He was not accustomed to dealing with people, feeling much more comfortable with the machinery he controlled. Plumping down behind a desk that could excite a real-estate agent, Director Cooper addressed his guest.

"Sir, Telkronics is going to use your suggestion." Visions of minor wealth flashed through Hussain's mind. "You will, of couse, receive the established life-pension. I congratulate you." Cooper summoned a weak smile that matched the stipend. "Next Thursday, the power grid of the entire Eastern USA and Canada will be channeled in through twenty-two kilometers of super-conductors that come into this building . . ." he gestured vaguely off to one side, ". . . and end up in the next room. Eight pages of paper, as per your suggestion, will be dropped into a quartz cylinder, and disappear—and with any luck at all, will then exist a few inches above the desk of a meticulously-chosen editor of a prominent publication late in the 20th century, at an appropriate day and hour. The man we've chosen is rather fond of this kind of stuff, and will happily print it."

Director Cooper leaned back. "Do you have any idea just what a problem it was to make up that paper for this project, Mr. Hussain? Formidable, indeed. But it will look like the real thing, have no fear. And the apparent typewriter work will look good, too. *That* was another problem, but quickly solved, of course. We had to make some changes . . ." Seeing the look of mild alarm Hussain allowed himself, the Director hastened to assure him, " . . . but only minor, I believe. For example, we cannot use your name as the author." It was obvious that Hussain felt this not to be at all minor. "It was quite necessary, I assure you," continued Cooper quickly, "since this editor would not recognize your name, and might hesitate to ac-

cept right away, considering problems of contract, and such. We used another name, one of a former contributor with whom he has had rather free and informal relationships previously. By the time he checks it out, the piece will be in print, and your—*our*—purpose will be accomplished."

Hussain leaned forward to speak, but Cooper was ahead of him. "As to that purpose, Mr. Hussain. We know full well that your intention was to introduce medical knowledge further back in time and thus save lives. Very commendable, of course. But you see, the most elementary knowledge of Interference Theory shows us that could be a disaster altogether. Too much. Far too much. Such a step could cause a catastrophic change indeed. We've changed the information in your little manuscript quite a bit, but for the better, believe me."

Hussain was crushed. His project seemed metamorphosed altogether if it did not carry into the past the essential biological data that would put medicine ahead by centuries. It had been too much to hope that he could have succeeded. He thought of how Telkronics proudly took credit for the Nobel prize-winning discovery of the one-shot oral vaccine that said farewell to the common cold forever back in 1986. How satisfying it could have been to have had his name on something like that. He was brought back to attention by Director Cooper leaving his seat and starting a determined walk back and forth before his guest. "The interference must be much more subtle that what you proposed, Hussain. Trust us to know that. There is no doubt. The thing that impressed us about your suggestion was both the way in which it was introduced—as a fictional exercise—and the immense practicality of the process of actual transport." He turned to a screen on his desk and punched two buttons. "Your few pages of manuscript weigh just . . . 40 grams! An ideal mass, to be sure. I

recall the time we sent 55 grams of pure gold back to the chap who called himself . . ." he punched up another few buttons, "oh yes, 'Paracelsus' . . . it non-located in his furnace, where he was cooking up some dreadful mess or other, and when he found it there, it gave new life to that dumb 'Philosophers Stone' search that was just about dead. What a waste! But—it kept him going, and we believe we're better off today for that interference."

The charm of this "inside" story was not entirely lost on Hussain. But he needed to know just how the system was using his idea. Again, Cooper anticipated him, in the manner common to Directors.

"We will introduce, not your medical/biological data, but instead a rather subtle suggestion that we have needed to inject for a long time now. You see, Hussain, the way to accomplish your design and many others is to speed up the discovery of the whole Telkronics idea itself! We need to have it discovered about 120 years earlier than it was—in our present time-pattern, that is. By moving back almost 1500 years, we can do this. And your idea will allow some bright young scientist of that era to *know* that interference with time is possible, and *has been done*. You see, getting the information there is only one thing. We will be giving a *suggestion*, not a proof. The bright ones who trouble to follow it up will *know* it is the truth. Asking for the original manuscript would be sufficient, showing the observer that such a material could not exist in that century! It was clever of you to write that piece in there, Hussain."

The visitor was somewhat mollified. It was becoming clear that there were subtleties to this matter he had not realized, and he was now willing to accept the protocol as outlined to him. It was evident that any investigator back in time who troubled to determine the genuine nature of this artifact would inject just enough impetus to the search that would take

that century-and-a-half off the development time. Yes, it sounded not only acceptable to him, but optimal.

The Director reached behind his desk with a genuine smile and came up with a tray bearing two glasses and a decanter. "Mr. Hussain, I trust you are not inhibited by personal beliefs in observing a very old tradition?" Hussain dismissed any suggestion with a shake of his head. "Then please join me in a toast to the success of the Hussain Experiment—modified, to be sure, but still your brainchild!" They raised their glasses and drained them. The budget of Telkronics was well represented in the quality of the beverage.

"Bear in mind, Mr. Hussain, a further benefit of your participation in this project. We have chosen a publication of which there are still records available. You will be able—providing the changes induced are not *too* pervasive altogether—to check those records and see your creation represented there!" beamed Director Cooper. "It will be published in the early 1980's."

Mr. Hussain began to take his leave, buoyed by the excellent liquor, the forthcoming life pension and the heady knowledge of his participation in one of the few experiments to change the destiny of Mankind.

He paused at the doorway as it opened. "Director, I have not chosen a title for my piece. May I leave that to you?"

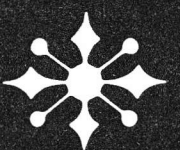
Cooper gestured assuringly. "Of course, my dear Mr. Hussain. Of course!" And the door hissed shut between them. Director Cooper took from his pocket an elegant pen, and leaned over the manuscript of Mr. Hussain. He hesitated only a second, then with a chuckle he wrote just two words at the top of the first page.

"Dear Editor . . ."

—James Randi

ON PREDICTING THE FUTURE: CRYSTAL-GAZING FOR FUN AND PROFIT

by Frederik Pohl



"SCIENCE FICTION IS THE WORLD'S FINEST INNOCULATION AGAINST FUTURE SHOCK." FRED POHL SAID THAT.

Not long ago I went to a worldcon. It was a giant affair that overflowed its two main hotels. Among the people present were Judith Merril, Robert Sheckley, Norman Spinrad and other familiar faces from science fiction, and the room parties were pretty fine.

Well, sure, you say, what's so special about that? World Science Fiction Conventions happen every year! True, but this wasn't one of them. What it was was the Third General Assembly of the World Future Society (also known as the First Global Conference of the Future, but that's too complicated to go into). It

took place in Toronto, and, although science fiction was much discussed and underlay a good many of the sessions, the people involved in talks and panel discussions were rarely primarily science-fiction writers. They included Herman Kahn and Timothy Leary, Aurelio Peccei (who founded the Club of Rome) and Orville Freeman (former United States Secretary of Agriculture).

The World Future Society was founded in 1966 in order to fill a need. The need was to provide some sort of central body to unite the growing population of human beings, world-wide, who need to know something about the future in order to carry out their duties as planners, researchers, politicians, industrialists or oracles-in-general. In order to do this, the research institutes (a.ka. "think tanks") have devised a lot of formal methodologies. For some time I've been meaning to write a piece on those methodologies; and the Third General Assembly reminded me to do it now—and this is it.

Since you're reading this, it's a good bet that you know about all the good things science fiction brings: Fun; imagination stretching; insights into the human condition; a sense of wonder . . . and, especially, advance peeks at the future. It has been said that science fiction is the world's finest inoculation against future shock (I know this is so, because I'm the one who said it). When the atom-bomb fell on Hiroshima in 1945, about the only people in the world who knew just how drastically the world had changed were a handful of physicists and military men—and about a million science-fiction fans. Nearly every major development in the world in the past century has been forecast in science fiction, from radar, television, atomic power, space travel, the airplane, the submarine and the tank to angst, anomie, terrorism and The Me Generation. The

people who read science fiction were privileged to get an advance look at just about everything that happened.

Of course, in the process they also got advance looks at a lot of things that didn't happen and a very great number that never will. A lot of science fiction's predictions have been grossly wrong. A lot have been just plain dumb. But (as I will presently explain in more detail) that's not necessarily a bad thing. It is in a sense a very good one. And in any case, the predictions of everyone else in the business, from Jeanne Dixon and Nostradamus to the fellows who lay out highway systems, are really no more accurate.

For a good long time science fiction had almost a monopoly on the techniques of long-range prognostication by non-occult means. There were a few oddities back as far as the 1920s and 1930s and even before, like H. G. Well's *The Shape of Things to Come* and Charles Galton Darwin's *The Next Million Years*, which were more or less "serious" attempts to predict the future. But they were sparse on the ground, and seldom very interesting. When Wells wanted to say something about the future he usually wrote science fiction; and so did W. Olaf Stapledon and Edward Bellamy and Jules Verne and Aldous Huxley and all the hundreds of people who filled the science-fiction pulps. Face it, science fiction was essentially the only game in town . . . until along came World War II.

World War II was *big*. It gave us the jet, the V-2, the atom bomb, great advances in meteorology and communications and, in devices like the proximity fuse, the beginnings of microelectronics. It changed the world. It did it so conspicuously and irrevocably that even the sorriest Senator or the most crustaceous corporate president began to worry. For God's sake, what next? They could have subscribed to *Astounding* like the rest of us, of course. In fact, a few of

them did. But mostly they wanted something more clear-cut and, well, *respectable*—something they could build plans on. So the think-tank was born, and there went our monopoly.

So in the late 1940s and 1950s certain scientists began to take a leaf out of our book in conducting kinds of research into the future. To a science-fiction reader they seemed both strange and familiar; essentially they were writing science-fiction stories with the story part left out. When I first found out that this new discipline called "futurology" was going on, it struck me as interesting in a professional way—as, say, a Madison Avenue advertising copywriter might be interested to learn that mainland Chinese were using hard-sell techniques to get the production norms met. It did not seem any more than that. I began to receive predictions generated by places like the RAND Corporation and the Hudson Institute and others (and even took part in a few), and they did not seem in any way more interesting or even more reliable than those tossed together by good science-fiction writers. And they were certainly a lot less fun to read.

But there were some differences. Two of the differences favored the think-tanks. The first was that, whether or not their prophecy was any good, it was certainly influential. Some very hard decisions were being based at least in part on the scenarios coming from the Hudson Institute; and the RAND Corporation, which had been set up in the first place by the Department of Defense, was providing inputs that seriously affected actual military strategies and even hardware. That had a very significant effect. If Herman Kahn said something was going to happen, and was believed by the people who make decisions, he could perhaps *make* it happen. John R. Pierce has pointed out that there are an infinite number of "possible futures" but that when the future becomes a

"present" there will be only one of it. Which "future" becomes a "present" depends on what decisions are made by the people who have the muscle to make them—as Dennis Gabor says, we can't really "predict" the future, we can only "invent" it—and to the extent that a futurologist affects the decisions that make that "invention" he makes his fantasies real.

The second thing was that most of the think tanks adopted what is called a "systems approach". In addition to attempting to predict specific events and changes, they attempted to relate them to as many other events and changes as possible, and to see how they affected each other. One example of this was what is called "relevance-tree" forecasting, in which all future events are displayed in a sort of tree-shaped diagram. Each branching point becomes a place where a decision must be made, and by looking at the map (or so it is hoped) you can lay out a trip to get to the place where you want to be. ("Relevance trees" exist in many other forms, most of them more useful, but the other forms do not relate directly to forecasting.) Some of the systems lent themselves to computer programming; all of them had the great advantage that they were more or less formal, and so could be used more or less rigorously.

So all this began to look interesting in a quite differrent way. Even important. And so, for ten years or more, as time permitted, I got involved in "futurology" (or "futuristics" or "future studies" or "futuribles"—the discipline does not have any very good and widely accepted name). I joined some of the professional organizations when they came along, like the World Future Society; I took part in any number of conferences and seminars, sat in on corporate planning sessions and trade organization conferences and even ran formal studies for some of them, taught the subject and gave lectures on it at a number of universities and spent quite a lot of time

with people who did it for a living. And my suspicion became a conviction; it *is* important and can even be useful, not only to large corporations and governments but even to you and me.

So what I would like to tell you is how it works and what it is good for, and even, if you stick around long enough, how to do some of these think-tank things for yourself.

One of the definitions of Man is that he is the time-binding animal. Other living creatures seem to have only behavioral concerns about what's coming next—squirrels store nuts, bears wait beside a salmon stream for their dinner to come along. Human beings plan, and wonder, and worry.

This trait reflects an awareness of causality, and the concept of causality is one of the great elucidating insights of human thought. We all learn about causality as tiny children. ("If you eat all that candy you'll get a bellyache.") Our race learned it in the same way, in its infancy too; and as far back as there were human beings, they understood that events of today led to consequences of tomorrow.

This is not to say that they understood which events led to which consequences—for that matter, most of us do not know that very surely now. But as farmers they learned that if you plant a seed you can harvest some wheat a few months later, and they even learned that there were seasons, and reasons for planting at one time rather than another. Some of this kind of learning became embodied in folklore: if the groundhog sees his shadow, winter will last a little longer; if there is a ring around the moon, a storm is coming; and so on.

This sort of prediction has great limitations, but agriculture based on it is more successful than agriculture based on nothing. There is a causal relationship between clouds and rainstorms, between the

behavior of animals and the change in seasons. To the extent that folk wisdom identified paired phenomena it was useful.

The search for such linked pairs—that is, for events which were fairly reliable omens of future events—was carried on assiduously throughout human history. It is too bad, really, that most of the time the search was looking in the wrong place. Omens were sought in stars, comets, the casting of dice, the wrinkles of the palm of the hand, the shape of molten lead poured into water, the identity of the first person to enter a door on a saint's day—everywhere you can think of to look, really. In our wisdom we realize what nonsense most of this is. We know no causal relationship exists between, say, the shape of a goat's intestines and the outcome of a naval battle. The Romans were not so sure. The principle of causality was so powerfully felt that it seemed certain there was *some* bit of present evidence that could be found that would make it possible to know about any given future event. The evidence might be hard to interpret, but that only meant you had to hire specialists to explain it to you: thus the great employment opportunities for augers, astrologers, haruspices and soothsayers.

It is obvious to any intelligent person that all of these occult fortune-telling modes are garbage. (This does not keep a lot of intelligent people from believing in some of them anyhow, but the belief structures of the human mind are outside the scope of this argument.) This does not mean that they are evil—at least, not in their origins—or even that they were useless. A baby's first step is always pathetic, however fine a runner he may grow to be. Attempts at divination served at least a heuristic end. If the art of predicting the future was a preposterous fraud in its beginnings, well, so, for instance, was the art of medicine.

The parallel is rather close: in both cases, the theoretical underpinning was lunatic and the statistical record of success very poor; but in both cases the practicioners of these dubious arts achieved great personal success. Perhaps if we lacked this habit of dauntlessly enduring frauds until the real thing came along we would have missed out on a lot of human progress. Neither the ball-point pen nor the electric razor worked worth a hoot when they first came out, but people bought them anyway and ultimately the manufacturers worked the bugs out. (It took longer to work the bugs out of medicine—many thousands of years longer—and perhaps they're not all out yet; but at least our present age does finally have the statistical probability that going to a doctor for an ailment gives you a better chance of recovery than staying away.)

The reason why early doctors and forecasters prospered is clear. There is a central area of hope in the human mind which will not be denied. For every perceived need, there is an attempt to meet it. If there is no rational and workable way to get help for illness (or for problem-solving), we will try to come by it by irrational and unworkable ways. Thus Laetrile and Lourdes* on one hand; thus astrology columns and tea-leaf readings on the other.

**Listen, please don't write me any letters to say that you know people who have been helped by Lourdes or by Laetrile. I do too. This does not prove that they are anything but irrational. It does not prove that they are workable, either, because non-medical cures have an even worse success rate than medical ones. All it proves is what I have already touched on, that not all the bugs are out of medicine yet and we still have a lot to learn about how and why some people recover from conditions that appear to be hopeless.*

Of course, not all perceptions of need are "real", in the sense that if you get what you ask for it will do you any good. One of the troubles with forecasting is that you often can't possibly give the right answers, because the customers haven't asked the right questions. Generally speaking, any question in the form "What will happen?" is the wrong question. Right questions, generally speaking, are either in the form "What *may* happen?" or "What will happen *if*—?"

The think tanks know this as well as I do. Their best methodologies are designed to give answers to "right" questions—morphological mapping and DELPHI to "What may happen", scenario-writing to "What will happen if—? " It is not their fault that the customers keep asking the wrong ones. Most of the rest of us do, too. We don't want any mumbly-mouthed evasions or conditional opinions. We want the *facts.* And we don't want to believe that the "facts" about the future, if we had them, would do us very little good at all.

This is one of the great paradoxes about the future, and it is embodied in Pohl's Law: "The more accurate and complete a statement about the future is, the less value it has."

Since this is obviously counter-intuitive, if not dangerous outright blasphemy, let's do a mind experiment to check it out.

Let's assume that we are the kind of person who needs most desperately to know about some future event. What kind of person is that? Well, generals in combat are that sort of person, so let's make believe we're generals. Essentially every war that has ever been lost has been lost because somebody made a bad guess about how some battle, or series of battles, was going to come out. If Hitler or Napoleon could have known what would happen to their Russian inva-

sions— If Lee had known about Gettysburg— If Cornwallis or Burgoyne had been tipped off in the American Revolution— If, in short, any general could know in advance which side would win, he could conquer the world—if—

If he could then manage only to fight the battles he would win, and avoid the others.

And it is this last provision that is crucial.

The general impression of futurological studies is that they involve a sort of methodological "forecasting machine", like a time radar, we turn on the machine and point it where we will, and it bounces back an image of what will be happening. Of course, no such machine can be built, but that's not what matters. What matters is that even if we had one it would do us little good; and the better it worked, the less good it would do.

For this reason, the kind of prediction we buy from a Gypsy palmist would not be worth the price even if it were reliable. Suppose you went to such a fortune-teller and found that, as you left her storefront, a giant runaway truck was going to leap the curb and kill you outright. In what way would that prediction be valuable to you?

Obviously, it would be worth having if you had the power to keep from walking out on that sidewalk. But you don't have that power! It is an *accurate* forecast. You *will* leave the storefront and be killed.

Even so, you might think, you could take a few extra minutes to put your affairs, or at least your soul, in order. Right?

Wrong. The prediction is not only accurate, but complete; or, to put it in terms of our time-radar, it gives you a full description of the state of the universe at the time you leave that building, and that description includes the statement of whether or not you had done any of those last-minute things.

There is only one kind of useful prediction about

the future; and that is the kind which we have it in our power to change.

In order for a prediction to be valuable, it must be at least potentially wrong. Not a "What?" but a "What may?" or a "What if?". Not "You will go out the door and be killed by a truck" but "*If* you go out that door you will be killed by a truck" or even "You *may* be killed by a truck". . . .and then, if you want to go on living, what do you do?

Simple. You exit through the back way, and the truck rumbles harmlessly by.

There are scores of separate methodologies for forecasting the future, even if you don't count the occult ones. As far back as 1966, in his book *Technological Forecasting in Perspective,* Erich Jantsch counted a hundred or so, and the number has increased every year. Some are extremely simple, and some extraordinarily complex. Fortunately for our attempts at understanding, most of them are not much more than variations on half a dozen or so basic methodologies, and it is those six basics we will spend our time on.

One variety is so simple that it needs to be mentioned only to be dismissed. It is the kind used to "predict" the results of elections or to "forecast" the sex of an unborn child.

What these two operations have in common is not technique, because obviously the techniques are different. To forecast an election you do what pollsters have been doing ever since the days of the *Literary Digest* in 1936. You ask a sample of voters who they are going to vote for. You have to be quite careful in how you phrase your questions, and particularly in how you choose your sample of prospective voters; but if you conduct the poll with care you will ordinarily be able to say who is going to win.

To forecast the sex of an unborn child, on the other

hand, the most reliable method is amniocentesis—which is to say, you insert a needle into the sac containing the unborn child in its mother's belly, withdraw a sample of the amniotic fluid the baby swims in, check it for male and female hormones and announce the winner. The method works quite well. If anything, better than polling voters does; and what the two methods have in common is that neither of them forecasts the future at all. They simply tell us facts which already exist in the present, but which we would not in the ordinary course of events learn until the parturition or Election Day.

Another trivial variety is one I learned as a young weatherman in Enid, Oklahoma. If you want to know what the weather is going to be an hour from now, your best bet is to look out the window and see what it is now, and then assume it will stay that way for a while. (We called this the "persistence theory of meteorology".) This works pretty well in the short range, far less well in the long, and is of no particular use in either case.

The third kind of forecasting on our list is related to the second, in that both exemplify Newton's Laws of Motion. Persistence theory says without outside intervention, a body at rest will stay at rest; this next kind says that a body in motion will continue in the same sort of motion. This third methodology is called "trend-line extrapolation".

The terrible thing about trend-line extrapolation is that, while it is almost as trivial and sometimes almost as useless or even deceptive as the other two we have mentioned, it is the way an awful lot of very important decisions are made. To perform it is simplicity itself. If you would like to know what the population of the United States is going to be in the year 2000, for instance, you simply get yourself some census reports and a piece of graph paper. You plot the population of the United States for 1900, 1920,

1940, 1960 and (as soon as it comes in) 1980, you connect the points in a curve and extend the curve two places farther and, voila, there is your 2000 A.D. population. The simplest way is just to place a ruler along the center of the cloud of points and draw a straight line. There are refinements: you can use log paper, or draw what are called "envelope curves". You can try to use Rene Thom's Catastrophe Theory to search out wiggles in the curve which will tell you when its slope is about to change dramatically: you do that sort of thing a lot if, for example, what you are interested in is not population but stock prices and you belong to the breed of security analysts called "chartists".

But what no kind of trend extrapolation can do for you is to allow for the effects of data which do not appear on the curve: a war, a famine, The Pill, a change in the abortion laws, a change in the perception of the role of the family, prosperity, depression, waves of immigration or emigration and so on.

Trend-line extrapolation is not only easy, it is so simple to understand that it is a good way, if you are charged with some large bit of planning, to cover your butt. For that reason it was widely used in planning for roads, utilities, water supplies, transportation and other social needs. It still is, in spite of the fact that it does not really work. One of the most carefully conducted trend-line studies was made of New York City's water supply shortly after World War II. With great relief, the commission announced that there was plenty of water at least until the year 2000 . . . and only about a decade later, water was being rationed in New York City.

However, trend-line extrapolation is ever popular, not only because the people who do it are not likely to be faulted as severely when it goes wrong as they would if they had employed more sophisticated methods but also because it is so easy you can do it

over and over. Each time new information comes in, you add it to the curve and announce a new approximation. By the time an actual event takes place, or a target date is reached, you are likely to be right on the money—because your last correction was made only a couple of weeks before.

We are not halfway through the six primary methodologies for forecasting the future, and at the halfway mark there is a phase change.

Amniocentesis and pre-election polling do not tell us about the future at all—the unborn baby is not going to *become* a boy, it already *is* a boy; we just didn't know it because it was hidden out of sight. They represent discoveries, not forecasts.

Persistence is another form of discovery; it only says that what is so now will probably go on being so for a while. And trend-line extrapolation is not much more than another form of persistence, dynamic rather than static.

All three give us "What?" answers (rather than "What if?" or "What may?"); which is to say that each of them considers one specific phenomenon in isolation.

But nothing in the real world happens in isolation. We live in an interactive universe. To find out anything real about the future, we need to know something about the interactions; and the next three techniques—morphological mapping, scenario-writing and DELPHI—are designed to let us do that. The price for this sort of power is that they can then give us only conditional or probabilistic forecasts—but then, we live in a conditional and probabilistic world.

When I said that science fiction was a sovereign prophylactic against future shock, what I meant was that if you have read all the science fiction ever writ-

ten you have seen described every significant event that is likely to happen in your lifetime or beyond. You don't know which *will* happen, or course. But you have a sort of Sears-Roebuck catalogue of all possibile futures.

When this sort of all-inclusive interation of possibilities is done systematically and formally in a think-tank, it is called "morphological mapping". Its principal proponent, Fritz Zwicky, predicted the buzz bomb and the jet by morphological mapping well before either of them appeared, along with a good many other technological marvels. It is not limited to technology. Madison Avenue ad agencies made great use of a form of morphological mapping, which they called "brainstorming". In a brainstorming session, all the creative personnel on a campaign gather together in a room. Object: to produce ideas. Method: shout them out, as fast as possible. They are not discussed or criticized; it's forbidden even to comment on them. When all the ideas are out in the open someone transcribes them and each of them is analyzed for worth and feasibility.

There is nothing quantitative about a morphological map, and so it is not in itself very valuable for planning. What it is really good at is showing alternate possibilities. If you compile a list of all the factors that may occur in the future or affect what does occur, you are a long way toward being able to identify and assess needs and problems, as well as opportunities, and thus to start to plan.

It's such a good thing to do, in fact, that we all do it all the time. We just don't call it "morphological mapping". We come home from work and think over the options for spending the evening: Go out to a movie? Call up a friend? Stay home and watch television? Stay home and read a book? Fix the light in the laundry room? Balance the check book? And with each iteration of an option we add the reasons for and

against, and so we make a decision. Not much of this happens on the conscious level, of course, but it happens. Our morphological map is the basic input to our decision-making.

Morphological maps are basic inputs to all more sophisticated forecasting methodologies, too, whether they are done formally and rigorously or, as with our own everyday decisions, automatically and almost without conscious thought. A good morphological map is essential to the next methodology, which is called "scenario-writing".

My friend Harlan Ellison says that the way he writes a movie script is to close his eyes for a moment and watch an imaginary scene happen. Then he opens them and writes it down, and closes them again to look at the next scene.

Scenario-writing, think-tank style, is much the same. It is a way of peering into the future a step at a time. Its foremost practicioner is Herman Kahn, of the Hudson Institute, and he has produced scenarios on a wide range of future subjects for a long list of sponsors and clients.

Described in ideal terms, the procedure is fairly simple. Someone asks for a scenario on, say, the future of the American automobile industry. A small group of knowledgeable persons gets together and tries to agree on what it will be like, say, six months from now: how many cars will be manufactured, how many sold, of what models and price ranges, what the competing imports will be doing; what the price of fuel may be, and how that will affect car-buying; what the general state of the economy will be, and what outside events (war? weather? demographic shifts?) may affect the industry.

Having described the near future, the group then ponders the implications of what they have said and goes on to try to describe the period a year later, and

then a year later than that, as far as their directive and their imaginations will carry them.

It would seem that this sort of stepwise iteration can go gravely wrong at the first step, and is bound to get worse and worse if the first step is wrong. Surprisingly, that does not seem to happen. In 1966 Kahn and his associates published several scenarios in the magazine *Daedalus*. One started with the sentence, "Major fighting in Vietnam will peter out about 1967; and most objective observers will regard it as a substantial American victory." Another began with, "In the United States Lyndon Johnson will have been re-elected in 1968." Of course, neither event happened; but the balance of the scenario in each case contains both hits and misses in more or less normal proportions.

Kahn is as aware as Dennis Gabor or I that there is not now nor ever will be a wholly reliable and useful science of "predicting" the future—not one that will tell us exactly what will be happening, for sure. So when he can he writes his scenarios in clusters. Asked to forecast the future of the USSR, he wrote three separate scenarios, each based on a different assumption: the "stagnating" USSR, in which nothing much is changing; the "contracting" USSR, in which the Politburo realizes it is over-extended, withdraws from all of its satellites and tries to straighten out its domestic affairs; and the "Kennedy" USSR, in which a bunch of Young Turks try to get things moving again—in some direction or other.

Is this useful? Yes, very much so—provided you don't take any of the predictions as immutable. It does exactly what any good future study does: it tells you what to worry about, and what you can hope for. Just as science fiction does . . . and, as a matter of fact, Kahn has made considerable use of science-fiction stories and of science-fiction writers from time to time. On one occasion, Robert A. Heinlein was

asked to participate in a study. On another, a Hudson staffer was set to work to read the complete canon of A. E. Van Vogt, to extract and list all of his scientific predictions. (!)

Scenario writing is very good at clarifying possibilities—which is to say, in the vocabulary of the field, it is "heuristic". A heuristic process is learning process. When you discover that you don't have enough money to go around and decide to put yourself on a budget, your first recommended step is usually to write down every penny you spend for a month or so to see where it goes. That's a heuristic process. It doesn't put a dime in your pocket, but it shows why you don't have one.

Scenario writing, like all of the other methodologies we've already mentioned, is hardly any good at all in showing ways to avoid problems of maximizing goods—which is to say, in the same vocabulary, it is not "normative".

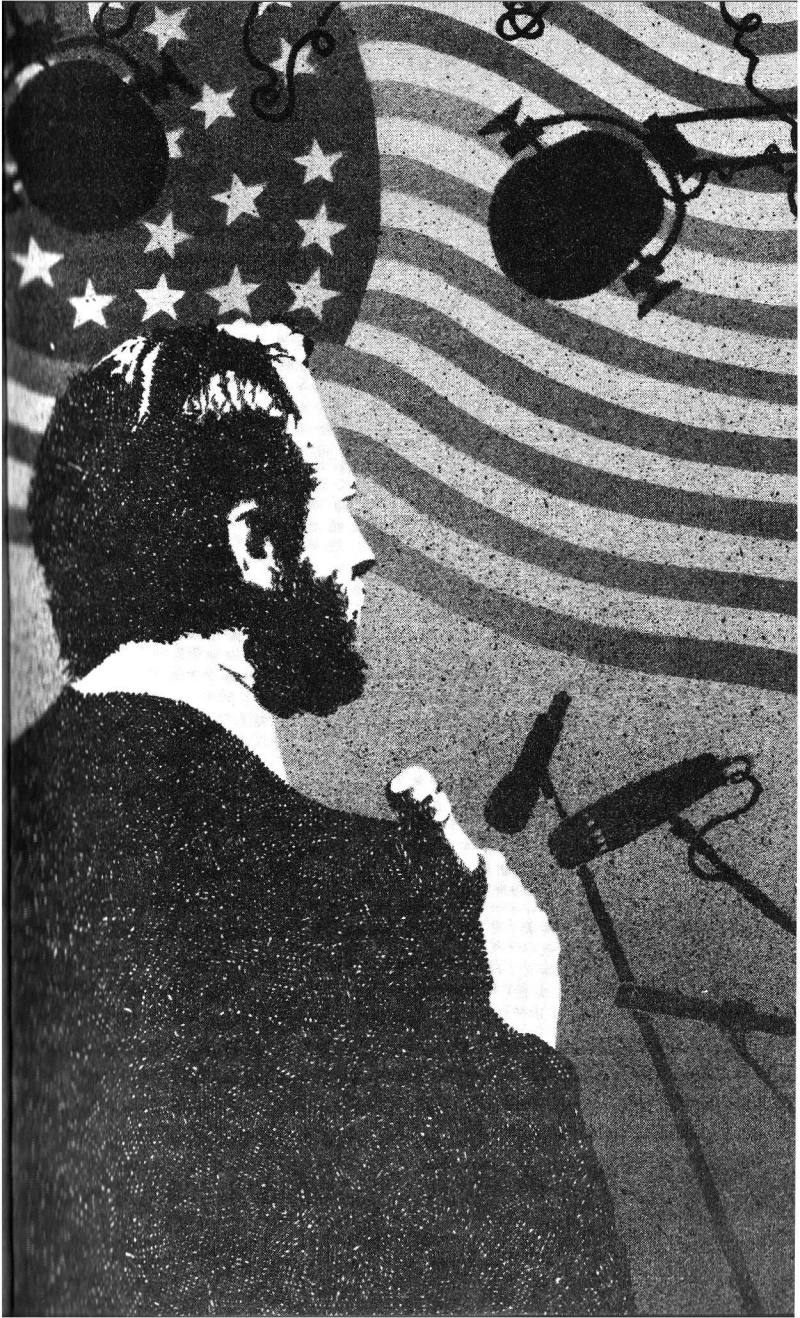
But normative methodologies do exist. Some work better than others, and some are highly promising. There are methodologies which use all of the ones we have just discussed only as inputs, in which you can take data from discovery, persistence, trend-line extrapolation, morphological mapping and any number of other sources, and use them to generate quantitative statements about the future. With a few refinements (including the relevance-tree construction already touched on), you can go even farther, Perhaps as far as identifying courses of action. Perhaps even to find a quantitative measure of what possible futures are "good" and what are "bad".

The name of the basic methodology involved is DELPHI; and DELPHI, along with some of the refinements that can be added to it, is what I will deal with in my next column.

—Frederik Pohl

THE FINAL DAYS

By DAVID LANGFORD



HE WAS A MAN OF DESTINY; THE PRESENCE OF THE WATCHERS TOLD HIM THAT. HE WOULD NOT FAIL THEM.

It was under the hot lights that Harman always felt most powerful. The air throbbed and sang with dazzlement and heat, wherein opponents—Ferris merely the most recent—might shrivel and wilt; but Harman sucked confidence from cameras, glad to expose something of himself to a nation of watchers, and more than a nation. Just now the slick, machine-

stamped interviewer was turned away, towards Ferris; still Harman knew better than to peer surreptitiously at his own solid, blond and faintly smiling image in the monitor. Control was important, and Harman's image was imperturbable: his hands lay still and relaxed, the left on the chair-arm, the right on his thigh, their stillness one of the many small negative mannerisms which contributed to the outward Harman's tough dependability.

Gradually the focus was slipping away from Ferris, whose mere intelligence and sincerity should not be crippling his handling of the simplest, the most hypothetical questions.

"What would be *your* first act as President, Mr. Ferris?"

"Well, er . . . it would depend on . . ."

And the monitor would ruthlessly cut back to Harman in relaxed close-up, faintly smiling. One of the tricks was to be always the same. Ferris, alternately tense and limp, seemed scarcely camera-trained. Why? Ferris did not speak naturally toward the interviewer, nor oratorically into the camera which now pushed close, its red action-light ablink; his gaze wavered as he assembled libertarian platitudes, and his attention was drawn unwillingly beyond the arena's heat and light, to something that troubled him. Harman glanced easily about the studio, and followed Ferris's sick fascination to his own talisman, the magic box which traced the threads of destiny. (Always to be ready with a magniloquent phrase; that was another of the tricks.)

He could have laughed. Ferris, supposedly a seasoned performer and a dangerous opponent, could not adapt to this novelty. Four days to go, and his skill was crumbling under the onslaught of a gigantically

magnified stage-fright. Posterity was too much for him.

Looking up from the box, the technician intercepted Harman's tightly relaxed gaze and held up five fingers; and five more; and four. Harman's self-confidence and self-belief could hardly burn brighter. Fourteen watchers. Favored above all others, he had never before scored higher than ten. The wheel still turned his way, then. *Ecce homo;* man of the hour; man of destiny; he half-smiled at the clichés, but no more than half.

The interviewer swivelled his chair to Harman, leaving Ferris in a pool of sweat. His final questions had been gentle, pityingly gentle; and Ferris with flickering eyes had fumbled nearly all.

"Mr. Ferris has explained his position, Mr. Harman, and I'm sure that you'd like to state yours before I ask you a few questions."

Harman let his practiced voice reply at once, while his thoughts sang *fourteen . . . fourteen . . .*

"I stand, as I have said before, for straight talking and honest action. I stand for a rejection of the gutless compromises which have crippled our economy. I want a fair deal for everyone, and I'm ready to fight to see they get it."

The words were superfluous. Harman's followers had a Sign.

"I'll tell you a true story about something that happened to me a while ago. I was walking home at night, in a street where vandals had smashed up half the lights, and a mugger came up to me. One of those scum who will be swept from the streets when our program of police reform goes through."

(He detected a twitch of resentment from Ferris; but Ferris was off-camera now.)

"He showed me a knife and asked for my wallet, the usual line of talk. Now I'm not a specially brave man, but this was what I'd been talking about when I laid it on the line about political principles. You just don't give in to threats like that. So I said damn you, come and try it, and you know, he just crumpled up. There's a moral in that story for this country, a moral you'll see when you think who's threatening us right now—"

(It was a true story. As it happened, the security man on Harman's tail had shot the mugger as he wavered.)

"A few questions, then," said the interviewer. "I think we're all waiting to hear more about the strangest gimmick ever included in a Presidential campaign. A lot of people are pretty sceptical about these scientists' claims, you know. Perhaps you could just briefly tell the viewers what you yourself think about these eyes, these watchers—?"

When you're hot, you're hot. Harman became still chattier.

"It's not a gimmick and it's not really part of my campaign. Some guys at the Gravity Research Foundation discovered that we—or some of us—are being watched. By, well, posterity. As you'll know from the newspapers, they were messing about with a new way of picking up gravity waves, which is something a plain man like me knows nothing about; and instead their gadget spotted these (what did they call them?) little knots of curdled space. The nodes, they called them later, or the peepholes. The gadget tells you when they're looking and how many are looking. It turns out that ordinary folk"—he suppressed the reflexive *like you and me*——"aren't watched at all; important people might get one or two or half-a-dozen eyes on them . . ."

At a sign from the interviewer, a previously dor-

mant camera zoomed in on the technician and the unremarkable-looking Box. "Can you tell us how many—eyes—are present in this studio, sir?"

The technician paused to make some minor adjustment, doubtless eager for his own tiny share of limelight. He looked up after a few seconds, and said: "Fifteen."

Ferris shuddered very slightly.

"Of course," said Harman smoothly, "some of these will be for Mr. Ferris." Ferris, he knew, had two watchers; intermittently; and it seemed that he hated it. The interviewer, giant of this tiny studio world, was never watched for his own sake when alone. He was marking time now, telling the tale of Sabinnen, that artist whom they tagged important in earlier tests of the detectors. Sabinnen was utterly obscure at that time; that ceased when they tracked the concentration of eight eyes, and his cupboardful of paintings came to light, and did it not all hang together, this notion of the Future watching the famous before their fame?

Harman revelled in the silent eyes which so constantly attended him. It recalled the curious pleasure of first finding his home and office bugged; such subtle flattery might dismay others, but Harman had nothing to hide.

"But I must emphasize that this is only a pointer," he said, cutting in at the crucial moment. "The people have this hint of the winning side, as they might from newspaper predictions or opinion polls—but the choice remains theirs, a decision which we politicians must humbly accept. Of course I'm glad it's not just today's voters who have faith in me—" He was full of power; the words came smoothly, compellingly, through the final minutes—while Ferris

stared first morosely at his shoe and then bitterly at Harman, while the interviewer (momentarily forgetful of the right to equal time, doubtless reluctant to coax the numbered Ferris through further hoops) listened with an attentive silence which clearly said *In four days you will be President.*

Then it was over, and Harman moved through a triumphal procession of eager reporters, scattering bonhomie and predictions of victory, saluted again and again by electronic flashes which for long minutes burnt green and purple on his retinas; and so to the big, quiet car with motorcycles before and behind, off into the anonymous night. He wondered idly whether any reporter had been kind enough to beg an opinion or two from Ferris.

He refused to draw the car's shades, of course, preferring to remain visible to the public behind his bullet proof glass. There was a risk of assassination, but though increasing it was still small. (How the eyes must have hovered over JFK, like a cloud of eager flies. But no one could wish to assassinate Harman . . . surely.) He settled in the rear seat, one hand still relaxed upon the leather, the other resting calmly on his own right thigh. The outline of the chauffeur's head showed dimly through more impervious glass. . . . In four days he would rate six motorcyclists before and behind; with two only to supplement the eye-detector's van and this purring car, he felt almost alone. Better to recall the seventeen watchers (the number had been rising still, the Argus eyes of destiny marking him out); or the eye of the camera, which held within it a hundred million watchers here and now. The show had gone well. He felt he might have succeeded without the silent eyes, the nodes of interference born of the uncertain principle which marked where information was siphoned into the years ahead. How far ahead? No one knew;

and it did not matter. Harman believed in himself and knew his belief to be sincere, even without this sign from heaven to mark him as blessed of all men.

And *that* was strangely true, he knew. The princes and powers of the world had been scanned for the stigmata of lasting fame (not the Soviets, of course, nor China); politicians—Harman smiled—often scored high, yet none higher than eight or nine. *Seventeen* showed almost embarrassing enthusiasm on the part of the historians, the excellent, discriminating historians yet to be.

I shall deserve it, Harman told himself as his own home came into view, searchlights splashing its pale walls and throwing it into due prominence. In a brief huddle of guards he passed within to the theoretical privacy of his personal rooms, sincere and knowing again that he was sincere. He would fulfill his promises to the letter, honest and uncompromising, ready to risk even his reputation for the good of Democracy. He paced the mildly austere bedroom (black and white, grey and chrome); he fingered the chess-set and *go*-board which magazines had shown to the nation. The recorders whirred companionably. His clothes were heavy with sweat, inevitable under the hot lights; the trick was not to look troubled by heat, not ever to subside and mop oneself like Ferris, poor Ferris.

This room had no windows, for sufficient reasons; but Harman knew of six optical bugs at the least. Naked in the adjoining shower, he soaped himself and smiled. Seventeen watchers—or perhaps nineteen or twenty, for the power was still rising within him—the bugs and the watchers troubled him not at all. That, he was certain, was his true strength. He had nothing to hide from the future, nor from the

present; in all his life, he believed there was no episode which could bring shame to his biography. Let the eyes peer! The seedy Ferris might weaken himself with drink, with women, but Harman's energies flowed cool and strong in a single channel, which for convenience he called The Good Of The Nation.

He fumbled into pyjamas, his erection causing some small discomfort. Four days. Only four days and then: no compromise. The hard line. Straight talk, nation unto nation. He would give them good reason to watch him, Harman, the ultimate politician. He felt, as though beneath his fingers, the Presidential inheritance of red telephones and red buttons.

The eyes of time were upon him. He knew he would not fail them.

—David Langford

A DEATH IN REALTIME

BY
RICHARD
SEAN
McENROE

THE REAL WORLD GIVES NO QUARTER. . . .

Join the navy and see the phosphor dots.

If Cooper hadn't been stationed aboard the USS *Quincannon,* manning his post might have been quite similar to watching television in a broom closet. But because the fast, cramped little Michaelson-class corvette was making thirty knots in a Force Seven blow as it steamed past the Migged-out North Sea derrick fields, he had the added pleasure of being thrown back and forth in his seat with such force that his

bowl-shaped helmet grazed the bulkheads behind him and above his console.

He braced himself against the ship's rolling, studying the pale green screen of the Decca-built R50/90A naval radar unit that was tied into one of *Quincannon*'s two Poignard tactical missile batteries. Switched to long-range sweep, its resolution was too coarse for the screen to be kept entirely clear of the Soviet ECM hash, but he could still make out the clustered blips of the Russian squadron his own small flotilla was steadily closing on.

When he was just a little kid, he had watched all the shows.

There was *Combat,* with Vic Morrow, and you could always tell who was going to die because it was always the same five or six guys who came back every week; everyone else was just a sympathy frag, at best. Then there was *Rat Patrol,* with Christopher George and his hat and those dynamite little jeeps and the German officer—was it Eric Braeden? He didn't remember—who never got court-martialed even though the jeeps kept blowing up all his General Grant tanks that were supposed to be panzers. And the movies, God, yes, the movies; he couldn't have been more than three years old the one time he ever saw *Guadalcanal Diary* but he could still remember the way the Marine Corps tanks had gone crashing through the jungle to chase the Japanese into the ocean—or *Battle of Midway,* the old one with Aldo Ray: he'd seen that one so many times that when he went to see *Star Wars* he got royally pissed at the way they took the whole last battle scene and just stuck it in, practically shot for shot. And then there was the one he'd seen so long ago that he couldn't even remember the title, where the GIs had knocked out a tank by collapsing a building on it; he had sat there peeling the chocolate coating off a Mallomar and

pretending it was the plating of the tank falling apart in the flames. . . .

The blips of the Russian ships were closing on the center of his screen now, and he switched over to short-range scan just as *Quincannon* shuddered and launched a brace of longer-range Harpoon missiles. The blips jumped magically back to the far edge of his screen, and where several blips had tended to blend into one amorphous mass before, each now stood out sharply distinct. Working a shorter range with the same power, he was able to fiddle with his clutter and squelch controls and clear his picture considerably. Then the last of the Soviet interference vanished as *Quincannon*'s own electronic counter-counter-measures finally got the best of it. Now he could see the much smaller blips of the NATO squadron's first salvo stabbing at the much more slowly-moving dots that meant ships and men. The screen broke out in a dozen blotches of pale light as the missiles struck home or were intercepted—*Quincannon*'s were—and a straggly line of pinpoints separated from the Russian ships, heading for the little cluster of blips around the center of his screen, heading towards him.

Doctor Strangelove, though, that was the one that really did it.

He had liked the old movies and programs, but he had always known they weren't really *real.* After all, Errol Flynn marched all the way through Burma and came out looking great, when Cooper only went camping once and caught such a collection of poison ivy rashes and bug bites and inflamed bramble-bush scratches that his mother had pulled him out of the scouts. And he knew he could never drive a jeep through North Africa; hell, he couldn't stand getting sand in his shorts at the beach and he burned like a lobster.

But then in *Doctor Strangelove,* in the scenes on board Slim Pickens' bomber, he knew what he was seeing was *real.* He knew that was what the inside of a B-52 looked like; he *knew* that that was what it would be like to evade a SAM missile. He didn't even mind that bullshit about Pickens riding the H-bomb down, that was just the director being cute. And it was the first movie he'd ever seen where the actors and models didn't have that tacky blue line around them in the projection shots.

Cooper's hands flew to his board and armed the two fire-and-forget missiles in his battery. From that point on the target programming system in the Poignard battery itself took over, and the missiles leaped flaming from their brackets to intercept the two most dangerous incoming targets. More pale light blossomed on his screen as those missiles and others detonated between the two clusters of ships. When it faded there were still three tiny missile-bogeys, pressing on stubbornly. Cooper paid those no more attention; they were in too close for counter-missilery now and would have to be dealt with by the Oerlikon and minigun crews. Far away through several thicknesses of metal, he could hear/feel the staccato stuttering as the 20mms and quad 7.62s opened up on deck, but he paid them no attention, either. They weren't part of his game.

He wasn't really going to the same college as everybody else. He would sometimes stop and watch the demonstrations on his way to and from classes, and once he even signed a petition a girl thrust at him, because he thought it would be the quickest way to get past her without being rude.

Then he went back to his dorm and watched Walter Cronkite riding as an observer in a Stratofortress, whopping with glee at the way the plane lurched

upwards as its bombload was released on the landscape below.

There was a thin red circle on Cooper's screen on short-range scan: it marked the outermost limit of engagement for his missiles. As he watched, the blips of the Russian ships drew nearer, and nearer—and touched. He immediately salvoed two more fire-and-forget missiles and then a third, laser-guided from his own console, holding his last LG missile in reserve while his battery recycled. Both system-aimed missiles plowed into a solid wall of counter-missiles and gunfire and vanished in incandescent fireballs, in silent splotches of pale green-white light. Cooper took his in on a long, predictable curve, then cut over sharply and sent the missile plunging into the ship vertically. He was rewarded with a great blot of light that continued to pulsate and expand long after the initial explosion. He immediately touched off two more fire-and-forgets.

Then they built a new amusement arcade in Penn Station. 'Station-Break', it was called, and it had everything, pinball machines, film-chain games, video games. Cooper was never very good at the film-chain games like *GUNSHIP* or *SHOOTOUT*; he could never handle the spacial relationships properly, his helicopter would always slew off to the side or he'd aim too high with the nickel-plated plastic six-gun and miss the man on the water tower. But the video games he loved. *STARFORCE*—what a great name, almost as good as 'Stratofortress'—in particular: you sat in this little cockpit-cubicle and controlled a set of crosshairs with the wheel, and once you were lined up on a target it locked in and all you had to do was pull the trigger. His real favorite though, was a ripoff of the last scene in *Star Wars*, going down the shaft, where every time you hit an

enemy ship it flew apart in a spray of stick-figure wreckage—he could beat *anyone* at that one; he never even missed the 'phantom raider' ship, the one that shot back and could take away half your points if it got you. He was in the arcade constantly, on his way to and from school, and so it was that when he boarded *Quincannon,* having chosen the Navy after he flunked the Air Force physicals, he performed what was very probably the one imaginative act of his life, and taped a quarter to the top of his Decca-built R50/90A naval radar unit. . . .

The two flotillas were within visual range of each other now. The men on deck could watch the gouts of flame blooming on the opposing ships as the missiles leaped out at them; the rapid-fire three-inch gun at *Quincannon*'s bow opened fire; the Oerlikon and minigun crews were firing constantly. At that range no motor could swivel a missile battery to track an incoming rocket faster than a frightened man could swing a gun around—the machine guns were now the main line of defense on both sides.

The two little fleets corkscrewed wildly around each other, each commander trying to place his force broadside on to the bow or stern of his enemy, to bring the full weight of his firepower to bear on those weakpoints. *Quincannon,* like all warships her size, was of a very narrow beam for her length. While this was to her advantage in terms of speed and maneuverability, it also made her very tender. As she cut and weaved across the sea, taking the steep gale waves on her quarter or even full abeam, she sent huge gouts of green water cascading across her decks. Cooper noticed none of this at his post save the ship's erratic movement. He was used to that. He seldom went up on deck anymore, as a constant view of unbroken water bored him. His shipboard life rotated mainly between bunk and mess and the staring green

eye of his console.

Now he was lining up another LG missile as his battery automatically launched brace after brace of fire-and-forgets. The air between the two fleets was thick with flame and shattered metal; aboard *Quincannon* an Oerlikon gunner sagged in his harness as a fiery shard tore away the side of his head; shrapnel spattered on the decks like steel and aluminum rain. Cooper saw nothing of this, only occasionally hearing the muted thunder of a particularly close explosion. He triggered his missile and sent it in on a long, weaving S-curve, watching with mounting excitement as it drew nearer and nearer its target—and vanished in a puff of light. Even as he muttered a disappointed curse he was firing his next missile, working the dials to sneak it through and score. This one went all the way, a phosphorescent white dot twisting across glowing green glass to intersect another dot and vanish in a slow, spreading flash. High score. Overtime play—

More blood mixed with seawater on *Quincannon*'s deck. Where electronics and state-of-the-art missilery clashed and largely cancelled each other out, older and more practiced means told. A 115mm shell impacted on *Quincannon*'s forward minigun battery and four men died. A hole was opened in *Quincannon*'s defensive envelope.

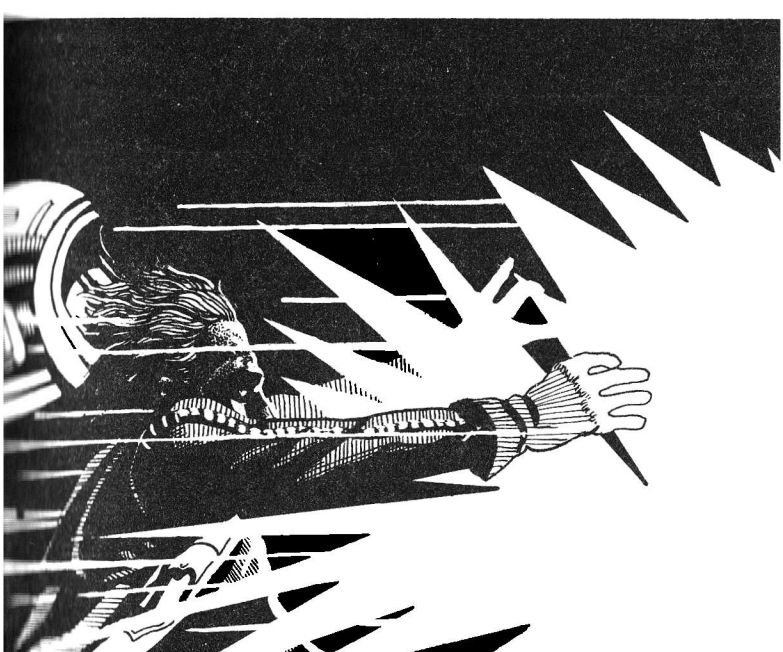
His next missile was intercepted. Cooper immediately launched another, eyes fixed on his screen, fingers working the dials.

A Soviet frigate, torn and burning from two direct hits, launched a last salvo from its one remaining operational battery. One missile erupted in flames and tumbled into the sea as the guns found it. Another detonated violently, taking out a third through concussion. The fourth found the gap in *Quincannon*'s defenses as other guns strained uselessly to make the impossible deflection shot that would stop it.

Cooper whooped with glee as his missile found its target. Then the bulkhead erupted inward and the game was over.

Quincannon limped back into Plymouth harbor. It took the engineers nearly half an hour to cut away enough wreckage to let the graves unit extricate the shattered body from the maze of twisted structural members and electronic scrap. Cooper's body had been so firmly embedded in the ruin that it almost seemed deliberate, as though the reality of war at sea had reclaimed him with such force that a steel fist had been clenched to anchor him in place. As the stretcher team carried the body across the planking leading from the gaping wound onto the dock, a careless foot brushed a tiny bit of metal and sent it tumbling over the side. The battered, deformed quarter fell into the water with the tiniest of splashes, unnoticed.

—Richard Sean McEnroe



Take Me To Your Teacher

by
Elizabeth Ann Hull, Ph.D.

"Every year there are new novels and collections that cry out to be discussed. But which ones?"

Science fiction, like sex, is coming into its own as a subject for study at institutions of secondary and higher education across the nation. Things are looking up for those of us who feel sf, like sex, is important enough to deserve serious, if not solemn, attention.*

Since you're reading this, it's likely you already believe it's a fantasy-come-true to get (or give) academic credit for a class that forces you to study the kind of books you're already reading voluntarily. But for the teacher arbitrarily assigned to face an sf class, it may feel more like rape. Even the willing novice sf teacher might feel like a nervous and unprepared bride.

"With access to a good library, a diligent scholar can prepare within six weeks to teach any undergraduate or high school course in literature."

Those immortal words came from the majestic lips of the Viatorian who taught me Bibliography and Research Methods in graduate school, a dozen or so years ago. At the time I thought he was joking, although it wasn't like Father Carl J. Stratman, C.S.V., to kid around in class. Now I've learned better. Teaching in a college with open-door enrollment, I've seen teachers given less than twenty-four hours to

*See "Lest We Forget: Some Good Reasons and Real Reasons for Teaching SF" in *Essays in Arts and Sciences* (University of New Haven, CT), sched. pub. mid 1980.

prepare to meet a class they hadn't expected. For some sorts of classes that may not be impossible. You review the notes in your own long-distant classes, you do some library research and then, with any luck at all, one of your faculty colleagues may have taught the course and you can ask her for help. But one of the places where that does not work very well is in the teaching of science fiction. To begin with, sf hasn't been taught on any large scale for more than a decade or so, and some of the usual resources are simply not available. Worse than that, science fiction changes while you look at it. Every year there are new novels and new collections that cry out to be discussed—or at least read. But which ones?

The teacher confronted with the task of conducting a science-fiction course does not have any easy row to hoe. We're often charged not only with teaching but with building appropriate library holdings. But the books we want are all too often out of print. The teacher needs to know what scholarship exists to draw from; but some of the most interesting criticism is publishing in quite unscholarly fanzines, which are virtually always uncatalogued in standard bibliographies. Even the teacher who is lucky enough to have read science fiction for pleasure doesn't always know where to start. The novice confronts her first class with the absolute certainty that at least a handful of the students are going to know a lot more than she does about the subject she is supposed to teach. One helpful step many teachers have taken has been to get involved in sf fandom. It helps, but it is not an answer. Science-fiction conventions are usually exciting but diffuse. What the teacher who is not already a fan really needs is reliable information and the opportunity to discuss science fiction seriously and systematically with other professionals.

Fortunately, help is at hand!

Pioneers in the field have blazed trails for the new-

comers to follow. There are several national and regional forums for science-fiction criticism and scholarship, and at least two annual seminars specifically designed to teach the teachers. The long nightmare of many sf writers and fans—that some of these courses may well be taught by people who think sf stopped with Jules Verne, or started with *Star Wars*—may be at an end. Assuming, of course, that the teachers who find themselves in this position know where to turn for help.

Best known of the scholarly science-fiction organizations is the Science Fiction Research Association—usually called SFRA, pronounced SEF-ruh. SFRA was fostered in its early stages by the Modern Language Association. Now it is independent, with its own annual conferences (1980's will be in Staten Island, New York City, June 22-23) and not one but two quarterly journals, *Extrapolation* and *Science Fiction Studies*. There is also a ten-times-a-year Newsletter, and membership is open to any person interested in the academic aspects of science fiction.

Not specialized in science fiction alone—but perhaps even more valuable for its cross-disciplinary approach—is the Popular Culture Association. Research papers read at a Pop Culture meeting have a special flavor. What is said has to be expressed clearly enough to be intelligible to non-specialists (or, more often, specialists at least the master's-degree level in some other field); the consequence is not only a lessening of specialized jargon, but also a useful feedback from scientists, sociologists, psychologists, film makers and critics, historians, etc.

Science fiction gets a good deal of attention at PCA. At the April, 1979 meeting in Pittsburgh, 57 people from half a dozen academic disciplines presented

papers or participated in panel discussions on sf and fantasy, making this the largest special-interest bloc in Popular Culture. The 1980 national conference will be in Detroit, April 16-20; there are also regional meetings, particularly in the midwest.

Both SFRA and PCA can be life-saving for teachers of science fiction who need collegial association. But there's more. For one-shot courses two separate series are available. Each is a quick and intensive survey of what science fiction is and why it is worth teaching. The students are actual teachers, and over the last couple of years they have come from a majority of the states of the U.S.A. to listen to, and interact with, the faculties of science-fiction writers and teachers.

Marshall Tymn, of Eastern Michigan University, is the guiding genius behind the "traveling road show" that in 1979 occupied one busy weekend at Florida Atlantic University in Boca Raton. The F.A.U. campus was once a naval air base—its takeoff strips have now become the longest, skinniest parking lots in the state—and in April held more than a hundred teachers at all levels from junior high through graduate school.

Dr. Tymn's seminar was then in its fourth annual reincarnation, and, as always, it kept the trainee teachers busy. Combining features of both a traditional academic conference and a fan convention, it featured solid informational sessions as well as seminars with working sf editor George H. Scithers of *Isaac Asimov's Science Fiction Magazine* a film program; art, book and resource displays; and a chance to listen to and talk informally with the guest of honor, Frederik Pohl.

For 1980, Dr. Tymn plans a series of Saturday-only seminars to be held in Michigan. But one consequence of the seminar's presence in Boca Raton in 1979 is already visible. Florida Atlantic University has begun an annual series of International Confer-

ences on the Fantastic in Literature and Film, the first of which was held in Boca Raton on 19-22 March, 1980. Coordinator Dr. Robert A. Collins (College of Humanities, Florida Atlantic University, Boca Raton, FL 33431) will send information for the 1981 program on request.

Younger by just a year and far more ambitious than Dr. Tymn's program is James Gunn's Intensive English Institute on the Teaching of Science Fiction, which is a three-hour course for either undergraduate or graduate credit (transferable to most institutions, but the wise will check before enrolling). Condensed into three weeks during the summer session at the University of Kansas (at Lawrence, KS 66045), it is just what the name claims—intensive, with an intimidating reading list of twenty-eight "basic" books, among which are Herbert's *Dune* and Asimov's *Foundation Trilogy* (counted as one book), as well as three anthologies of short stories.

Obviously it is not for the fainthearted or frivolous. In its third year this past summer, an admittedly self-selected group of people with a commitment to sf (but not necessarily all with an extensive background in sf) unanimously deemed it well worth the time and effort demanded.

Teachers contemplating giving up three weeks out of their valuable vacation next year for this program may well wonder what they're in for. The reading list, which changes somewhat each time, is provided with the acknowledgment of initial application for registration, recommended no later than May 1, so the students can have finished it before they arrive on campus, since classes meet five days a week, mornings, afternoons, and evenings. With the aid of a dozen films made in previous years with visiting writers on his campus, Gunn himself presents the morning sessions giving his perspective as a still active writer deeply involved in the development of the

genre. Stephen Goldman of K.U. is the discussion leader for afternoons, and guest-writers each in residence for a week (Gordon Dickson, Frederik Pohl, and Theodore Sturgeon) talk with the students each evening. This arrangement works very well, since it provides variety in both teaching style and content, according to the special background each brings.

The physical facilities on campus are ideal, a residence hall and classroom in one building with access to the rest of the campus at a time when regular student enrollment is relatively low. Those whose preconceptions of Kansas have been primarily founded on *The Wizard of Oz* may be as pleasantly surprised as I was to discover how pretty and pleasant the rolling hills of eastern Kansas are and delighted to see the full glory of the lilies blooming in Lawrence in July in colors ranging from sunny yellow to tomato red.

Supplementing K.U.'s already extensive and unusual holdings, the Kenneth Spencer Research Library has been designated as the American site for the first of six official repositories around the world for the young organization, World SF. This should not be confused with the fan group which awards the Hugos. World SF is an association of individuals with a professional interest in sf internationally, including writers, publishers, editors, critics, historians, librarians, curators, teachers, agents, artists, translators, producers or directors of film or tv. Among their very ambitious ultimate goals is providing a virtually complete collection of all sf published anywhere in the world. Anyone who has a private collection to donate or who wants further information about the development of the collection can write or call Spencer Librarian Alexandra Mason (913) 864-4334.

An added feature in 1979 which Gunn is planning to repeat in 1980 was an opportunity to participate in the John W. Campbell Memorial Award ceremonies

between the first and second weeks of the course. This event brought still more sf personalities on campus, such as Kansas writer Lee Killough and Doc Smith's daughter, Verna Trestrail, a teacher of sf in a rural Indiana high school—which helped offset the only major weakness of Gunn's program: an all-male staff. (The 1979 class included 14 women and 7 men. Two of the students announced they were more interested in writing than teaching; the others taught or were preparing to teach at both high school and college levels and came from all corners of the U.S.)

The resource people each planned presentations and informational material they wanted to cover, but the format was flexible enough that participants could comfortably redirect discussion into areas of special interest. Starting from the lectures and the reading list, the topics discussed ranged from moral and psychological interpretations to classroom strategies to points of plot construction to linguistic studies and semiotics to the history of pulp magazines and editorial influence on writers to new wave concerns and their impact on sf today to the emergence of women writers in the 70's to fandom and the Hugo awards with side debate on the relative prestige of the Nebulas to concepts of celebratory fiction to sf humor and wordplay to film and tv—skiffy vs. esseff—and invariably back to the ubiguitous unsuccessful but undaunted attempts to formulate a definition of sf satisfactory to everyone. In short, students added what they could and took what they needed from the well of knowledge and insight.

Group solidarity and spirit was demonstrated in the special tee shirts they ordered for their last evening's celebration: the front proclaimed KAMPUS GUNN CLUB; the back added I STILL LIVE!

This may not be exactly what Father Stratman had in mind, but I have the feeling he'd give his benediction.

Useful addresses:

Joe DeBolt, President
SFRA
3191 W. Remus Road
Mt. Pleasant, MI 48858

Ray Browne, Executive Secretary
Popular Culture Association
Bowling Green State University
Bowling Green, OH 43403

Dr. Marshall Tymn, English Dept.
Eastern Michigan University
Ypsilanti, MI 48197

Robert A. Collins, Coordinator
International Conference on the Fantastic
Florida Atlantic University
Boca Raton, FL 33431

James Gunn, English Department
University of Kansas
Lawrence, KS 66045

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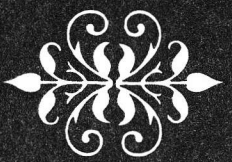


DREAMS COME TRUE

BY

ERIC VINICOFF

ADVENTURES ON OTHER PLANETS - THE UNIVERSE

SPACE Comics

THE PLANET RANGERS
"SLAVERS OF THE BLUE WORLD"
DALE MARS

JAN. No. 5

$2

TO LOSE A DREAM IS A TERRIBLE THING.

1987

Rod looked out the window westward, where swirls of orange and purple were the tail end of sunset. The Houston skyline was a black cardboard cutout, punctured by rare essential-service lights. There weren't any cars in the streets. He liked the almost-rural night calm—the next-to-best thing to come of the collapse.

"Close the drapes," Karen said as she spread the snacks wider on the table to make them more impressive, and set the jug of homebrew beer in the middle. "The neighbors are down on us enough without flaunting our food."

He pulled the drapes shut. "If they could see beyond their eyebrows—"

There came a knocking at the door. Karen opened it. Two men, in their late twenties like Rod and her, spilled in. Kimson, the ursine astrophysicist, growled, "A drink! A drink! Thirteen blocks is a bit of a stroll."

Chang, the microwave engineer, settled onto the pillowed floor. "Not to mention ducking two curfew patrols. Do we look like looters, I ask?"

"One of us doesn't," Kimson chuckled.

Karen passed out glasses and poured beer. In the candlelight the old, cramped apartment took on a magical charm appropriate for a meeting of apprentice wizards. The others joined Chang on the floor.

Rod raised his glass. "Thanks for joining us in this modest celebration. A toast—to tomorrow."

"To tomorrow," they echoed, and drank.

Kimson raised his glass again. "To irony. Here we are, part of the work that will turn the lights back on, huddling in the dark."

"Not for much longer," Rod said. He felt damned good, higher than any beer alone could lift him. He turned to Chang. "You still tight with Lucas in Admin?"

"Yes."

"So what does he tell you about the other stations?"

"Very little—a career bureaucrat, you know. But between the lines I deduce that if the prototype functions properly, we go to crash status on them."

"You two are going to be national saviors after tomorrow," Kimson cut in. "Meanwhile my department is virtually ready to go out and start mining. The Lunar and asteroid prototypes are all set. When you power types stop monopolizing the launch facilities—"

Karen giggled. "You talk like you were department heads or something."

"Why shouldn't we share in the glory?" Kimson

burped. "We've sure as hell taken the heat. I for one am sick of being a 'criminal squandering the world's last dregs of hope on a fantasy.' "

"You aren't the only one," Rod muttered.

The conversation drifted over to Topic One, coping with the shortages of practically everything. Rod laid back and looked up at the worn space art posters on the wall. From dream to reality, starting tomorrow.

The dream had taken shape in his lifetime, and he had been a part of it almost from the beginning. So had Kimson and Chang, and many others at NASA. It had grown with Mercury, Gemini, Apollo and Skylab. It had survived the cutbacks. The dreamers conversed, wrote letters and books, formed clubs, and held conventions. They were a loose-knit fraternity (and sorority), ridiculed by outsiders, using code words like Third Industrial Revolution, L-5 Society and High Frontier.

The dream was for a better life for humanity. But the dream itself was nurtured by a special hunger in their hearts.

The conversation had swung back to business again. Chang was consoling Kimson. "I believe, from Lucas' hints, that your mining hardware may begin going up with the last solar payloads."

Kimson wasn't consoled. "Eight months at least! Your department is already setting up a personnel lottery. Odds are you'll both be rotated up to a station within two, three months."

"We'll wave down at you," Chang promised. "Don't go sour on us. What do a few months matter—the point is, we'll all make it. Not a physical, abilities or psych downcheck in the group."

Only Karen didn't smile at the thought. She was worried for him, Rod knew, but he also knew she wouldn't say anything. He was going! Only Earth orbit, but it was space. He would look down on land and sea. He would see the stars more clearly than any

of the thousands of times he had stared at them since childhood. He knew he wouldn't find answers, just wonder that fed on itself and demanded more.

Chang raised his glass. "To space." They drank.

2012

Rod Becker went downstairs carefully, watching for boobytraps in the guise of Craig's scattered toys. These bleary-eyed morning descents were the most dangerous, he knew from painful experience. At the foot of the staircase he paused to take inventory in the hall mirror.

"Not much time for breakfast, hon!" he shouted at the kitchen.

"Whose fault is that?" Karen shouted back. "*I* didn't roll over and go back to sleep. Your plate's on the table. Come on."

He yawned. Maybe he should call in sick. It was so damned hard to get in motion these mornings. No medical reason, the doctor had said. Just a typical case of the blahs. Any job could become dreary routine after so many years. Even his.

Hell of a lot the doctor knew! Wait until he reached fifty and traded in his rainbow for aches and liver spots. Wait until he wore each day like a band of drying leather around his neck.

Rod walked back to the kitchen. Bright morning light shafted through acres of windows.

Craig was twitching in his chair at the small table. "Hi, Dad!"

"Morning. How's breakfast?"

The ten-year-old made a face. "Eggs! Ugg!"

"A full plate of food is a wonderful thing, son. During the Collapse your mom and I couldn't afford eggs."

Karen brought her breakfast plate from the range and set it down next to Rod's. "Finish your juice, Craig. The bus will be at the corner in five minutes."

He looked at her eating in her worn housecoat, hair up in a bun, face wrinkled and un-madeup. She too was getting old. He no longer loved or desired her. They made love rarely, and then usually to commemorate special occasions. But they were friends, attuned to each other, and he never got so mad at her that he wanted to live alone or with anybody else.

Craig jumped up. "Bye, Mom! Bye, Dad!" He came around the table to kiss them, then grabbed his lunchbox and books off the counter.

Rod saw a colorful comic book amid Craig's texts, and plucked it before Craig could get out of range. He stared at it. *Space Ace.* A classic guy-girl-goon cover. It could easily have come from his old collection. The illo depicted action on 'a world far, far away.' His hands shook slightly, and hard coldness wrapped around his stomach. "I don't want you reading this garbage!"

Karen frowned. Craig looked like he had just taken a sucker punch. "I want to be a spaceman like you, Dad!"

"How many times do I have to tell you not to call me that! Remember, you're not too old for a good hard spanking!"

Karen grabbed the comic book from him and handed it back to Craig. "That's enough, Rod."

"Why do you let him screw himself up with that stuff?" Bitterness put a whining tone in his voice.

"There's nothing wrong with imagination. You should know."

"I *do* know! The damned problem around here is no one will listen to me!"

Karen turned to Craig. "Go on now."

Craig went to the doorway, then stopped. "Don't be mad at me, Dad. I'm sorry."

Rod clamped down on his feelings. It was seeping into his cranium that he had over-reacted. "I'm not mad. Have a good day at school."

"Can we go to the center this weekend and watch the shuttles launch on the big screen? Please!"

Even on his days off! Was it asking too much to dig a hole and hide two days out of the week? But he saw Karen's smoldering look. "Okay. You better get going."

Craig vanished, followed quickly by the sound of a door slamming.

1987

Rod was supposed to be concentrating on his board, and he did most of the time. But frequently his gaze soared above the phalanxed consoles and fellow flight controllers to the main screen.

The shuttle was an ungainly thing, standing on its tail next to the service structure. The strap-ons and external tank made it resemble a Siamese quartet. Spotlights glistened off the white and silver hull. LOX fog lay close to the ground.

"T-minus-eight minutes and counting."

The speaker voice dominated Mission Control. The undercurrents of low voices and equipment sounds were like wine to him. He was where he wanted to be (only one place better), doing what he wanted to do. Chang was two rows up and six boards to his left, on a Z6M telecom auxiliary. Kimson was undoubtedly in one of the galleries, watching.

The countdown, of course, had been well underway when Chang and he had taken over their boards during the last shift change. They had been at it for over three hours, but he was still riding an adrenalin high. His board wasn't particularly vital to the launch; Systems Monitor B1, Cargo Bay. But it was vital to the world. The bay held the MHD generator module for Solar Power Station One.

It was a constantly jarring thought that the screen images were really a thousand miles east, amid the sandy terrain of Cape Canaveral. Commander Ghu

and Pilot Barron were ready to truck the module up into geosynchronus orbit, and Mission Specialist Friedrich was ready to nurse it out of the bay. Two payloads later the inflating Habitat would go up. A rotating assembly gang of four techs would live in it until Station One was ready to go on line. A team of two engineers would then run the station and keep it in repair, also on a rotating basis.

"T-minus-seven minutes and counting."

His board was clear. Short of a blowup not too much could go wrong before liftoff. The shuttle kept luring his attention. He envied Mike Friedrich more than he had ever envied anyone in his life. They had taken the torture of EVA training together. But the luck of the draw, dammit . . .

"We have a hold. Holding at T-minus-six minutes twenty-six seconds."

Hell! Holds below T-minus-ten were the worst sort of hoodoo. He switched to standby mode and peered around, looking for the excitement.

Admin types were clustering around the fuel feed telemetries. As their noise level rose, most of the rest of the room hushed. They knew what he knew. Fuel trouble could be bad. A scrub. Or worse.

He glanced back and up at the media gallery. The nation, the world was watching. God, let the hold be a short one!

"Holding at T-minus-six minutes twenty-six seconds."

The cluster was bigger now, and the debate within reaching substantial volume. Occasionally a person would bolt into or away from it at a dead run.

Word began to filter down the rows. An A3 attitude feed near the bow was down red for pressure. No luck so far clearing it up through the boards. They were pouring over computer simulations, trying to figure out the cause and whether a bypass was feasible. But hopes were bleak.

Rod slumped back in his chair, exhaustion catching up with him. A fuel feed. They would have to go in and repair it. Hours at least.

Sudden activity drew his eyes to the life-support consoles. Most of the cluster ran over there, and the shouts were loud enough for him to hear, though not for the media behind the glass panes.

Fumes were leaking into the cockpit environment.

"Go to suit air," someone ordered. That was SOP, but only a partial solution. There was still the very real danger of a fire, like the one on the blackest day in NASA history.

"Contamination in all suit environments!"

Agitated reports were coming in from the biomed telemetry boards.

Director Wendyne was huddled with the Launch Officer and several department heads. "Shit! Get them out of there. We scrub it."

The blow rolled through the room. Soft orders went into throat mikes. The EES tube snaked out from the service structure and suckled the shuttle hatch. An interior camera showed the red team cycling the hatch and extracting the crew. Fire teams were standing by for their orders.

Meanwhile the flight controllers were initiating an emergency shutdown. It was a laborious, heartbreaking task.

There was no fire. When word came in that the crew had suffered only minor poisoning symptoms, cheers filled the big room, but cheers diluted by defeat.

Rod and Chang looked to each other for comfort neither could give. The media cameras were panning, and commentators were moving their mouths energetically. In the glare of their hype this would become a virtual disaster, three brave men on the brink of death. More proof of the insurmountable dangers of space travel. Hot-load ammunition for those who wanted to stop the entire project.

He stared at his board. There was nothing else he could do as around him the launch shut down. Probably forever.

2012

"Don't do that to Craig," Karen said softly.

"Don't what?" Rod felt the bright kitchen walls pressing in on him. "Don't try to set my son straight? I want to keep him from making my mistake."

"What mistake?"

"Let's not get into it again, hon."

She took their empty plates to the dishwasher. "Craig and I are proud of you. Why can't you be?"

It was hopeless. Limited vision. She saw the substantial income, where twenty-five years ago they had been in the middle of the worst global depression ever. She saw the lovely new home, where the re-

source shortages had all but torn civilization apart. She saw the panoply of electrical helpmates, where blackouts, gas rationing and drastic conservation measures had been the rule. She saw Craig, whose conception had waited upon better times. To her, and to most of the world, a dream had come true.

Breakfast was a lump in his stomach. They had been so much to each other for so long, how couldn't she understand? Had she paid lip-service to his god while worshiping Deus Suburbia at a secret altar? She was supposed to be on his side, dammit!

He stood up. "I better get rolling too."

"Please don't harass Craig."

"Okay, okay. Time enough for him to learn the sad facts of life when he gets older."

He went to the front door, snagging his attache case on the way, and stepped out into the hot morning. Houston had two types of weather; hot and dry, and hot and wet. The sky was cloudless.

Walking to the curb, he climbed into his car. The motor hummed, and he eased out into the almost empty lane. Briarwood was a very classy, very new development near the Johnson Space Center. Tiny young trees lined the front yards. Back in the bad old days it had geen grazing pasture. Now it was a complete, packaged neighborhood. Karen and Craig mixed; he didn't. Most of the breadwinners were Space Center workers of the new breed. They were a result, not a cause, but he had nothing to say to them.

Thus the endless lonely times, perfect for brooding.

The quiet streets evolved into a busy commercial strip, then a freeway. He cut in the safety radar and accelerated to eighty-five, a comfortable cruising speed.

Two new office buildings were going up on San Antonio Avenue, amid the clustering franchise food outlets. Subdivisions were spreading again like a blotchy rash across the rangelands. The boom was

definitely on. Here. Everywhere.

Craig and his damned comic books!

He remembered the Sunday afternoons of his own childhood. Pinball at Loper's drugstore. The comic books he read there because he couldn't buy all his favorites after a few games and a soda. Adventures of intrepid spacemen, aliens, exotic worlds and awesome technologies. He read them, and nights he would stare at the sky and wonder.

And here he was. Spaceman! He looked at his paunch, his wrinkled hands. It was to laugh. No adventures on the space frontier for him. Or for his son.

He took an offramp, and pulled into a service station. The meter was dropping below quarter charge. As the attendant removed the battery and put in the new one, Rod admired the industry's cleverness. When electricars with reducing oxidation batteries had replaced gas-guzzlers, service stations almost joined the passenger pigeon. People could buy two batteries, and recharge one at home while using the other. Some tight-fisted folks did just that. But most were too lazy to do the work, and to plan on being home when the charge ran low. So service stations took your battery, put in a charged one, and collected a 'modest' fee.

Some things changed. Some didn't.

Five minutes later he flashed his pass to the guard in the gatehouse at the Space Center. Winding through the sculptured landscape and gleaming edifices, he saw change here too. More buildings were going up. But the astronaut training facilities were closed pending the decision on what new use to put them to.

He made himself blank out that thought. Why did he stay? Did he get some kind of masochistic pleasure from rubbing salt in the wound?

No, the answer was the same prosaic one that had destroyed him and his fellow dreamers in the first

place. The cold reality of economics. In this case, the money was too good to leave.

And there might have been something else, a lingering bit of childhood.

1987

The President slumped back in his chair, took a deep breath, and tried to recall why he had wanted the job in the first place. The hours were lousy. He was too lazy to be power-hungry. Back in his idealistic youth, before taking on the world's damnedest responsibility, he had wanted to accomplish something. But now he couldn't remember what.

Nine men and women were gathered around the small conference table. But most were there for imput—only four mattered now that the reports had been delivered. Dyer, his Congressional liaison. Pierson, his science adviser. And Wendyne and Harald, the point men for the two High Frontier alternatives.

"The public reaction to the accident has been bad." Dyer was a short, slick lady lawyer. "Our House votes in particular are feeling the heat—elections on the horizon. Frankly, as things stand now, I don't see getting the appropriations for next year's HF programs through."

The President nodded. The accident had been a PR disaster. Their consensus, none too strong to begin with, was falling apart.

He turned to Piierson, the imperturbable university scholar. "Cut through the tables and graphs for me, Doctor. I need the bottom line. If we don't go ahead with the programs, what are our options?"

"Hmmm. We're doing about as much as we can in the near future with conservation, recycling and native resources. But the situation continues to deteriorate."

"How bad will it get?"

"Hmmm. You want simple statements. Very well.

War against the resource nations within five years. The end of technic civilization within twelve."

It wasn't a new pronouncement, but it had its usual chilling effect.

"So we need the programs," the President said. "But how to convince Congress and the people. Even before the accident it smelled too much like an aerospace boondoggle when we can least afford one. Now that it looks like it'll cost lives too . . ."

It came down to Harald, and he knew it. The corpulant Canadian engineer was smiling smugly, a stark contrast to Wendyne's ill-concealed venom aimed his way. Both were nominally on the same NASA and High Frontier team, but hell hath no fury like two scientists with different Ways to the same End.

Harald coughed—an irritating affectation. "Now, I take it, we're going to proceed in the direction we should have from the beginning. The direction we would have except that certain people at NASA feel America and science are synonymous words—"

The President cut in before Wendyne could burst a blood vessel. "Can we avoid personalities, please? We have a serious problem here."

Harald had the grace to look embarrassed. "Very well. As you know, my theories grew out of the work I did on the shuttle bay space arm. But when the High Frontier programs were being formulated, I was pushed aside—"

"For valid reasons that still stand!" Wendyne, the NASA head, erupted. "His proposed technology is untested, speculative! The existing programs are grounded in known technology and ready to go. We must make the people see that their fears are groundless."

"Unfortunately," the President said, "scientific and political realities aren't the same. Look what Three Mile Island did to nuclear power." He turned

back to Harald. "I have the same misgivings now that I had when we initially decided to go with Director Wendyne's proposals. They aren't based on nationality. They're based on probabilities of success."

"Our technology *is* proven," Harald insisted. "Ask the atomic plants. The satellite builders. The manganese module mining companies. *Et al.*"

"This isn't quite the same thing."

"True. Though not as different as you might think. But isn't the real point, Mister President, that it's my theories or not at all? Isn't my alternative the only one you can sell to Congress and the American people now?"

Silence answered him.

"My team can be ready to go on a crash basis—most of the hardware already exists. We can integrate it with the existing High Frontier hardware and not fall too far behind the present schedule."

The President took another deep breath. There was no time for lengthy considered judgment. Which in a way made it easier. "We'll try your theories, Mister Harald. And they better work like hell."

* * *

2012

Rod parked, got out and walked across a wide Space Center concourse to the monitor building. It looked rather ordinary except for the antennae bristling on the roof. Herds of people were entering and leaving with the shift change. He knew the faces too well. Mostly the new breed, young ones from the companies with investments to protect. They had grown up with the boom, the Third Industrial Revolution. What they did for a living was just work, nothing special. Joking, chatting about their cars and the scores of baseball games, they went about their daily routine.

He achingly envied them.

Admixed with the younger faces were a handful of NASA veterans like him. They were mostly quiet. Few smiled. He nodded to some, said good morning. Kimson, Chang and other old friends were still around, but they didn't get together for brew and banter anymore. They were to each other ghosts of the dead past.

Inside, air conditioning provided relief from the heat. He rode an elevator to his floor, went down a corridor and came to his door. He went in.

The monitor room was like the dozens of others in the building, small and dimly red-lit to highlight the displays in the horseshoe console. A young man was seated in a padded chair inside the horseshoe. "That's what I like about you, Becker," he yawned. "Always on time."

"Any action?"

"You mean deviations from program? No such luck. Never anything to liven up the graveyard shift." He stood up. "Me for home and bed."

"Take care."

"You too." End of meaningful discussion between two eagles of the spacelanes. The young man left, and Rod settled into the warm neo-leather.

He scanned the displays. Everything was green. The main screen showed Earth floating in space in high-contrast B/W. A picturesque view to fill the slow hours, but not very useful. He cycled through the external views of space, then the hull externals and the internals. No problems he could see. Hardly any discernable transmission lag—the shuttle was closing on Orbital Factory Twenty-Two. Docking would take place in about three hours, and he would have to pay particular attention then.

BFD.

Redundancy Systems Monitor. He would watch the telemetry displays and screens for eight hours,

minus lunch and breaks. If anything went red, he would report it. Of course the shuttle systems would already have reported it (except in the rare instance that was the justification for all this expense). Then he would initiate corrective procedures if the shuttle hadn't (also a rare instance).

He flipped a secondary screen through some transmissions from other monitor stations. It was magnificent. Beautiful. And a mockery with serrated cutting edges.

His fingers dug into the padding on the chair's armrests.

MHD solar generators were silver blossoms kilometers across, in geosynchronus orbit, beaming millions of megawatts to microwave rectennas around the world. Labyrinthine factories in lower orbits were refining ores and producing goods, ejecting pollution and wastes into space. Descendants of the first space shuttle were blasting off from Cape Canaveral, docking with the factories, taking on cargoes and bringing them back. Beneath glistening Lunar domes were mines excavating trace elements desperately needed for Earth's depleted farmlands. Similar domes squatted over heavy metal deposits on Mercury. Spidery spaceships were attaching themselves to asteroids with waldoes, and digging out anything of value. In the L-5 position a huge complex of facilities was carrying out scientific research. Ugly lumpish spaceships linked the mines, L-5 and the orbital factories.

From them the resources, energy and knowledge of the solar system flowed down to nourish Earth.

Technology had created computers smart enough to do almost anything a human could (though not smart enough to appreciate their achievements), and servo-mechanisms with the dexterity of human limbs. Machines had assembled the factories and stations and spaceships and mines. Machines ran them.

When a machine broke down, modular design enabled other machines to repair it. Machines needed no life-support, were usually lighter than their human counterparts, didn't suffer from harsh accererations or zero-g, didn't have to be paid, and never embarrassed their owners by dying in space.

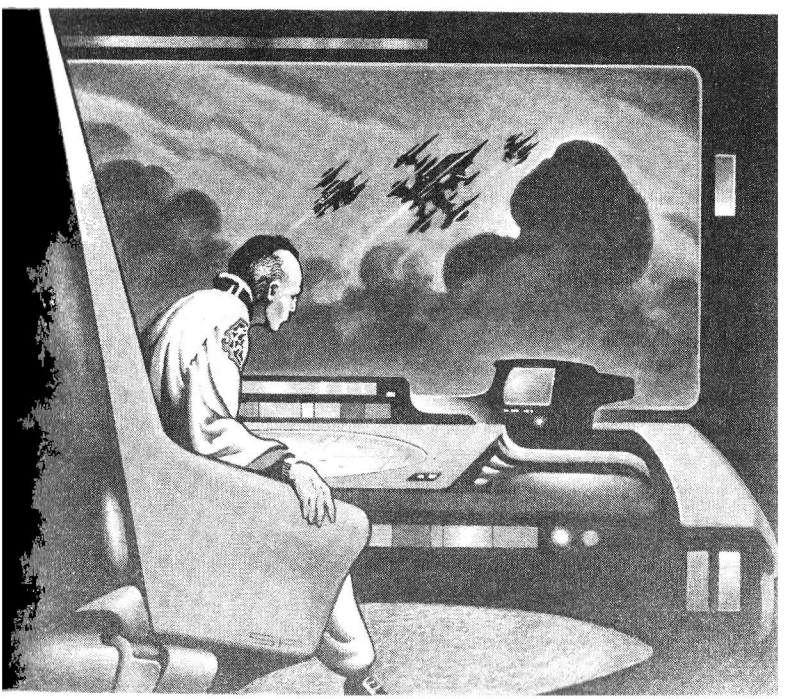
Unmanned probes were exploring the outer planets, for potential commercial exploitation as well as research.

No touching the face of God. No adventures. Just economics.

Someday ships would be launched to Alpha Centauri and beyond. But Craig wouldn't be riding in one. The machines would conquer that frontier for humanity too.

He looked down at his lap and wished to hell comic books had never been invented.

—Eric Vinicoff

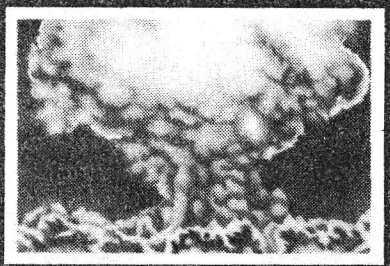


NUCLEAR SURVIVAL

PART FOUR:

POWER– AND POTTIES!– TO THE PEOPLE

BY DEAN ING



"SENSORY DEPRIVATION STUDIES SUGGEST THAT WE MIGHT GET THROUGH THE SHELTER ORDEAL MUCH BETTER IF WE HAVE LIGHT, SOME MEANINGFUL ACTIVITIES, AND GAMES OF SOME SORT TO OCCUPY US WHILE THE CLOCK TICKS AWAY.

In recent issues of *Destinies*, we argued that the average citizen would have fair-to-excellent survival chances after an all-out nuclear exchange—but only by having certain awarenesses, and acting on them. To summarize briefly: the first piece explained that the government now favors mass evacuation from high-risk areas following an alert, since firestorm is a more immediately lethal threat for city-dwellers than is fallout. But you will probably be on your own when evacuating and improvising shelter because no sufficiently powerful lobby group has fought to fund the machinery—software and hardware—of city evacuation. We discussed the logistics in some detail and suggested that you relocate *now* from primary target zones.

The second article showed how to build air filtration and pump devices from household materials in a few hours, so you can breathe relatively uncontaminated air once you find shelter beyond a firestorm-candidate area. Finally, we promised some tips in future articles on making your shelter more liveable; things like lights, hygiene, and so on.

Okay, it's time to power your shelter. Take heart: even though our premise is that you haven't amassed special equipment, we've tested enough commonplace equipment to prove it's rather easy to generate enough electricity to run lights, radios, even a cassette recorder—from at least one source we'll bet you never thought about.

A moment's thought will remind you that cars, motorcycles, boats, even many bicycles are equipped with subsystems that you could use in a shelter. It's a sorry automobile that doesn't have a complete electrical system with a hefty battery to store electricity; a generator to generate more electricity; many yards of wiring; several electric motors, some connected to fans that you might use for shelter air; and more light bulbs than you'll need. Of course we don't suggest that you run your car inside your shelter. We do suggest that you familiarize yourself with a car that you can park in your garage and then strip of some life-support items when the time comes. You can always replace the hardware quickly if you need it in the car again.

We won't go into detail on removing car parts because electrical systems differ a lot. Study your own, and ask any mechanic for details on cannibalizing it. We will mention a few things that could free you of frustration when you're trying to set up an emergency power system.

To start with, be advised that a good car battery can strike sparks if its 'positive' terminal (also called the 'hot' or '+' terminal) comes in contact with metal parts of the car. This does *not* mean the battery could shock you. Its twelve-volt jolt is much too low. You simply have to remove the cables from the battery terminals with care.

The average car battery has enough energy stored in it to operate a small light for a week or more without a generator. You can find tiny lamps with

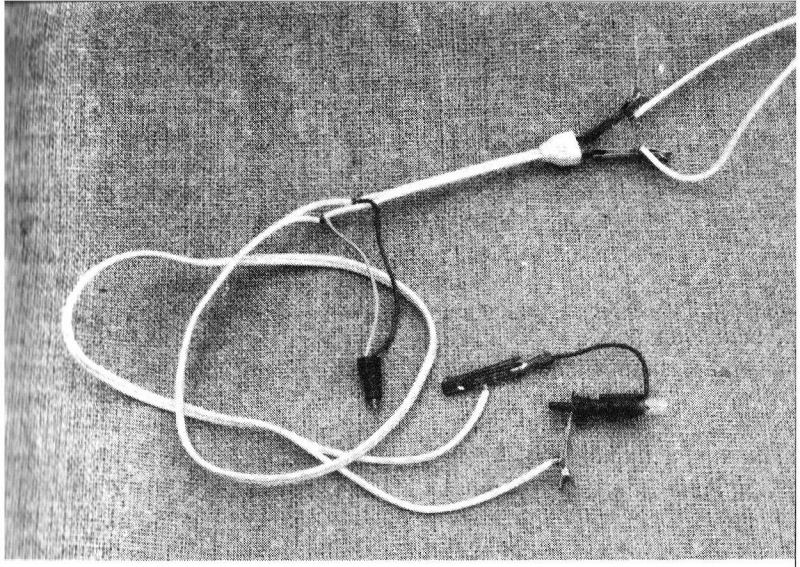


Figure 1

removable sockets in glove compartments, in instrument panels, on roof interiors, and next to license plates. Many of the interior lights are designed to be installed and removed instantly, socket and all. In Figure 1 we have wired a tiny transmission shift selector light, and a slightly larger light pried out of a glove compartment with its socket, to the remains of an extension cord. The wires lead to a 12-volt power source that could be a car battery. Or it could be something else—about which, more later.

Light bulbs in your brake and tail-lights, directional and backup lights, and so on require more power and provide more light. Finally you could remove a headlight, which sheds tremendous light on the subject but also gobbles up a battery's stored energy in a few hours.

Generally, the brighter the light, the more power it consumes. You may think you need a high-wattage bulb in your shelter until you plug off the last window

with old books, and find out how dark it gets in a secure shelter. Then you'll see that a 6-watt glove compartment light makes the difference between merely shadowy, and downright scary. Remembering that

1 watt = 1 volt x 1 amp, so that
6 watts = 12 volts x 0.5 amps,

you can see that a 'half-amp' rating for a bulb in a 12-volt system means it draws about 6 watts. When considering a 12-volt motor that has a wattage, but no amperage, on its ID plate, you can solve for the amperage. Select appliances that use little power, so the battery will last longer. If you must do a lot of reading, cuddle up near a small light and put a mirror or other reflector where it will help. If you have a fluorescent drop-light intended to plug into a 12-volt system, gold. It's stingy with power and doesn't give off much heat. In the days when shoemakers and tailors worked by candlelight, they found a nifty way to concentrate what little light they had. They suspended a water-filled glass globe so that the globe created a lens effect, giving a powerfully concentrated beam of light onto a small working area. Try it with a wineglass; you'll probably find a long slender patch of light, intense enough for threading needles.

If you haven't already noticed: we make a worst-case assumption that you don't have welding equipment, special tools, or arcane talents with you. Probably you won't have rolls of insulated wire or tinkerer's alligator clips for making test connections. But you can use extension cords and, in lieu of alligator clips, hair-curl 'clippies'. That's what we used to cobble up some power and light devices for this article. You can slice through an extension cord and bare its wires with any kitchen knife. Yes, it'd be better if you could clamp or solder your final connections; but if you tightly twist copper wires together and tape over the connection, it will usually work

well. Millions of temporary electrical connections have been made by forcing a sturdy safety pin through insulated wires; this is often done when hooking up trailer lights to the wiring in your cars.

We also assume that you can recognize the places where you must connect a wire to a light bulb or its socket. In the simplest use of your system, just bind one naked wire-end to a battery terminal and one naked end of your second wire to the other terminal. Then touch the other ends of those wires to the cannibalized lamp and you should have light. Since 12 volts won't shock you, you can even do it by hand.

Don't worry about the battery burning out the tiny lamp if the lamp was taken from a similar 12-volt system; the lamp will draw only the few watts it needs. You could probably have a string of tiny lamps going simultaneously (connected in parallel, not in series) with less use of power than if you used a brake light.

Electric motors usually use electricity faster than several small lamps; be advised. For God's sake don't use a battery to run a heating element, e.g., the little elements that plug into cigarette lighters to keep cups of coffee warm. A heating element really squanders electricity. You'd be better off using a candle for heat.

If you're up to it, you might remove the generator from your car and mount it against the rear wheel of a bicycle. Most modern car generators are called 'alternators' because they generate AC, and they're quite efficient. But if you intend to build such stuff, remember that an alternator won't generate any juice at all unless a battery can supply at least a trickle of power to it to energize its field coils. You don't believe me? Disconnect your car battery and get your car going downhill at any speed you like, then try to start your car with the alternator alone. The nice thing about the old DC car generators was that they'd start your car even if your battery had

been stolen! Talk to your friendly junkyard man; some old DC car generators are still around.

Now, about that bicycle that took you past the traffic jam . . . . You must somehow jack the rear wheel clear of the floor so you can pedal in place, the rear wheel spinning the generator pulley that's snubbed against it. If you align the pulley against the rubber tire, the friction of tire against pulley will serve as a pulley belt. You may have to dismember a chair, or even rip into a wall somewhere, for sturdy wood to whittle and bind a frame for mounting your car generator to the bike. Here we're talking about fairly rugged rigs, and at this point many of you may be deciding to forget a generator. Hold it: if you have a bike, you may also have a quicker answer.

The fist-sized little DC generators built for bike lights are so cheap, every bike can and should have one. They mount on the bike frame, spring-loaded so they can ride against the tire as it spins, generating enough amperage to run a bike headlamp and tail lamp. If you can, get one that is rated at 12 volts or thereabouts. Because, so help me, it can also power an AM/FM radio or cassette player of the sort you can plug into a cigarette lighter. Our kids are the only ones on the block who have had tape decks on bikes! It was just a guess, but we guessed right: the cheap commercial adaptors sold to adapt a car's 12-volt system to 6- or 9-volt hardware, can also be wired to the little bike generator.

Figure 2 shows how handily a bike generator can be adapted to power an AM/FM-cassette recorder. The only trick is in wiring the generator to an adaptor that was intended to plug into a cigarette lighter, as shown in Figure 3. Our adaptor came with several different plugs, to fit the different kinds of small appliances. For instance, one of the plugs fits a hand calculator. Our adaptor also has a tiny switch that lets you choose 6- or 9-volt output. Our cassette

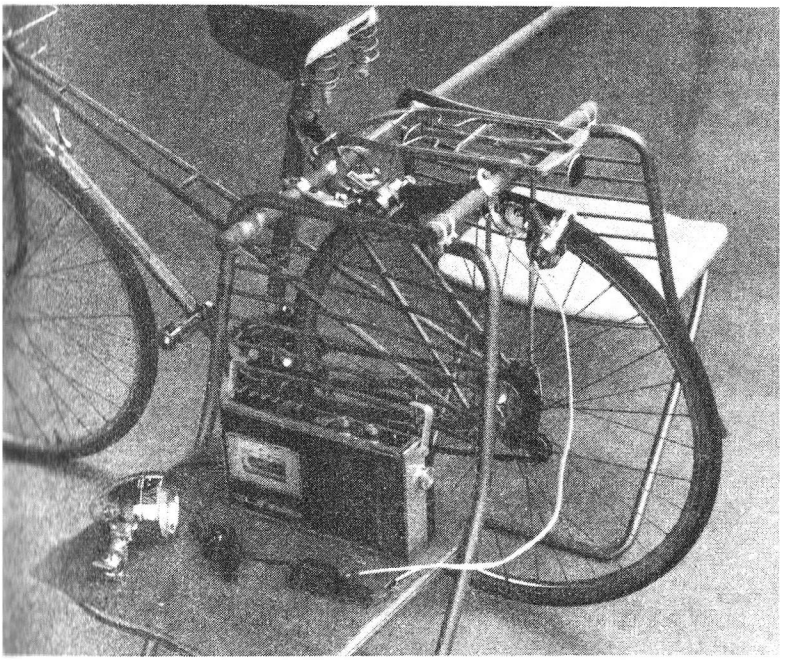


Figure 2

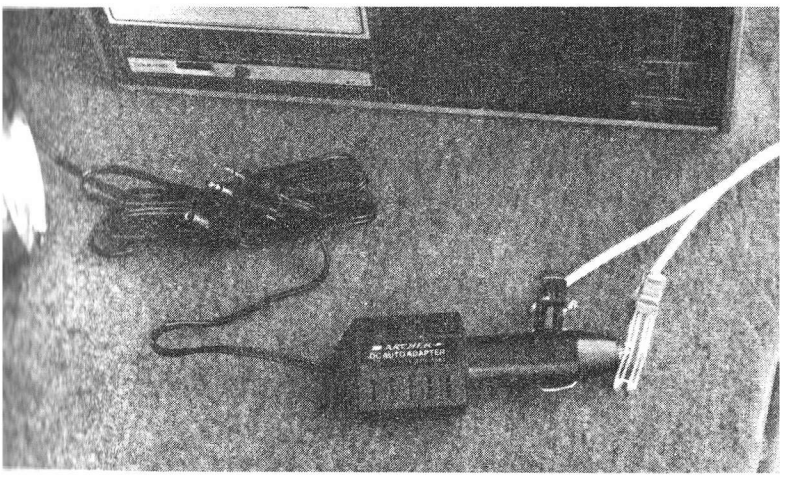


Figure 3

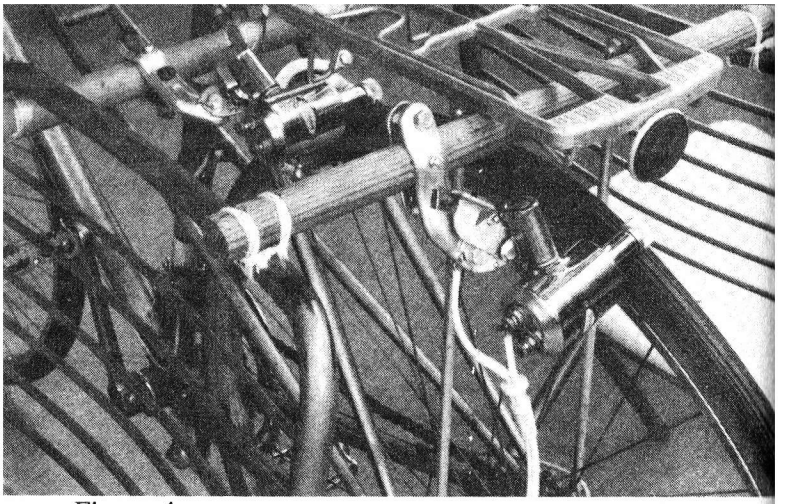


Figure 4

machine uses 6 volts; most hand calculators use 9 volts. Don't try to run both simultaneously.

In Figure 4, the bike's rear end is suspended with pieces of broomstick across the backs of two folding chairs. We bound one broomstick with cord and the other with strapping tape just to show that either will serve. Then we mounted *two* bike generators on the broomsticks so that they engage the bike tire on its tread. If mounted on the sidewall as is often done, the toothed generator pulley tends to chew the tire's sidewall up. We could've mounted three or even four of the little generators on that tire. The point is, the generators don't cost much and they don't load the tire down much either. You can actually recharge a great whopping car battery by trickle-charging it with a bike generator—more quickly using several bike generators wired in parallel.

One brief gimmick: ordinarily a bike generator is grounded against the bike's metal chassis. Of the two terminals protruding from the aft end of the

generator in Figure 4, one accepts a wire leading to the weak little tail lamp while the other accepts a wire leading to the headlight. So neither of these terminals is a 'ground' terminal. By mounting our generators on nonconducting broomsticks, we made it necessary to supply a ground wire from the generator mount to a ground connection on the adaptor as shown in Figures 2 and 3.

If you buy bike generators for this broad-spectrum use, *don't* get the kind with both lamps built into the generator body. You'll want to run wires here and there in your shelter; to a battery, or to a bike headlight used as a reading lamp or maybe to that cassette player so you can have Villa-Lobos to keep you company.

A bike generator will light its little bulbs even if you haven't lugged a car battery into your shelter as a storage tank for electrical energy. But without a battery, you'll have to keep pedaling as long as you want light. The pedal effort is slight, and does not seem appreciably greater when two generators are mounted against the tire; but even with no generators, the effort will tire you and cause you to use a lot of air during a half-hour of steady pedaling. That's a good reason to have a car battery, and to install more than one tiny generator.

We tried some other ideas that didn't work well, so we didn't illustrate them. One idea was to tape bricks on the bike pedals, turning the bike upside down, so you could crank the pedals by hand and use the mass of the bricks to get a flywheel effect. If you could somehow fill a bike tire with lead weights it might be marginally effective, but the bricks added little inertia because they weren't very heavy and their moment arm was short. Sorry 'bout that.

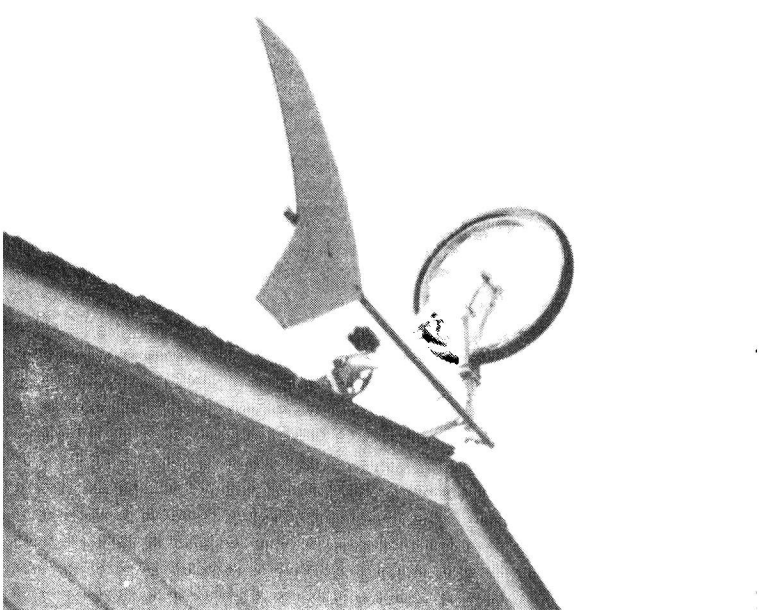
On the other hand, we're still playing with some other ideas that sprang from the bike generator.

Example 1. Find a way to mount an adult's bike on

the end of your roof, so that the front wheel minus handlebars can pivot easily. Now cut pieces of venetian blind slats and, with tape or wire, mount the slats like turbine blades among the front wheel spokes. If the slats have a modest angle of incidence (that is, angled like propeller blades), the wheel should spin in a decent breeze. With a homemade weathervane mounted through the handlebar socket—ours was a mop handle with a cardboard rudder tacked onto it—you can make the device turn itself into the wind, pivoting as it would with handlebars. Voila: a small windmill. If you use a big 26-inch wheel, it should barely run a bike generator in a good breeze. *Certainly* it's primitive, nowhere near as effective as some other systems; but it's a free power source. Oh: don't forget to mount the generator on the front wheel *fork* so that it pivots with the wheel, as we did in Figure 5.

Example 2. A wind-driven bike wheel can also let

Figure 5



you convert a bike speedometer to a small power drill or other rotary-motion tool.

Example 3. A big-motha' windmill, with 4-meter epoxy-coated high-aspect ratio blades and a capstan drive made from a wheelchair (why didn't Oklahoma State toy with such handy little windmill drives in their development work?) is in development on a ranch near us. But it runs a chevy alternator which wouldn't be worth a cent if something happened to the huge truck battery below, because there'd be no initial jolt to energize the alternator field. Well, we're going to put a tiny little bike generator on the site just for emergency engagement to energize the big alternator. We're not saying it will be an optimal answer—only that it may be one very quick answer. We don't even have to mount the bike generator up high; it could be kept on the ground, out of the weather.

So much for those ongoing experiments. Now it's time to inject what we can call an in-text footnote because it isn't really a digression: candles and other combusion devices. Combustion uses up your oxygen; sometimes it stinks, too. Unless you have plenty of air, don't use up much of it with candles or kerosene lamps. If you use a kerosene lamp, trim the wick and keep it adjusted for minimum combustion without smoke. For years we've used a tiny kerosene lamp, a Japanese scale model of the big ones, to read while backpacking. It uses an ounce of fluid every three hours; neither it nor its fuel takes up much room in a pack; and it's a cheery companion when you're on a sierra solo, with a wire gizmo made to let a coffee cup stay warm atop the little lamp. A quart of fluid can keep such a lamp burning for ninety hours but, unless you have air to spare, think twice about it.

Oh, yes; we played with the stubby little candles of the votive or 'fondue warmer' type. When free-standing, they become a broad puddle of wax all too

quickly. Placed in a container that keeps molten wax from running away, one of the little candles can burn for 9 hours or more. Just remember, it's using a lot of oxygen and adding to the heat and carbon dioxide in a semi-closed life support system. Make sure your air supply is adequate.

We also made experiments with flashlights using two 'D'-size cells. Standard heavy-duty cells powered a bulb for 18 hours, while alkaline cells powered it for 30 hours. We burnt out several bulbs before we learned to accept the fact that the duty-cycle of most flashlight bulbs is brief. That is, you mustn't expect a common flashlight bulb to burn more than an hour or so in one session. Use it for awhile; let it cool awhile; then turn it on again when you must. Flashlight batteries will recover a bit after they've rested for a few hours. But if you depend on flashlight bulbs and batteries, keep spares for both.

A few people will be ahead of us with gasoline-powered electrical systems or windmills. Just remember that even the smallest gasoline engines use a lot of fuel and oxygen, put out a lot of noxious exhaust, and make a lot of noise. You'll almost certainly want to keep such bellowing little brutes outside your living quarters. A windmill is much quieter and uses no precious fuel.

Summarizing your power-and-light options, and presuming you don't have solar cells or a hydroelectric plant handy, a windmill seems a very good bet if you can make one. But for every shelter boasting such a power source there'll probably be hundreds making do with a bike-powered generator and perhaps a car battery. If you manage to haul two fully-charged car batteries into a shelter, you might have enough stored power to dispel the dark for the better part of two weeks without a generator of any kind. And many pundits are guessing that, if you can stay put that long, radiation from fallout will have greatly

diminished.

In two weeks of continuous occupation, a shelter can get pretty ripe, considering body wastes and other odors. You must find or make a portable potty.

A sturdy bucket or even a cardboard box, with a garbage bag for a liner, makes an acceptable john. It is important that you sprinkle household bleach or hydrated lime into the bag after defecating into it. Not only the smell, but the danger of disease, will be lessened by disinfectants. If possible, train all shelter occupants to do their doo-dahs at roughly the same time. If you have no plastic bags, you may have to use brown paper bags or newspaper as a liner. In that case, you'll quickly learn to urinate into an old milk carton or other waterproof container to minimize the mess when emptying the john.

For: empty it, you must; and as soon as practicable after use, if you expect to live in an enclosed area for several days. If you have reason to suspect that even a moment outside shelter might be lethal, you'll have to store body wastes in a covered garbage can or the equivalent until the first possible chance to get rid of the waste. It should be dumped in a hole far from the shelter, then covered with dirt.

Figure 6 shows an emergency john made from a wastepaper basket, several layers of cardboard taped together with a hole cut through them, and a plastic bag taped into the hole. Okay, so it ain't the Waldorf; it only took ten minutes to build and it's fast, fast, fast relief. Once the john has been used by all who will, some hardy soul must sprinkle a few ounces of lime into the bag, extract the bag, tape it shut and dispose of it.

Hygiene is more than simply a system for disposing of fecal material. It involves staying as clean as you can; using dilute bleach solution to clean messes with minimum waste of precious water; donning rain gear

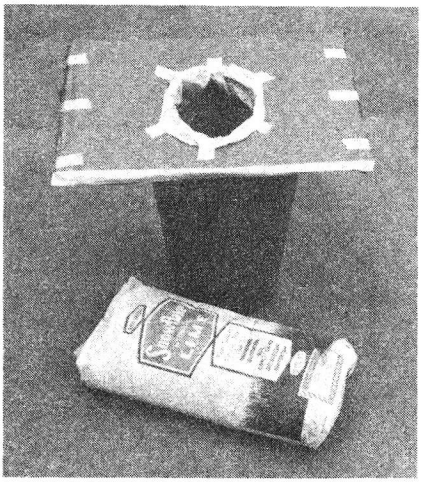


Figure 6

for any essential forays outside the shelter; shaking dust particles off of yourself before you get to the shelter opening; carefully shucking the rain gear before you enter the shelter itself; and more. Don't forget that your hair is a dandy dust-trap; wear a shower cap or other cover to keep from trapping fallout particles in your hair when you're outside. And as we've cautioned before, make a dust mask from flannel, or use something even better, to avoid breathing unfiltered outside air. All this is hygiene. It keeps you relatively free of contaminants you cannot afford.

Mental hygiene fits in here somewhere. Sensory deprivation studies suggest that we might get through the shelter ordeal much better if we do have light, some meaningful activity, and games of some sort to occupy us while the clock ticks away. If we don't have playing cards we can make them. The same is true of checkers, chess, dice, and many other games. Anyhow, the sooner we get used to manufac-

turing what we can't buy, the sooner we'll be back in charge of a high-tech existence.

Each shelter occupant might keep a journal, jotting down any ideas that might be fruitful for the future—including a log the radio provides on daily local and not-so-local survival conditions. In between reading favorite books, you could do worse than read some basic texts on gardening, electricity, food preservation, first aid, and appliance repair, to name only a few. Whatever you need to know that you don't know already: start learning it while you have enforced leisure.

If you've digested the information in the three articles so far, you have a good chance of emerging from a shelter two weeks after a major fallout event, without serious illness. A healthy adult *can*, if necessary, live for nearly a week without water, over three weeks without food. If you've provided yourself with food and water, you might survive with no ill effects—except that you might have a mild case of claustrophobia. If personal experience is any guide, we expect that you'll also have a brand-new outlook on life. How sweet it is to be alive, when you look back on the nearness of death!

Even if you're still breathing through a homemade flannel mask, you're still breathing; planning; making ready for whatever comes next. We hope you've given some previous thought to the day when you emerge from shelter because, as Freeman Dyson has opined, a lot of people will probably outlast an all-out nuclear war. In the next article we'll suggest some things you should know—for example, that castor oil is easily extracted from the beans and is a good engine oil. And we'll mention some things you should have all packed away for the post-shelter era.

Not in a hope chest. In a tenacity chest.

—Dean Ing

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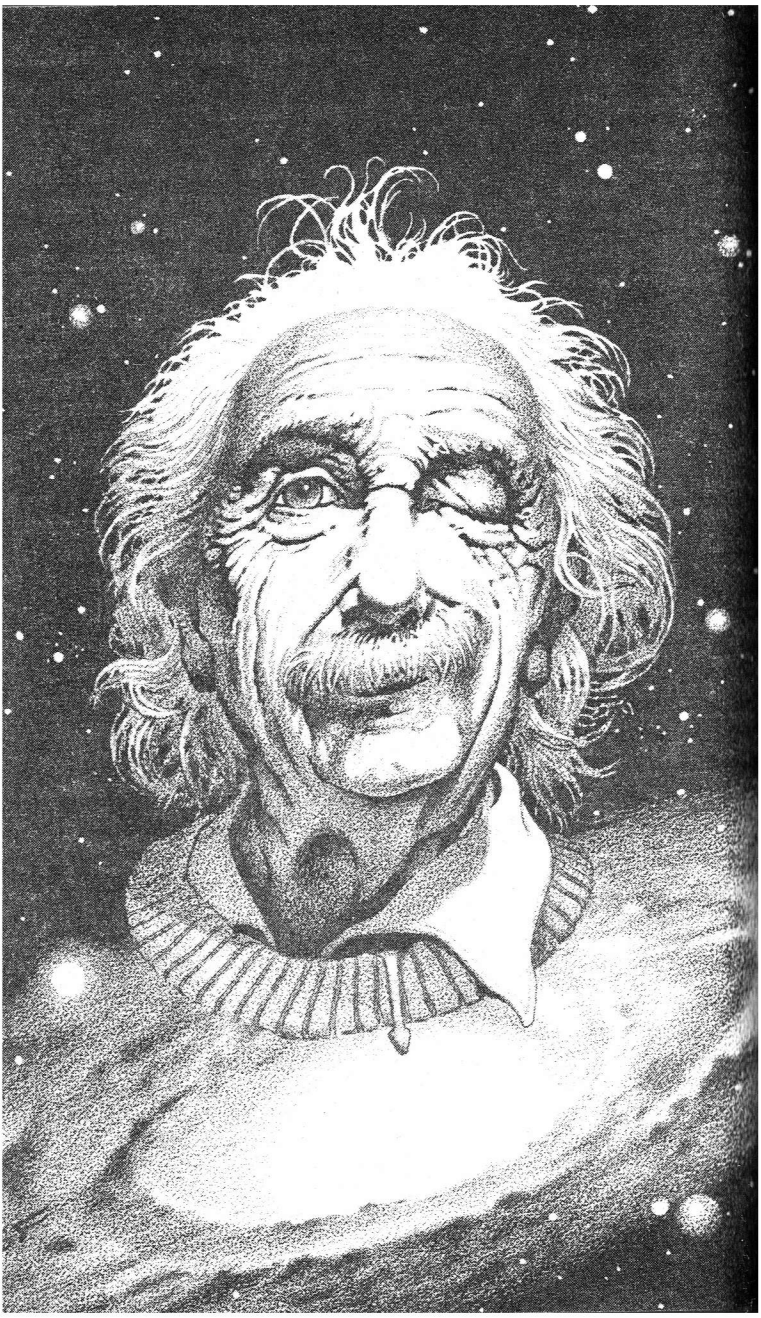
Understanding Ein

by James Gunn

Albert Einstein, the scientific genius who led physics into a new era of relativity and uncertainty, also influenced science fiction in ways that ought to be explored. In 1919 Einstein became the most famous living scientist. In 1923 Hugo Gernsback published his "Scientific Fiction Number" of *Science and Invention*; in 1924 he sent out letters proposing a magazine to be named *Scientifiction*; and in 1926 he



created *Amazing Stories*.

I do not mean to imply a necessary and direct relationship between these events, but it might be interesting, in the years following the centenary of Einstein's birth (March 14, 1879) to consider his life in relationship to science fiction. Einstein was the focus of controversy during his lifetime; today his theories are attacked by such critics as G. Harry Stine, writing in *Analog* and *Destinies*, as the new orthodoxy.

Back in the late Twenties Einstein's name was used frequently in the letter columns of Amazing Stories. In those days his name evoked a kind of awed respect, with the editor confessing that he didn't understand everything that he would like to know about Einstein's theories, and it was popular to repeat that only half a dozen persons in the world understood Einstein.

The precise effect of Einstein on science fiction would require a lengthier analysis than this, but I would like to suggest a few possibilities: that is, Einstein's theories brought the universe within the scope of humanity's imagination at the same time that it made the process of understanding its laws sufficiently esoteric that almost any manipulation of space and time was credible. His Special Theory of Relativity published in 1905, for instance, established the speed of light as a constant and a limit, but for science-fiction writers such as Edward Elmer "Doc" Smith, this was simply a challenge. He could speed his spaceships along at ninety parsecs (3.26 light years) an hour by claiming that Einstein's theories set no limit to the velocity of *inertialess* mass. Other writers, such as Isaac Asimov, would talk of hyperspace and Jumps that would provide shortcuts through normal space. More recently writers have resorted to black holes or tachyons, those theoretical particles whose property is that they always go faster

than light.

Faster than light—FTL became the symbol for an entire genre of fictional spaceflight. One of its earliest manifestations may have been in the limerick published in *Punch* in 1923 and written by Arthur Henry Reginald Buller:

> There was a young lady named Bright,
> Whose speed was far faster than light;
> She set out one day
> In a relative way,
> And returned home the previous night.

Einstein also turned humanity's attention toward the very small. His paper on the photoelectric effect, also published in 1905, established the theories whereby it could be understood how light could be a particle and behave like a wave, and began the consideration of the smallest particle of light energy, the quantum. His paper on Brownian motion, also in 1905, provided theoretical proof for the existence of molecules. And his Special Theory of Relativity, with its famous equation, $E=MC^2$, suggested not only the equivalency of matter and energy but the incredible amounts of energy locked within the atom.

Other scientists were contributing to the new physics and the new understanding of atomic phenomena and the evolving universe. Max Planck's quantum theory preceded Einstein's, Louis Victor de Broglie expanded Einstein's wave-particle duality to a dualism between energy and matter, and Werner Heisenberg in 1927 announced the uncertainty principle that Einstein never was able to accept. In the Thirties Enrico Fermi in Italy and Otto Hahn in Germany did the actual splitting of the atom. In the field of cosmology, Harlow Shapley announced in 1918 his theory that the Milky Way galaxy was ten times as large as previously estimated, and in 1924 Edwin P.

Hubble finally proved the existence of other galaxies and demonstrated that our own was no more central in the universe than was our sun in the galaxy or our Earth in the solar system.

One cannot discount, either, the books of such science popularizers as Sir James Jeans, who brought esoteric concepts into common use. Instead of "solid, massy, hard, impenetrable, moveable particles," as Isaac Newton called them, atoms became exciting little solar systems of mystery and strange power, and from a static, unreachable assemblage of stars, the universe became a huger space filled with billions of galaxies like our own, some of them billions of light years away, and getting bigger all the time because it was expanding.

The relationship between all of these observations and speculations in the scientific world and the beginnings of stories about the atom and of novels about interstellar travel may have been no coincidence after all. In the midst of the whole ferment was the image of Albert Einstein. He was absent-minded, eccentric, smoked a pipe, played the violin, and had a halo of white hair floating around his head, and several generations believed that was the way scientists were supposed to look.

Einstein's impact on the world and on science fiction was not all beneficial. He also reinforced the image of the eccentric scientist, if not even of the mad scientist. It was an image that had been created around medieval alchemists, had been given shape by Mary Shelley's Dr. Frankenstein, and that pervaded magazine science fiction through the Twenties and Thirties and has not yet been driven from motion pictures. And Einstein's contribution to a growing feeling of mastery over the enigmatic operations of nature may have been matched by a growing feeling of confusion about the way it was done.

How did Einstein accumulate this power to shape

not only science but the images of it in the public mind that were reflected in the science fiction of the period?

For all his single-mindedness, for all his mental powers, he was a bundle of curiously human contradictions. He demonstrated a phenomenal capacity for abstract thought, but he learned to talk late in his childhood—he wasn't even fluent at nine—so that his parents feared he was retarded and his headmaster in school, when asked what profession young Albert should adopt, said, "It doesn't matter; he'll never make a success of anything."

He was the absent-minded, impractical man of science who did not care about material things, who did not own more than a couple of suits and they were always rumpled, who seldom wore socks even to formal dinners, but he held four different academic positions in as many years, each one better paying than the one before. He was a German-born Jew who learned to hate the Germans in his school days, renounced his citizenship and became Swiss, but he accepted a prestigious position at the newly created Kaiser Wilhelm Society for the Advancement of Science, did some of his most important work in Berlin, and accepted German citizenship from the Weimar Republic.

He was a pacifist who criticized those German scientists who contributed their knowledge to the service of the German Army in World War I, particularly those colleagues who developed new explosives and poison gas, and he lent his name and voice to pacifist activities for several decades, but in 1933 he urged the world to arm against Hitler and six years later wrote a letter to President Franklin D. Roosevelt that launched the Manhattan Project to create the atom bomb.

He led a generation of scientists into the world of modern physics, but he became alienated from the

forefront of physics in the last two or three decades of his life because he could not believe in the uncertainty principle of the quantum mechanics that he had helped create. "God," he said, "does not play dice with the world."

The figure that Einstein became after Eddington's measurements of star displacements had confirmed the General Theory of Relativity is so set about with other images that it is difficult to determine the real person in their midst. He is the Scientist thinking great thoughts that ordinary mortals cannot understand, such as relativity and $E=MC^2$. He is the father of the atom bomb and around that image blossom the mushroom clouds of Hiroshima and Nagasaki. He is the Hero-Scientist with the power to change people's lives, or to save them. He is the Politician-Scientist, moving among other great men and lending his voice to the decisions that will shape the world.

He also was the Swiss patent clerk whose thoughts about the nature of time and space and energy changed the universe from a comfortable, comprehensible Euclidean place where a triangle always contained 180 degrees and where a thing always was what it was and never its opposite, where common sense was a reasonable guide to understanding, to a place where an ordinary person could never expect to understand the fundamental nature of things.

He was a confident young man. At the age of sixteen, a high-school dropout who had not yet started to college, he sent to his uncle a paper outlining his plans to study the relationship between electricity, magnetism, and the ether. Although he was unable to find a teaching or research job after graduation from the Swiss Federal Institute of Technology and had to work for eight years as a clerk in the Swiss Patent Office, he had no doubts about his abilities as an original thinker. He held long discussions with the young scientists he gathered around him in Berne,

began contributing papers to the scientific journals of his time, and not long afterwards began corresponding with many of the leading physicists in Europe. In 1914, just before an attempt to check his theory of relativity during an eclipse of the sun, he said that if the evidence did not agree with his theory, the evidence was faulty. And in 1919 part of the divorce settlement for his first wife was the cash that would come with his Nobel Prize, which would not be awarded until three years later. Neither he nor his wife had any doubt that he would receive it.

When it came, however, it was for neither his Special Theory of Relativity nor the General Theory published in 1915. They were too controversial, and they were already coming under attack for their obscurity, their running counter to experience, and their Jewishness. General meetings already were being held in Germany in 1920 to denounce the theory; oddly enough, they were led by German Nobel Laureate Philip Lenard, whose work on photoelectricity had preceded Einstein's. By 1930, with the Nazis moving toward power, the theories were attacked as the culminating confidence trick of a Jewish conspiracy. In 1929 a book was published entitled *100 Authors Against Einstein*; Einstein commented that if he were wrong one scientist would have been enough.

The Einstein Nobel Prize was awarded "independently of such value as may ultimately be attached to his theories of relatively and gravity, if these are confirmed, for his services to the theories of physics, and especially for his discovery of the law of photoelectric effect."

The law of photoelectric effect had its own controversial aspects. Scientists such as Lenard had noted that certain metals emitted electrons when light fell on them; more light produced more electrons, not more energetic electrons, while a change in the fre-

quency produced electrons with more or less energy. Classical physics found this difficult to explain if light were a wave phenomenon. Einstein's paper explained it by returning to Newton's theory that light was a particle and reconciled that with its behavior as a wave. But his theory demanded that light be considered both a particle and a wave at the same time.

But it was his theories of relativity that revolutionized the physics of his time. They consummated his boyhood plan to study "the relationship between electricity, magnetism, and the ether." The Michelson-Morley experiment of 1887 had attempted to detect the presence of the ether; ether was the substance that was assumed to pervade all space. It had to exist if light were a wave, because a wave requires a medium; for this reason it was sometimes called the "luminiferous"—light-carrying—ether. The Michelson-Morley experiment attempted to measure the differences in the speed of light when the Earth is traveling toward the source and when the source is at right angles to the movement of the Earth. The experiment is among the most famous of those that produced negative results: there was no apparent difference. Dayton Miller repeated the experiments in 1921 and 1924 and arrived at a different answer, but scientists believed that his results were inaccurate. In any case, from the Michelson-Morely negative results—or independently of them, for he told it both ways—Einstein deduced that there was no absolute space, such as the ether represented, in which everything moved. Instead, every phenomenon occurred relative to an observer.

In 1915 Einstein produced the General Theory, which deals primarily with gravitation and the nature of space. It is called "General" because it deals with objects under acceleration while the Special Theory deals only with objects in uniform motion.

The General Theory sprang, in part, from Einstein's dissatisfaction with Newton's assumption that gravity was propagated instantaneously. Since The Special Theory requires that nothing exceed the speed of light, Einstein began to consider ways in which matter could produce gravity in other ways than by attraction. He concluded that gravity was a function of matter—that it influenced the shape of space around it. In popular terminology, the theory said that matter curved space; more accurately, it produced a special non-Euclidean space, a Riemann space, that influenced the path of anything that traversed that space—even light, which was thought to be immaterial. If this was true, Einstein speculated, it could be checked: light should be bent in a gravitational field and it should be shifted toward the red under massive gravitational influence.

The astronomer who was going to check the theory of relativity during the 1914 total eclipse of the sun in the Crimea was captured by the Russians when World War I broke out before the eclipse occurred. In 1919, however, another total eclipse gave experimental support to Einstein's theories. On September 27 he received a telegram from Dutch physicist Hendrik Lorentz (half of the Lorentz-Fitzgerald contraction): "Eddington found star displacement at rim on sun, preliminary measurement between nine-tenths of a second and twice that value."

Suddenly Einstein was famous. He had been totally unknown until 1912 and almost totally unknown until 1919. After that he became the man of science, much honored and much sought after to support such causes as pacifism and the Zionist movement to establish a homeland for the Jews in Palestine. Toward the end of his life, after the death of Chaim Weizman, with whom he had worked closely, Einstein was offered the presidency of Israel. But he was too independent of mind and tongue to be an

unmixed blessing for any cause.

Through it all he never forgot that his science was his basic mission. Even after he became famous, he fought for his privacy, for his time to think. His first marriage may have been sacrificed on the altar of his scientific single-mindedness. He was an artist of science, and for an artist no sacrifice—even of one's family—was too great. His first wife had been a classmate at college and a scientist as well. His second wife, a cousin, knew her responsibility: it was not to talk to him about his work, which she did not understand, but to take care of him and protect his valuable time.

The latter part of Einstein's life, after the announcement of the General Theory, was spent futilely trying to develop a unified field theory that would bring together into one equation the electromagnetism dealt with in the Special Theory and the gravitation dealt with in the General Theory. Perhaps it was impossible. Wolfgang Pauli thought so. "What God has put asunder no man shall ever join," he said. Einstein himself believed the chances of success were small. Unlike a younger man, however, he could afford to risk failure.

He also spent much of his latter years, until his death April 18, 1955, at the age of 76, trying to refute the uncertainty principle; he had a running debate with Niels Bohr. Einstein summed up his attitude in a couple of famous statements. "God is subtle but He is not malicious," he said, and "quantum mechanics is certainly imposing. But an inner voice tells me that it is not yet the real thing. The theory says a lot, but does not bring us any closer to the secret of the Old One. I, at any rate, am convinced that He does not throw dice."

Perhaps a few more glimpses of the man behind the scientist might help us think about him in a more human context. There is the boy of five who was given

a pocket compass and stimulated by the thought of invisible forces at work. There is the older man looking back at his childhood slowness and speculating that he might have developed the theory of relativity because his intellectual activity was retarded and he only began to wonder about space and time when he had grown up. There is the eager young scientist so engrossed in his ideas that he scribbled equations all over a friend's best tablecloth—about which the friend's wife recalled in later years that she should have kept it unwashed as her husband told her. There is the lecturing scientist in Prague in 1921: a young man insisted on speaking to him and getting his advice on a process he had invented for producing a new and immensely powerful explosive based on $E=MC^2$; and the scientist said, "The foolishness of the idea is evident at first glance." There is the great man who heard himself praised at a formal dinner and leaned over to whisper to a companion, "But the man doesn't wear socks."

There is the mythmaker at the Institute of Advanced Study in Princeton to whom the girl down the street brought her "sums"; who had trouble figuring what coins to give a bus driver; who called the office of the Dean to find out where Dr. Einstein lived; who forgot his own unlisted telephone number. And there is the scientist whose discoveries affected much of contemporary technology but who didn't like motors, who never drove a car because it was too complicated, who returned the gift of an outboard motor, who was over fifty when he handled a camera for the first time, and who barely learned to use a typewriter.

But to understand the man who certainly influenced the world and may have influenced science fiction it may be better to think of Einstein as the abstract thinker who insisted that relativity did not come out of metaphysical speculation but from con-

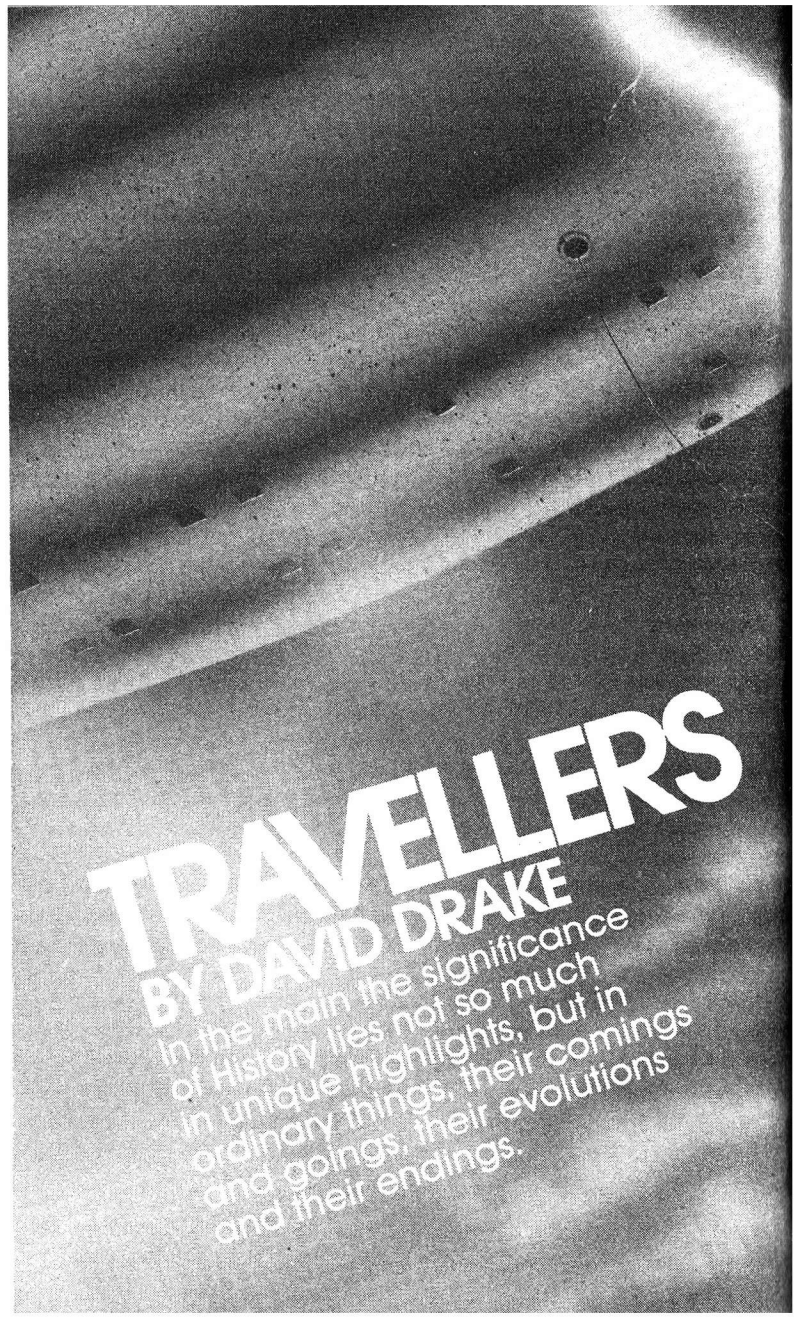
sidering scientifically the results of experimental evidence. He and scientific theorists like him not only gave humanity more control over the forces of nature but they pushed science beyond the grasp of even the educated layman and widened the chasm between what C. P. Snow called "the two cultures." Lord Rutherford used to say that "it should be possible to explain the laws of physics to a barmaid," and Einstein, that "all physical theories, their mathematical expressions apart, ought to lend themselves to so simple a description that even a child could understand them."

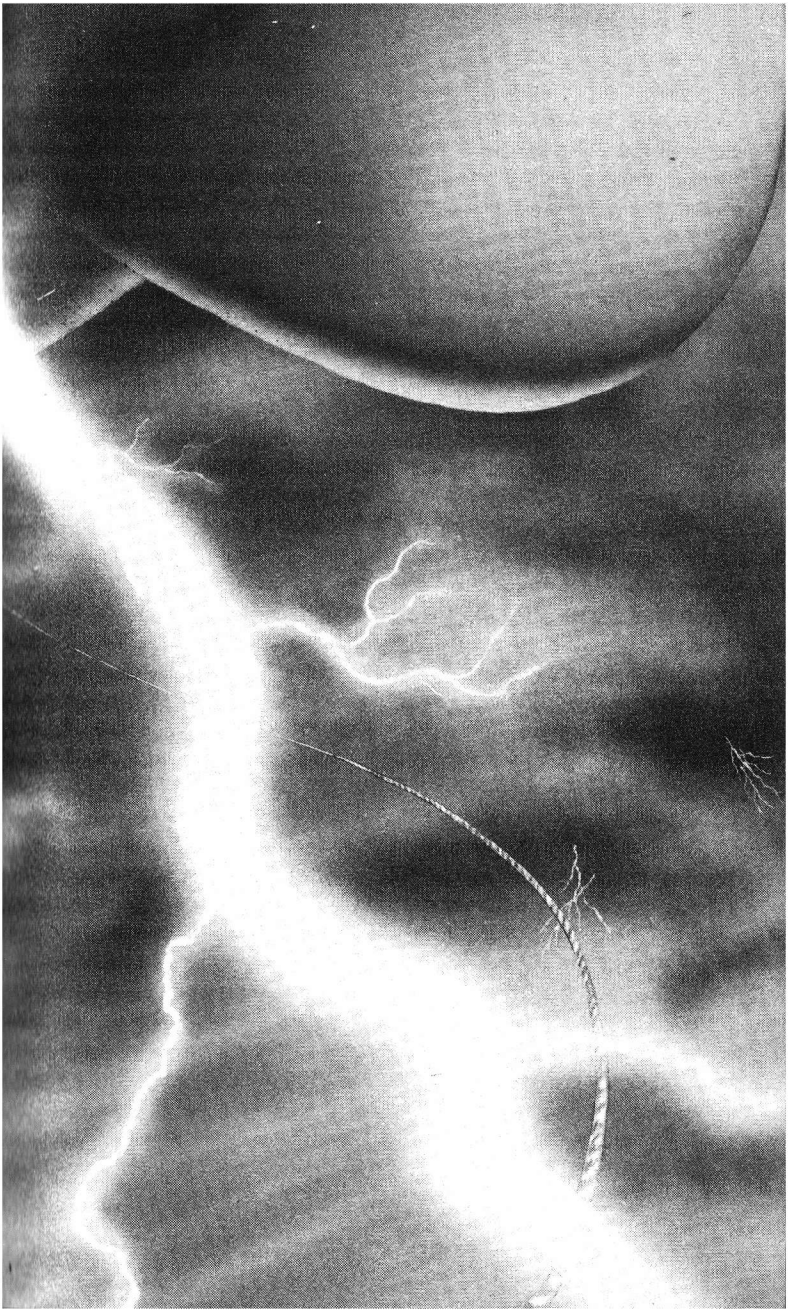
But few people really understand Einstein's theories even today. The difficulty of Einstein's concepts led to another popular limerick of the time:

> There's a wonderful family named Stein.
> There's Gert and there's Ep and there's Ein.
> Gert's poems are bunk,
> Ep's statues are junk,
> And nobody understands Ein.

But perhaps the best way of "understanding Ein," insofar as we can understand him at all, is to think about him as man overcome with the sense of wonder at the marvelous manner in which the universe operates; as man at his most science-fictional considering the incredibly difficult ways of understanding the universe, from its beginnings to its ultimate end, from the smallest of particles to the greatest of stars; as the man who said, "I want to know how God created the world. . . . I want to know his thoughts, the rest are details." If thought is, as I believe, the most human of human activities and the characteristic of science fiction at its most significant level, then the best way to think about Einstein is as the most human of men, as man the scientist, as man thinking.

——James Gunn


TRAVELLERS
BY DAVID DRAKE
In the main the significance of History lies not so much in unique highlights, but in ordinary things, their comings and goings, their evolutions and their endings.



Carl had not seen it coming over the eastern horizon toward the farm.

As the trickle under which he had washed died away, Carl slid the bucket beneath the pump. He worked the handle with three smooth, powerful strokes, the creaking of the case iron evoking squeals from the piglets in the shed. Over his head the sky was clear enough that stars already flecked it, but the west beyond the farm house was a purple backdrop of cloud. Carl stretched, sighed, and picked up the bucket his mother would need for the dinner dishes.

A spotlight threw his long shadow on the ground before him. Carl turned, the bucket splashing some of the muck from his boots. The light was round and for an instant as harsh as the sun. Prismatic changes flickered across the face of it. The beam spread to either side of Carl in a fan that illuminated but no longer blinded him. The light was hanging above the barn. There was a bulk beyond it, solider than the sky: an airship such as Carl had never dreamed he would see.

"Stand by to take a line, lad," called a male voice. Carl's knees were trembling and the bucket was forgotten in his hand as the airship drifted upwind toward him. Something aboard made a sound like chains rattling, muted where Carl stood but loud enough to have roused the cows. Their bawling would bring his father out at any moment, a part of Carl's mind recognized, but nothing in the world of a moment before was real any longer.

The airship crawled directly over Carl. It was huge, blocking most of the hundred feet of sky separating

house from barn. Besides the spotlight, now diffusing its radiance across most of the farmyard, there were rectangles of yellower light from the gondola hanging beneath the main hull of the airship. A hatch opened in the side, silhouetting a gangling figure. "Here is comes," said the figure in the voice that had spoken before. A grapnel on a line thudded to the ground in front of Carl. It began to dig a double furrow in the dust as the airship drifted backwards. "Well, set it, lad—set it!" the voice called. "So that we can land."

Carl came out of his numb surprise. He dropped the water bucket and ran to the line. It was of horsehair, supple and strong. Someone played it out above as Carl carried the grapnelled end to the pump. He hooked it to the underedge of the concrete well-cap.

As soon as Carl had set the grapnel, the line stiffened. There was another rattle from above and a whine like that of an electric pump. The airship began to settle. Four jointed, mantis-like legs were extending from the belly of the gondola. Carl backed toward the house a step at a time while the great form sank into the farmyard. The legs touched, first one and then the four of them together. Their apparent delicacy was belied by the great plumes of dust which the contact raised. The whine rose to a high keening, then shut off entirely. The light died to a glowing ember in the night.

Behind Carl the screen door banged. "Carl," called Mrs. Gudeint, "where are—oh dear Lord have mercy! Fred! *Fred!*"

The gangling man reappeared at the gondola door. He swung three metal steps down with a crash. The stranger wore a brown tweed suit of coarse weave with a gold watch-guard and a fob of some sort hanging across the vest. He smiled at Carl, crinkling the full moustache that looked so incongrous beneath his high forehead. Looking back into the gondola he said, "Oh—if you will snuff the light, my dear?" A girl

appeared in the doorway, turning down the wick of an oil lamp. Carl stared at her as he had at the airship itself. There was a bustle behind him as his father and brothers pushed out of the house with eating utensils still in their hands.

The girl was beautiful even in the dim light. Her hair, caught neatly in a bun, was as richly black as the pelt of a sable. She wore a patterned percale wrapper, simple but new and of an attractive cut.

"Carl, what have you brought here?" Mr. Gudeint rumbled from close to his youngest son's shoulder.

"Gentlemen," said the stranger, turning again with the girl beside him and the airship a vast gray backdrop beyond, "I am Professor John K. Erlenwanger, and this is my daughter Molly." The girl curtsied. Erlenwanger caught sight of Carl's mother beyond the wall of broad-shouldered men. He made a little bow of his own. "And madam, of course; my apologies.

"Madam and gentlemen," he continued. "I am, as you see, an aeronaut. My daughter and I are travelling from Boston to California, testing my airship, *The Enterprise*–which, I may say, contains certain advances over all earlier directable designs. We have stopped here for a safe mooring during the night and perhaps some assistance in the morning."

"You're from Boston?" demanded Fred, the eldest of Carl's brothers. "You flew this thing a thousand miles?"

"We have indeed flown a thousand miles," the Professor said with a quick nod, "and I expect to fly twice again that distance before completing my endeavor. But although we have set out from Boston, I am myself a Californian by birth and breeding."

"Well, they'll have dinner with us, surely," said Carl's mother, twisting her hands in the pockets of her apron. She looked up anxiously at Erlenwanger. "You will, won't you? We've a roast and—"

The Professor cut her off with another half-bow. "We would be honored, Mrs. . .?"

"Gudeint," Carl's father grunted. He wore a blue work shirt, buttoned at the throat and cuffs as it had been all day despite the heat of the Indian Summer sun. His sons wore sleeveless undershirts or, in Carl's case, only a set of galluses that had blazed a white cross in his otherwise-sunburned back. Mr. Gudeint extended his hand, broad and as hard as the head of a maul from fifty years of farming. "I'm Fred Gudeint and that's my wife Maxine there—"

"Fred, I'll take the stoneware off and put out the china and the silver since—"

Carl's father turned on her, his red forehead furrowed like a field in springtime. "Maxine, you'll pretend you've got the sense God gave a goose and do no such thing. We've already started eating from the stoneware!"

Mrs. Gudeint bobbed her head and scurried back into the house with a worried look on her face. Carl's father shook his head and said, "Your pardon, Professor, but we're not used to guests dropping out of the sky on us. It upsets the routine." He grinned perfunctorily, as if that would make his statement less true. "That's Fred there, my oldest—" Fred, his father's surrogate in form as well as name shook hands in turn—"George, Danny, and that's Carl, the last by six years. Boy, be sure to fill that bucket before you come in."

"Yes, father," Carl said. Professor Erlenwanger's hand was cool and form and smooth as a farmer's hands can never be. As Carl's father and brothers led the guests into the house, the Professor's daughter tilted her eyes at Carl and gave him a timid smile. Why, she looks as nervous as I am, Carl thought as he pumped the bucket full again beneath the airship.

Carl entered the house through the side door to leave the bucket beside the sink. His mother had

already slipped a third leaf into the table and replaced the checkered oilcloth with her best Irish linen table cover. As Mr. Gudeint had insisted, the stoneware plates still remained with the mashed potatoes and slices of beef with which they had been heaped before the excitement. The two new place settings, to right and left of the head of the table where Carl's father sat, were of the Sunday china. The delicate cups and saucers looked particularly incongruous beside the heavy mugs at the other places. From the front room came the creak of Grandpa Roseliep's rocker; nowadays he always ate before the rest of them.

Carl sat quickly between his mother at the foot of the table and his brother George. He began serving himself. Danny was saying, "I'd read a story about your balloon in the *Register* last week in the barbershop, Professor; but I recall it gave then name as Cox. Sure, Cox."

Professor Erlenwanger ladled gravy onto his mashed potatoes with a liberal hand. "I can't say who Mr. Cox may be, sir; but I assure you that he and I are not the same. I have eschewed all publicity for the Erlenwanger Directable Airship—not balloon, I must protest, any more than your Guernsey milkers are steers—eschewed all publicity, as I say, until I have proven the capacity of my invention in a fashion none can doubt. Unless I am fully satisfied, no one will hear a word from my lips about it. Except, of course, for the good people like yourselves who have acted as hosts to my daughter and myself, Madam," he added, nodding to Mrs. Gudeint, "these fresh peas are magnificent."

Erlenwanger ate like a man who appreciated his food. His bites were gentlemanly and were chewed with the thoroughness demanded by a roast from a superannuated dairy cow, but he cleaned his plate handily despite the constant stream of questions di-

rected at him by the Gudeints. Carl noticed that Molly spoke rarely and then with a distinct Irish brogue at variance with the Professor's cultured accents.

Carl said little himself. The Professor's descriptions—sunlight flaring from cloud tops; tailwinds pressing the airship along faster than a railway magnate's special—were in themselves so fascinating that Carl was unwilling to interject a question. It might break the spell.

At last Fred, speaking through a mouthful of roast and gesturing with his fork, said, "Look here, Professor. You're an educated man. What do you think about all this business about Cuba? Isn't it about time those Dagoes're taught what they can and can't do on Uncle Sam's doorstep?"

Erlenwanger paused, staring across the table. The light reflected from his high forehead. He looked half the bulk of the big farmer, but at that moment the stranger's dominance was no less certain than that of a diamond over the metal of its setting. "I think," he said with neither conciliation nor overt hostility in his firm tones, "that misguided men will fight a foolish war over Cuba very soon. The world as a whole will be none the better for such a war, and many individuals will be very much the worse." He stared around the table as if daring anyone to disagree with him.

In a sudden rush of bitterness, Carl said, "The Army might be better'n the back end of a plow horse, day in and day out."

"There are roads to adventure that are not built on the bodies of your fellow men, lad," Erlenwanger said. He turned back to Fred and added more harshly, "And there are ways of honoring the flag that do not call for 'civilizing' native races with a Krag-Jorgensen rifle. It will take men a long time as a race to learn that; but until we have done so, we have done

nothing."

Mr. Gudeint sopped the last of his gravy in a slice of bread, swallowed it, and pushed his chair back from the table. Professor Erlenwanger cleared his throat and said, "You have been so generous to my daughter and myself that I wonder if I might impose on your time for one further moment? You will have noted the cases I brought in with me." Erlenwanger nodded toward the leather grips now standing against the wall next to the curio cabinet. "They contain my camera equipment. I would be most appreciative if you would permit me to photograph your whole family together."

"You mean in the daylight, don't you?" said George, who had his own Kodak. "You can't take one now?"

"On the contrary, the process I am using is so sensitive that what the eye can see, my lens can record," the Professor replied. He turned to Mr. Gudeint. "With your leave, sir?"

Carl's father frowned. "Strikes me that you're wasting your plates; but then, I never saw a fellow fly before, either. Sure, we'll sit for you. How do you want us?"

"In your front room, I believe," said the Professor, his hands already busy with the contents of one of his cases. "In whatever grouping seems good to you; thought with seven subjects to fit into the plate, I trust you'll group yourselves rather tightly."

"Seven?" repeated Fred. "There's only—oh, sure," he broke off, looking at Grandpa Roseliep in his stuffed rocker.

"You will join us, will you not, sir?" Professor Erlenwanger said, looking up at the old man as he fitted his camera onto its collapsible wooden tripod. Beside him, Molly had removed a plate from the other grip and was carefully polishing dust from its surfaces with a soft cloth.

Roseliep was reading *Der Kanarienzuchter,* one of the three bi-weekly issues that had arrived from Leipzig in yesterday's mail. From the shelter of the paper he grunted, "What do you want with me? I know nothing about cows, so I am useless—hein? And with these hands, I am surely no cabinetmaker any more." The paper shook, perhaps in frustration rather than from a deliberate attempt to emphasize the arthritis-twisted fingers which gripped its edges. "Go on, leave me alone."

Professor Erlenwanger stood, the brass and cherry-wood of his camera glinting under the light of the dining room lamp. He spoke in German, briefly and fiercely.

Grandpa Roseliep set down his canary-breeders journal. His full, white beard blazed like a flag. The old man fingered the stem of his pipe on the end table, but he left that sitting as well. In deliberate English he said, "An old man is a man still? Wait till you become old, Professor." The two men stared at one another. Abruptly, Grandpa Roseliep said, "But I will be in your picture, since you ask."

The old man levered himself out of his chair, stiff-armed. Carl moved to him quickly, holding out an arm for his grandfather to grip. The old man's shoulder brushed the covered canary cage beside his chair. One of the birds within peeped nervously. Absently, Roseliep soothed it with a murmur from deep in his throat.

Carl's parents and brothers were standing by the fireplace, looking a little uncomfortable. The Professor had set up his tripod in front of the staircase across the room. Molly stood beside him, holding out the photographic plate. Carl led his grandfather into the center of the group between his father and Fred. He knelt down in front of them, facing the camera as the Professor loaded it.

Grandpa Roseliep turned slowly. His foot caught

on the edge of the fireplace fender. He stumbled, gripping Mr Gudeint's arm to keep from falling. The farmer jerked back. He looked down at the knotted fingers with instinctual distaste.

Roseliep followed his son-in-law's glance. "Yes," he said, "but once they were strong, were they not? Strong enough to build this house for my daughter on her marriage." With his left hand he rapped the carven oak mantlepiece. "And the house gives shelter yet."

Mr Gudeint bit his lip. He put his arm around his father-in-law, gripping him under the arm and absorbing enough of the weight that the old man's body could stretch back to its full six feet of height. "We're ready for your picture now, Professor," he said.

Across the room the camera lens winked, and the Professor's bright eyes winked above it.

Carl and his father returned from the barn together for breakfast. The three older sons were already at their pancakes, along with Professor Erlenwanger and Molly. Mr. Gudeint called into the front room, "Georg? Come on in and sit with us, will you? Your birds can take care of themselves for a while. I want to rig a pole and winch to load bales into the barn, and I figure you can help."

Grandpa Roseliep walked slowly into the kitchen on his crutch-headed cane. "You know, Frederick," he said, "I am no longer a woodworker."

Carl's father grunted. "I know you can figure how to make a piece of wood do everything but talk," he said. "We'll do the muscle work, me'n the boys, if you'll tell us what to do. For that matter, we're not talking about fancy work—and I don't know but what swinging a hammer'd loosen your joints up some. But that's up to you."

The big farmer took his usual place at the head of the table and noticed for the first time that all the

place settings were china. He poured milk into the wine goblet beside his coffee cup and said with half-humor, "Professor John K. Erlenwanger, hey? From the way Maxine's acting, I'd judge the 'K' must stand for king."

Erlenwanger touched his napkin to his lips. "Kennedy, sir. To my parents, a greater man than any king could ever be." Mr. Gudeint looked puzzled, but before he could speak the Professor added, "Last night you thought it would be possible to take my daughter and me into town to purchase supplies. Is that still the case?"

Carl's father nodded with his mouth full of pancake and molasses. "Sure, the boy can haul you along when he carries the milk into the dairy after breakfast. But I'd have thought you'd just fly?"

"I prefer to avoid built-up areas," Erlenwanger explained. "The appearance of my airship would arouse more interest than I desire at this time, and maneuvering a construct as large as *The Enterprise* becomes a . . . difficult proposition in close quarters." The shadow of the great, gray cylinder darkened the dining room, lending weight to the stranger's shrug.

"Look," said George abruptly, "I'll carry the milk in today instead of the kid."

Carl jumped to his feet, flushing, and cried, "Look, I'm going to take them in. And get off this 'kid' business—I'm eighteen and I'm as much a—"

"Carl, sit down!" Mr. Gudeint snapped. "And George, you be quiet too. I'll decide who's going to do what around here."

"Though I was rather hoping that Carl would drive us to town, as you'd said," Molly interjected unexpectedly. She gave a nervous smile to Mr. Gudeint, who blinked at her. She was wearing a bengaline cotton dress with vertical stripes of green and olive this morning. The silk threads gave it a sheen like that of

her black hair.

"The boy'll do it," Carl's father said. "It's his chore." He turned to Carl. "About time you got started, isn't it? The sun's high enough, though you don't see it with that great metal thing out in the yard."

"Yes, sir!" said Carl, bolting the last of his breakfast and washing it down with his milk. To the visitors he added, "I'll have the wagon loaded in two flips of a lamb's tail. I'll holler when it's ready."

It was killing work to hand the heavy, tin-plated milk cans up to Danny on the wagon bed. Carl finished the job in record time, however, and without any spillage past the pressure-fitted lids. Erlenwanger and Molly came out of the house just as Danny ran the safety rope across the box of the wagon to keep the cans from oversetting on the bumpy ride. "Just in time," Carl called to them. "I'll get the horses and we're off."

Molly sat between Carl and Erlenwanger as the pair of bays plodded along the familiar trail with only voice commands. A light breeze from the south kept the worst of the road dust from the travellers, but a plume rose behind the wagon like smoke from a grass fire. "It'll be all over us coming back," Carl said.

"And you have to drive this every day?" Molly asked. "There's so much work on the farm."

"Not enough for four sons," Carl said gloomily. He caught himself and added, before anyone could follow up his earlier comment, "I guess you need food, hey?"

"Not at this point, I think," Erlenwanger replied. "What we particularly need is lamp oil."

"Lamp oil?" repeated Carl. "Good Christ, Professor—sorry, miss—we'd have given you lamp oil if you'd spoken. We're not electrified out where we are!"

The older man smiled past Molly's bonnet. "Not a

hundred gallons, I think."

"Good Christ—oh Hell, I'm sorry again," Carl blurted. "What on earth do you want with that much lamp oil?"

"It's for our motor," Professor Erlenwanger explained. "Other researchers into directed airship flight are concentrating on petrol-burning motors of the Benz type. This is a serious error, I believe. Compression-ignited kerosine engines built to the design of Herr Rudolph Diesel are far more efficient. In addition, lamp oil is available at even the most out-of-the-way farmstead in a pinch, no small recommendation on a journey which crosses the very continent."

The city limits were marked by a metalled road. It was bright with the rich yellow limestone gravel crushed out of the bluffs on which the city was built. A bicyclist passed the wagon, free-wheeling with the momentum he had picked up coming down a side street. "Darn fool," Carl grunted, noting Molly's attention to the speedster. "In town, a gadget like that's good for nothing but running you under a wagon. Now I've rode'em, but it was at Starways Rink where they belong."

Carl turned onto Central Avenue, letting the horses ease along despite his desire to oblige the Professor. The brick avenue was slippery, and it would be easy to throw a shoe if haste brought nothing worse. Carl pulled around the yellow-brick building of the dairy and backed expertly to the loading dock, clucking to his team. "Won't be a moment," he said to his passengers. He poised on the wagon seat, then vaulted over the milk cans to land on the pine bed with a crash. "Charlie! Jess," he shouted into the dairy. "Lend me a god damn hand! I'm in a hurry."

Erlenwanger and his daughter watched with silent interest. Carl rolled the heavy cans on their rims up the loading gate to the dock where the two dairymen

manhandled them into the building. His muscles rippled, but the familiar effort did not even raise sweat-stains on his shirt. "Christ you guys're slow," Carl grumbled as he rolled the last can onto the dock. "I'll hook out the empties myself." It took him two trips, carrying a pair of the heavy cans in either hand each time. They would be hauled back and refilled the next day. Life was an endless cycle of milk cans and horse butts, Carl thought savagely to himself.

As he settled back onto the wagon seat, Carl noticed for the first time that the Professor's two camera cases were on the shelf beneath. "Frummelt's is just down Central," he said. "Say, you carry that camera most everywhere, don't you?"

"I do indeed," Erlenwanger agreed. "No amount of trouble in carrying the apparatus along is too great to be justified by the capturing of one scene that cannot be duplicated. And compared to the effort of bringing the apparatus . . . to the vicinity . . . any trouble to be endured on the ground, so to speak, is nothing."

Carl pulled in through the gate in the green-painted hoardings, into the yard of Frummelt's Coal and Ice. It was crowded with delivery wagons. Carl locked wheels with one and traded curses with the Irish driver as he angled into a place at the dock.

"We need twenty cans of coal," Carl shouted to the squat loading master.

The Frummelt employee cocked an eyebrow at them, lifting the brim of his bowler. "Christ, boy," he said, "I see why you came here steada' the front. If it's charge, you'll have to go up to the front anyhow, though."

"It's cash," said the Professor, balancing his weight carefully as he stepped onto the dock with his camera. He reached into his coat and brought out a purse from which he poured silver dollars into his left palm. One of the coins slipped and rang on the concrete. Carl knelt and handed it back to the older man. It

bore an 1890 date stamp, but the finish was as bright and clean as if the coin had just been issued. Carl's eyes narrowed, but the loading master took the payment without comment. He counted a quarter and two dimes from the change-maker on his belt and shouted an order to a pair of dock hands.

"I wonder if I might photograph you and your men at work?" Erlenwanger asked as he watched the load of laquered rectangular cans being rolled out on a hand truck.

"Good God, why?" demanded the loading master, ignoring the driver of an ice wagon waiting for orders.

"Today, this is the petroleum business," the Professor explained obliquely. "If a time comes during which all carts and wagons are replaced by self-powered vehicles, the whole shape of the world will change You and your men here will be important in the way the first lungfish to scramble onto dry land to snap at an insect was important. Your feelings, your sense of place in the world—this will never come again."

The loading master touched the right curl of his handlebar moustache. "You can't get all that in a picture," he said.

"What I call my photographs capture more than one might think," Erlenwanger responded.

"Then go ahead and waste your time," grunted the squat man as he turned away. "So long as you stay clear of the wheels and don't waste my time too."

As the bays plodded back along Bluff Road, Carl said, "I've thought about what you were saying back at Frummelt's, Professor."

"And?" the older man prompted.

Carl turned and saw Molly's intent smile instead of the Professor. He lost his train of thought for a moment. At last he said, "Well, it won't happen. The

wagons with motors, I mean. Not in Iowa, at least." He gestured toward the road in front of them. "When it rains, this's mud. Two, sometimes three feet deep, up to the bed of a wagon. I've seen traction engines get stuck in fields in a wet year and us have to hitch the plow horses, three teams all told, just to get the milk to town. They'll never make an engine that'll handle mud like a good team will."

Professor Erlenwanger nodded seriously. "There's reason in what you say, Carl. Many men much older and better educated would say the same thing. But one of the most important lessons that people must learn if they are to deal with the coming age is that nothing, whether good or bad, cannot happen. If there is something to do with the way humans interact with their world, it probably will happen. It is only when we all recognize that as a fact that we have a chance to guide some of the change that will occur anyway."

The Professor waved as Carl had at the track of rich, black earth pulverized by horse hooves and the iron wheels of wagons. "For instance," he said, "no one today—or a century hence—will find it conceivable that this topsoil could be stripped utterly from the land by wind, rain, and 'normal farming methods'. Such an occurence would be to the benefit of reeds in the Mississippi Delta and the detriment of everything else, humans in particular. Yet, if it shall have been permitted to happen, the humans of the Nineteenth and Twentieth Centuries will bear the burden of failing to have controlled a development which they thought was impossible—until it became inevitable."

Carl looked at the horses ahead of him. He licked his lips, ignoring from long familiarity the gritty taste of the dust on them. "Professor," he said without turning around, "I want to come with you. On your airship."

"Molly and I can use another hand on *The Enterprise,*" Erlenwanger said mildly, "and there is ample room and lifting capacity, to be sure. But have you considered just what leaving home will mean to you?"

Carl risked a glance. Molly was looking straight ahead, twisting her ungloved hands in her lap. The Professor was leaning forward with a bland expression. Carl nodded, his throat tight. "I'm leaving, that's decided," he explained. "I thought it was going to be the Navy, is all. You see, it's not that I don't love my folks . . . or them love me, for that matter. But I'm the little kid. I'm eighteen and I'm the little kid. So long as I live and even one of my brothers lives, I'll be the little kid—if I don't get out now. Maybe after I've made my own way for a time, I can come back. Maybe I could even work the farm again, though I don't guess I'd want to. But for now, I've got to cut the traces."

"Very well, Carl," said the Professor. "I won't insult you by questioning your decision. If I did not think you were capable of soundly assessing a situation, I would not have considered making you the offer. You no doubt realize that we will leave as soon as *The Enterprise* has been refueled?"

"Oh, that's best," breathed Carl in double relief. "I'll bundle my clothes and . . . say what needs to be said. Then it'll be best all round if I leave." His eyes sought the Professor's, caught Molly's instead. They both looked away.

Carl's mother came into the room her two youngest sons shared. Carl was rolling the extra set of dungarees around the rest of his meager belongings. He tied the bindle off with twine. Mrs Gudeint said nothing. Carl glanced at her, saw her tears, and looked away again very quickly. She was in the doorway and Carl was finished packing. Looking out the window, he said, "Mom, I brushed down the

horses before I came in. I'm not going to stay here, I never was—you know that. So just kiss me and don't . . . all the rest."

Turning very quickly, the boy pecked his mother on the cheek and tried to swing around her in the same motion. She clung to him, her face pressed against his blue cotton workshirt. At last she said, "You've told your father?"

"I'll be back one day soon and I'll tell him," Carl said. He squeezed his mother closer and, in the instant that she relaxed, disengaged himself from her. "Mom, I love you," he said. He reached the staircase in one stride and was down its ten steps in three great jumps. He did not look back after the screen door banged behind him.

While Carl finished his business with the farm, Professor Erlenwanger had poured the twenty cans of kerosine into the funnel-mouthed nozzle he had extended from the rear of the gondola. Molly was stacking the empty cans up against the wall of the barn for the Gudeints to use or return for credit. She nodded to Carl as she entered the gondola and sat primly at a bank of sixteen levers, each with a gauge above it. The Professor himself stood at a helm like that of a ship. The spokes appeared to have additional control switches built into them. To the right front of the helm, along the glazed forward bulkhead, was a double bank of waist-high levers. The control room was no more spacious than the garret bedrooms Fred and George each had to themselves, but it was only the front third of the gondola.

"Carl, if you'll take a seat at the other console," Erlenwanger said, gesturing to the chair just aft of the gondola's door. "Soon I'll teach you how to operate the motor controls yourself; but now, in the interests of a prompt departure . . . ."

Carl nodded and sat as directed, eyeing the north field where his father and eldest brother were haying.

The Professor leaned over him and threw a switch. "Since we ride on hydrogen," he said cryptically, "it's no difficulty to bleed some into the injectors in place of ether for starting . . . ." He flipped a second switch. Something whined briefly and the motor grunted to life. It sank quickly into a hum that was felt but not really heard in the forward compartment. Erlenwanger listened for a moment, then said, "Very good." He pointed to a knob with a milled rim. "When I direct you to, Carl, please turn this knob a quarter turn clockwise. It engages the airscrew, which we don't want to do until we have a little altitude, do we?" He smiled brightly at both his crew members. "Not pointed at the house as we are, that is."

Erlenwanger returned to the helm. "There doesn't seem to be enough wind today to require us to make an immediate jump for altitude. I'm always concerned about that, for fear that a line stoppage will lift us asymetrically; so Molly, if you will fill tanks five and eight."

The girl quickly threw two levers. The gauges above them began to rise as the metal fabric trembled to a mild hissing. The older man said "Each of the sixteen tanks is split in two by a movable partition. The partition acts as a piston when the pressure on one side of it becomes higher than that on the other side. One and sixteen, Molly; then two and fifteen," the Professor continued.

Molly worked the requested pairs of switches, pausing after the first to make sure the operation was smooth. She glanced at Carl over her shoulder and said, "What he means is, the gas pushes air out of the tanks when we want to go up, and the air pushes the gas out when we want to go down."

Erlenwanger turned and blinked. "That's very good, Molly. I'm afraid I often talk more than I communicate. Though air is a gas as well as hydrogen, of

course . . . . Still. If you will fill the next three pairs in order, please."

The hiss of gas was a living sound now. The gondola was rocking like a rubber ball on the surface of a lake, not lifting off the ground but responsive to every ripple in the air. "I think we're about ready," said Erlenwanger. "Carl, I'll give you the word in a moment. Molly, fill the central tanks."

The gondola shuddered. The pattern of light through the side windows shifted as they swung beneath the lifting hull. The ship was rising at a walking pace, drifting toward the barn and rotating about 30° in the grip of the mild breeze. "Carl, engage the screw," said the Professor. The boy obeyed, his hand so tight on the knurled brass that it did not slip despite its sweatiness. Erlenwanger rocked his helm forward on its post as he felt the propeller bite. The side-slipping continued but was lost in the greater surge of the airship's forward motion. They were still rising. Looking through the windows beyond Molly, Carl could see the hay-cutting rig at the point of the bright swathe cut from the darker green of the north field. The horses were the size of chihuahuas. The two men in the field shaded their eyes with their hands as they stared at the shimmering oval in their sky. They were too far away for Carl to have recognized them by sight alone. They did not wave. After a moment, as the field and his former life slipped behind at locomotive speed, Carl did.

Professor Erlenwanger released the helm and stepped over to where Molly sat. The airship continued moving smoothly at better than twenty miles an hour. The rolling land was now almost three thousand feet below. "We're a little higher than I care to be without a reason," Erlenwanger said. "Probably because the sun is so bright. Molly, would you care to balance all the tanks at 75%? That should bring us down about a thousand feet. Besides, I prefer

to have some pressure in all tanks rather than flying with some voided and others full."

Molly slid the fourteen open switches down to three-quarters. Simultaneously, she slid the other pair up to the bar with her free hand. The airship lurched, steadied, and continued to skim through the air. It was dropping noticeably, a sensation less like diving into a pond than it was like a toboggan ride down Indian Mound Hill. Erlenwanger studied the line of silver in the etched glass column above his helm. His lips pursed and he touched another display to the side of the column. "We aren't getting the lift we should out of the forward tanks," he said to no one in particular," though we seem to have leveled off satisfactorily. Moisture in the tanks, I suppose. We'll have to empty them in the near future."

"Where do you buy your hydrogen, Professor?" Carl asked, staring down through the transparent quarter-panels of the gondola. He had seen fields from atop the sharp bluffs which wrinkled eastern Iowa, but there was something marvelous in watching solid ground flow by below like a river choked with debris.

"I manufacture it from water," the older man said. "Our motor powers an electrical generator. When it is necessary to fill a hydrogen tank, I simply run a current through a container of water and collect the separated hydrogen atoms above the cathode."

Warming to his subject—though little of what he had already stated made sense to Carl—Erlenwanger continued, "You see, that is where some theorists go wrong in asserting that helium is safer than hydrogen because it cannot be ignited. What they ignore is the *cost* of helium. The only way to keep an airship safe over a long period is to clear it of the condensate that otherwise—and inevitably—loads it down to the point that a storm smashes it. And the only sure way

to clear the condensate is to vent your tanks and dry them periodically. Helium is rare and far too expensive to be 'wasted' in that fashion—so lives will be wasted instead. Hydrogen is cheap and can be manufactured anywhere, either from acid and iron filings or—much more practically—by electrolysis, as I do."

The Professor shook his head. "It will be a long time, if ever, that men will stop sending other men to their deaths by ignoring the practical realities which make their theories specious. We should not enshrine human realities, my young friends, whether economic or otherwise; but neither should be expect them to disappear because we ignore them."

Erlenwanger caught himself. He smiled wryly at both his companions. Their eyes were focused at about the level of his stick-pin in determined efforts not to look bored. "Well," he said, "I think it's far more important to teach Carl the rudiments of *The Enterprise* than it is for me to go on about things that only time will change. Molly, would you care to show our new recruit how your panel functions? I can listen and make suggestions if it seems useful."

The older man sat in Carl's chair, watching as Carl moved over beside Molly. The airship flew on at a steady pace, over farms and wooded hilltops, water courses in which cattle stood to their bellies, and occasionally a small town in a web of dry, gray roads. Throughout the afternoon, Carl learned the workings of the machine which was less wonderful to him than was the girl at whose side he sat. The levers of the starboard panel controlled the flow of hydrogen between the buoyancy tanks and the storage reservoir in the keel. "It's held in a liquid state," the Professor interjected, "and the insulation of the reservoir is an improvement—a very great improvement—over previous applications of Dewar's principles."

Understanding the technique of raising or lowering

the airship was easy, but executing the technique was another matter again. Carl made several attempts to modify the craft's buoyancy at Erlenwanger's direction. Each experiment sent *The Enterprise* staggering through the air at an unexpected angle or altitude. At the end of the session, the boy had a fair grasp of what the duties entailed—and he had enormous respect for the girl who performed them.

"How long have you been practicing this?" asked Carl as Molly brought them back to level flight at two thousand feet following his own series of unintentional aerobatics.

"Well, about four days, now," said the girl, glancing over at the Professor for confirmation. "I've been doing it ever since the Professor—oh dear." She broke off in indecipherable confusion, blushing and looking away from both men. "I'm sorry, I didn't mean to—"

"Nor did you, my dear," Professor Erlenwanger said calmly. "And in any case, I intended to explain the situation to Carl at once anyway. "You see," he continued, turning to the boy, "Molly is no more my daughter than you are my son—which is how I intend to describe you to those whom we meet on our travels. I assure you, there is no improper conduct involved in Molly's accompanying me, any more than there would be had she been a blood relation. However, so as not to offend those persons whom we meet, I determined to tell an untruth—a lie, if you will. I dislike lying, and I will not lie to another's harm; but the truth is less important than the fellowship of many humans meeting without enmity."

Carl licked his lips. "What did your real parents say?" he asked.

Molly looked down. "I haven't real parents," she said softly.

"Molly was a foundling," Erlenwanger said. "She was in service at a house in Boston until she refused a —an improper demand by the master of the house.

She was turned out of her place the day before I met her."

"I never told you that!" the girl blurted.

"Nor do I mention it to embarrass you, my dear," Erlenwanger said. "We will be together for some days and in close proximity, however, and I think it necessary that Carl understand your situation as clearly as you do his."

They proceeded through the airship's two other stations. The motor-starting drill appeared to be ridiculously simple: depress the hydrogen feed for three or four seconds, release it, and flip the starter switch. Shut-down was even more basic, a third switch that 'shut off the injectors', which meant nothing at all to Carl but obviously seemed an adequate explanation to the professor.

There were a dozen circular gauges above the switch panel. "While the motor is running," Erlenwanger said with a gesture, "the pointers should all be in the green zone. If one of the pointers falls into the red or rises to the white, tell me. Nothing very dreadful is going to happen without our hearing it, though, so don't feel you have to stare at the dials."

"It isn't really very simple, is it?" Carl said thoughtfully.

"Umm?" said Erlenwanger, pausing in mid-step as he moved to the helm.

"You make it look easier than running a feed mill," Carl went on. "Maybe it is, too. But it's not simple, it's just simple to run. Being able to milk a cow don't mean you could build a cow yourself."

"That's true, of course," the older man agreed with a pleased expression. "I'm really delighted to have met you, Carl. One has an emotional tendency to equate ignorance with stupidity, which meeting you—meeting you both—" and his hand spread toward Molly— "has dispelled.

"But to answer your implied questions, Carl, *The*

Enterprise is unique in the world. However, if she were examined at length by today's finest scientists and engineers, they would find only her workmanship to be exceptional. Others—many others today—have all the 'secrets' I have embodied in the Erlenwanger Directable Airship. I have refined metals to great purity and machined them to—great—tolerances; but all this can be duplicated." The Professor paused and smiled again. "So while I will agree that the construct is not simple, my friend, it is simple enough."

The helm station was another example of the horribly complex overlaid by barnyard basic. Rotating the spokes did not change the direction of travel, as Carl had assumed from analogy to a steamship; rather, it controlled the amount of power the motor developed. "The diesel runs at constant revolutions," Erlenwanger said, "with the output delivered through a torque converter."

"I don't understand."

"Oh." The Professor blinked. "Well, you know how a block and tackle work," he began. At the end of half an hour's discussion, Carl *did* understand a torque converter, because he had seen the one in the engine compartment. The diesel squatted there, hot and oily but as silent as heat lightning. The humming of the prop drew up and down the scale as the Professor adjusted its pitch to demonstrate. They went forward again, through the central compartment with its three fold-down bunks and a tiny but marvelously-equipped lavatory. Carl was conscious (as he had not been before) of the *machineness* of what they were riding. Flying had been like drifting in a cloud or—better—floating on his back in the stock pond with water-wings at his ankles and neck. Now . . . the diesel made no sound, but the gondola trembled to its power; and the linkage of control to power to motion had become part of Carl's universe. Amazed by the

concept rather than any single object, Carl and Molly watched Erlenwanger change their direction by turning the helm on the axis of its vertical support.

"What do these do?" Carl asked, reaching out a hand toward the levers in front of the helm.

"Oh, careful—" Molly cried, her own hand catching Carl's. "These spill the gas out through the top. As low as we are now, we could—well, it wouldn't be a pleasant drop."

"I wasn't going to move it," Carl explained; but the incident reinforced the dangerous reality of what had initially seemed to be a fairy tale.

They were heading West by South-West—255° on the compass which somehow flashed onto the forward window when the Professor thumbed a button on the helm. The sky darkened with awesome suddeness. Because *The Enterprise* was headed into a horizon as rich with color as any Carl had seen since the aftermath of Krakatoa, even that darkening was not an immediate warning. "I think we had best find a place for the night," Erlenwanger was saying. "The land beneath is a good deal more broken than that in the glaciated portion of the state, isn't—"

The first gust of the storm racing down from the north caught *The Enterprise.* The gondola rotated twenty degrees around the axis of the buoyancy chamber.

Carl had youthful reflexes and a farmer's familiarity with shifting footing. His left hand caught the edge of the diesel control panel, firmly enough to twist the light metal. His right hand caught Molly as she rebounded from the starboard bulkhead when the gondola swung back. Professor Erlenwanger was slower and in a worse position to act. A leather strap hung from the roof above him, but instead of snatching for it the older man froze on the helm. The helm simultaneously turned and pivoted, and the airship

nosed into the squall with its prop idled and unable to keep a way on. *The Enterprise* tumbled in a horizontal plane, swapping ends twice and shuddering as updrafts sucked it toward the thunderheads invisible above.

Erlenwanger got his footing and thumbed a button. Lime-colored lights brightened the cabin. They were dim, but in contrast to the storm's sudden blackness they felt as warm as the kitchen stove in winter. The craft steadied, the motor giving them enough headway for control despite the buffeting of the wind. Rain slashed *The Enterprise* with a sound like tearing canvas, and the interior lights reflected in surreal nightmares from water-rippled windows.

Then the lightning bolt hit them.

Carl had heard the boiler blow at the Star Brewery in 1893. Perhaps that was louder than the thunderclap—but Carl had been half a mile from the brewery, not inside the boiler at the time. Now the thunder was only a stunning physical counterpart to the blinding dazzle of the lightning. Carl's flesh tingled. Molly's hair was standing out straight from her head like the fuzz on a dandelion. rackling with tiny blue discharges from the tip of each tendril. Rubber was smouldering everywhere. It did not occur to Carl to marvel that the direct voltage of the lightning had been insulated from the occupants of the gondola.

"I have to land," Erlenwanger cried, his voice tinny in the aftermath of the thunderclap. "Molly, can you—?"

The girl nodded. The emergency lights were gone but St Elmo's Fire frosted all the external metal surfaces and illuminated the cabin through the glass. Molly's mouth was open as she struggled to her feet, but the muscles of her cheeks were set in a rictus, not a scream. A fat blue spark popped to her finger tip. Her gasp was a soft echo of the spark, but she grasped her controls without hesitation and slid two of the

levers down to their bottom positions.

They were presumably dropping, but with the darkness and the wind's hammering it was impossible to tell. The altimeter column was invisible; it would have been uselessly erratic even if Erlenwanger had had enought light to read it. The Professor was leaning over the helm, peering helplessly at the black countryside. Carl wondered why the older man did not use the spotlight. Then he noticed that Erlenwanger was ceaslessly flipping a switch in the center of the helm, back and forth, back and forth, though he must have realized minutes ago that the lightning bolt had put the spot out of commission until repairs could be made.

Erlenwanger slid the gondola door open. Droplets slung from the doorframe eddied and spattered within the compartment. The tendrils of St Elmo's Fire were growing longer and brighter. They blunted the night vision of those in the gondola without helping to illuminate the ground beneath. Carl hung from the door jamb, his head and shoulders out in the onrushing night. Big, wind-flung raindrops bit his cheeks like horseflies. Molly sat at her controls, feet locked on the bench against the hammering gusts. Her face was pale but prepared.

"There's a level field beneath us!" the Professor cried over a roll of thunder from half a mile away. "I'm going to void a tank to set us down quickly." He reached for one of the levers beside the helm. A landing leg extended across Carl's field of vision like the arm of a mantis. The boy peered forward, blinded by a lightning flash and trying to superimpose what its instant had showed him over the yellow after-image on his retinas.

"Trees a hundred yards ahead," Carl shouted.

The Enterprise lurched. In the same moment there was light, a great blue flare reflecting from the cloud ceiling as static ignited the hydrogen released from

tank nine. Carl screamed, "Jesus Christ, we're over water! Get up, *get up!*"

Even as Carl spoke, Molly was thrusting her levers to the top, a help but too slow a help. The silent fire still blazed above them, mirrored by clouds and the storm-tossed Missouri River beneath. It was a huge sheet of illumination a mile in diameter. The Professor slammed his throttle forward, to and through the gate that blocked it with an inch of potential travel. The diesel roared, racketing even against the storm as yard-long flames spurted rearward from exhaust cut-outs. *The Enterprise* wallowed like a bogged wagon. A landing leg touched a wave top and dragged a line of spray to tilt the gondola. They were over mudflats, the wind swinging them as they struggled to rise above the line of willows that fringed the Kansas shore. The storm whipped a willow-frond up at them, the tendril snaking in through the open door and stripping off its leaves on the trailing corner as they pulled past. But that was the last touch of the storm and itself more a love-pat than a threat.

They were skimming a pasture, the six-foot heads of bull thistles throwing sharp silhouettes against the cropped grass as lightning flared again. Erlenwanger throttled back and swung the airship into the wind. Molly's fingers played on the controls. They sank, brushing the ground as they drifted back toward the dark bulk of the far hedgerow. The Professor edged his throttle a half point open and the ship steadied, bumped, and settled solidly onto the field. The pumps whined to empty the tanks into the hydrogen reservoir. Lightning skipped across the sky to the south of them, but the thunder was half a minute coming.

The Professor looked at his companions, like him exhausted. He beamed. "I think we all owe ourselves a vote of thanks for able action under difficult circumstances. Now, who would care to join me in a

supper of ham, fresh corn, and . . . cider, I think, from New Hampshire?"

Carl looked away from the sparse vegetation below them. "Are you trying to set a record time crossing the country?" he asked Professor Erlenwanger.

"Goodness no," said the older man, squinting a little in surprise. "That's for the railway barons, cleared track and fifty miles an hour. I will reach San Francisco in—a matter of time. But for me, the . . . well, the journey is itself the destination."

Carl nodded. "I just wondered," he said, "from the way we spent a day there at the river."

"Oh, well," Erlenwanger said, gesturing down at the alkaline landscape. "We needed to replenish our hydrogen, and I thought it best to do so before we got much farther west. As we have. Besides, the peddler we met was a fascinating person."

"He was just a peddler, wasn't he?" Molly asked. "I wouldn't of thought you would want a picture of him in particular."

The Professor bobbed his head, animated by the discussion though he disagreed with the implications of the statement. "Yes," he said, "an ordinary peddler. But have you ever considered for how brief a time a peddler may be normal?" He spread his hands, palms upward. "With growing centralization, with the better communications that metalled roads will bring, there will no longer be a need for goods to be trucked from door to door, from farm to farm. That man with his mule and his wagon and his . . . little bit of everything civilized—he is on the end of a chain stretching back ten millenia. And he really is the end of it."

Erlenwanger smiled at Molly to show there was no hostility in his disagreement. "He is very much worth—photographing—you see. Very much worth preserving for another age."

From the air, western Kansas was a waste of chalk gullies and buffalo grass. *The Enterprise* had sailed over cattle too scattered to be called herds; there had been no other signs of human habitation for forty miles.

"That's a campfire," Carl said, pointing out the forward window.

"Why yes, I believe it is," agreed Professor. He tilted the helm a point, centering the tendril of gray on the pale evening sky. Molly sat quickly at her bench, waiting for instructions.

In the fading sunlight, the airship must have been a drop of blood to the slouch-hatted man who saw it as he tossed another buffalo chip on the fire. He yelped. The younger man across from him, turning the antelope haunch, spun around. He jumped to the rifle leaning against the wagon box and levered a cartridge into the chamber. The gondola door was already open. Neither the Professor nor Molly could leave their stations. Carl leaned far out into the air, clinging to the jamb as he had two nights before in the storm. He shouted, "Hey, what's the matter with you? We don't mean you no harm!"

"Great God, there's men in it!" the rifleman blurted.

Behind him, the tent flap quivered to pass a third man wearing dungarees over a set of combinations. He was older than either of the others, balding and burly with a gray moustache drooping to either side of his bearded mouth. "Of course there's men in it, Jimmy," he thundered. "Did you think it was alive?" He glanced down at the meat and added to the slouch-hatted man, "Watch the roast, Corley, or it's back to rice and beans."

The airship had drifted very close to the campsite. The landing legs creaked out. Carl picked up the grapnel and a handful of its coiled line. He had learned that the hooks were not a necessity but that

they made a landing easier by keeping the vessel headed into the wind. "Can you set this solid?" he shouted and hurled the grapnel to the ground. The burly man took the idea at once. He nodded and wedged the hooks just down-wind of the camp between a pair of the boulders that dotted the surface of more friable rock. A moment later they were down, the airship wheezing to itself as it resettled its hydrogen.

Carl stepped to the ground and shook the great, calloused hand which the eldest of the campers thrust at him. "Carl Gudeint," he muttered.

"Claudius Bjornholm," the other said. "And these are my assistants, Mr. JamesBeadle, and Mr. Corley whom I hired to drive and to cook for us."

Carl found himself spokesman from his location. "Ah," he said, "Professor Erlenwanger and Molly, ah, Molly Erlenwanger. The Professor built this bal—airship."

There was mutual murmuring and shaking of hands, though Carl noticed that Corley was hanging back. Apparently he was afraid to step beneath the looming buoyancy chamber of *The Enterprise.* Most of the light now came from the campfire. Carl eyed the array of digging implements stacked near the wagon and asked, "You, you're . . . prospecting?"

"You mean, 'You're crazy?" Bjornholm replied good-naturedly. "No gold in this chalk, of course. But it could be that I'm madder still, you know. I'm here—we're here—hunting for bones. It's been my life now for thirty-seven years, and I expect to carry on so long as the Lord gives me the strength to do so."

Carl and Molly exchanged blank glances. The youngest of the campers, Jimmy—he must have been Carl's age though he was much more lightly built—knuckled his jaw in some embarrassment. Professor Erlenwanger, however, said, "Yes, of course; searching for the fossils of the Great Nebraska Sea. Have

you had much success?"

"Very little this far," Bjornholm admitted, "though Jimmy believes he spotted something in a gully wall while bringing back our supper here—" he nodded at the antelope haunch. "We'll see to it as soon as there's enough light to work without chancing damage to the finds." The big man looked at Erlenwanger appraisingly. "You're a learned man, sir," he said, "as one would have expected from your—" he nodded—" creation. It seems far too huge to be so silent."

The Professor smiled. "People accuse machinery of being a curse when their real problems are with the side effects rather than the machines themselves. Noise is one of the most unpleasant side effects, I have found; but it can be cured." Waving at the fire from which Corley had just removed the meat, Erlenwanger added, "Perhaps you'd be willing to share your fire? We can of course provide our share of the supplies. And—if possible—I would greatly appreciate it if we might accompany you in the morning on your search."

Bjornholm straightened. With the glow of the fire behind him and the power of his stance and broad shoulders, he was no longer a part-dressed figure of fun. "Sir," he said, "we would be honored by your presence—tonight and whenever else."

Fresh vegetables from the airship were well received by the bone-hunters, but the greatest delicacy Erlenwanger provided was fresh water. Bjornholm savored his first sip, tonguing it around within his mouth until he finally swallowed. "You don't know what it's like," he said slowly, looking at each of the visitors in turn, "to have nothing to drink for months at a time but water so alkaline that even a handful of coffee beans can't kill the taste. Every mug is a dose of salt—literally, I'm sorry to say." He nodded solemnly at Carl, who was farthest around the circle from

Molly. "You waste away during a dig, and the good lord help the poor fools who try to live here and farm."

"But why do you stay?" asked Molly, handling her plate ably on her knees as she squatted on the ground with the men.

"You see, it's not really like this," said Jimmy unexpectedly, lowering the dainty antelope femur at which he had been gnawing. He waved out at the endless, gullied night. "This was a great bay, ten times the Gulf of Mexico and more. Still water, hiding monsters the like of none on Earth today; still air with gliding reptiles greater than any birds. It's—" He stopped, his lips still working as he decided what words to frame. More than the fire lighted his narrow face. He continued, "I'm at Haverford. Last year I heard Professor Cope lecture and . . . it wasn't a new world opening, it was a thousand new worlds, as many new worlds as there had been past ages of our Earth. Can you imagine that? Can you—see tarpons sixteen feet long, flashing just under the surface as the mackerel they chase make the sea foam? Or the tylosaur, the *real* sea serpent, lifting itself long enough to take a sighting before it slides through the depths toward the disturbance?

"Can you see it?"

Bjornholm was nodding. "I've worked for Professor Cope—God rest his soul—on several occasions in the past He sent Mr. Beadle to me with a letter of introduction; and Mr. Beadle has proven a splendid and trustworthy companion in my search of the world of two million years ago."

"Two million?" Erlenwanger repeated. "Oh, yes; of course. Lord Kelvin proved from the temperature of the Earth that it could be no more than—twenty to forty million years old, wasn't that the figure? I am sometimes amazed at the conclusions a great scientist can draw from data which a man of more—

common—understanding would have found hopelessly inadequate for the purpose." He smiled.

"Yes indeed," agreed Bjornholm heavily. "I have always envied men like Professor Cope the understanding which I can only draw on second hand. I grew up in Cincinnati, where every building stone is marked by a crinoid or a clam preserved eternally from a past age. When I was fifteen, I determined that I would have some part in bringing that past to light, whatever it might cost me personally."

He looked around the circuit of firelight, the tent and wagon, both of them worn; the tools and the brutal labor they implied; the faces of his companions, like his unshaven for the waste of water shaving would entail. "It has a cost. But though I've done things besides digging for fossils, nothing else will really matter after I'm dead except the part of the past I leave to the future."

Corley spit into the fire. "Bones," he said without looking up. "Bones and stones and durned fools."

"And yet you're here too, Jake," Beadle said sharply. "A dollar a day, all found, and corn for your horses. Well, maybe those're better reasons than ours, but—you're here too."

The fire popped back in emphasis, and the dark moved a little closer.

Leaving the tent and the great, hollow bulk of the airship behind, Professor Erlenwanger's party climbed into the wagon with Corley and the equipment. There was barely light enough to see by. Carl was not surprised to notice that Professor Erlenwanger carried his camera cases. Bjornholm and his assistant rode their own horses, the burly man displaying a quiet mastery of his beast that belied his apparent clumsiness.

"Too much for the team to draw," Corley grumbled as he harness the horses.

"With three months of my feed in their bellies, they'll draw this load better than they did the empty wagon when I hired you," retorted Bjornholm.

Jimmy Beadle directed them, scowling under his hatbrim as he searched for landmarks in a country of ruts and scrub grass. He looked older by daylight than he had seemed around the fire. Far on the horizon they could see a pair of pronghorns. Beadle laid a hand on his saddle-scabbard, but Bjornholm noted curtly, "We've better ways to spend our time today."

They skirted one gully and crossed a second, the wagon passengers dismounting as the iron-bound wheels crumbled the rock of the far rim. The sun rose higher and the wind picked up with a burden of dust so finely divided that it looked like yellow fog. At last, as they approached a gully that almost deserved the name of canyon, Jimmy pointed and sid, "There—on the far wall. See where the speck of white is?"

They halted at the rim, squinting across the hundred feet or so at a brighter splash against the yellowish chalk. "We can't get across that," Corley said suddenly. "It's sixty feet down and durned near straight up and down on t'other side."

"Be easier to hang down from the rim, wouldn't it?" Beadle suggested. "It's about half-way up the wall, and I'd sure rather swing down than climb up."

"We'd have to climb that wall to be able to hang over," Bjornholm said. "Unless you've found a way around this arroyo that I haven't. We can get down this side easy enough—"

"Not the wagon!" Corley interjected.

"Not the wagon," Bjornholm agreed, "but on foot. We'll figure a way then to get up the other side."

They used their hands to descend the draw, and Carl made the last ten feet in an uncontrolled rush besides; but they all made it. Molly had less evident trouble than Carl did, picking her footing and getting to the gully floor with no more than a smear of chalk

dust on her linen wrapper. But the wall that loomed above them was nearly as straight as a building's, though there was enough batter from the middle upwards to hide the fleck of bone from their eyes.

Bjornholm absently worried a twig from one of the mesquite bushes that pocked the arroyo. "We'll have to cut steps," he said. He set the blade of the shovel he carried against the wall and twisted with his weight on it. Flecks of chalk spat and the steel rang. "Have to use the hatchet, I guess," he said disgustedly.

"I can get to it if you give me a boost," Jimmy said, eying the stone.

Bjornholm frowned. He laid down his shovel, leaned on the arroyo wall, and looked upward. "It's still to high," he observed.

Corley said, "Bjornholm, if you can take the weight, I'll stand on your shoulders and tug the kid up."

The burly man turned his head to stare. Corley seemed to shrink inward, but he did not lower his eyes. "Climb up, then," Bjornholm rumbled. He braced himself against the chalk. Corley gripped Bjornholm's shoulder and raised a cracked boot to the bigger man's jutting right hip.

"Here!" Carl said, springing to Bjornholm's side and gripping a handful of Corley's dungarees to haul him upward. The gangling teamster balanced bent-over for a moment, then straightened with a boot on the shoulder of each of the bigger men beneath him. "All right," Corley grunted, reaching one hand back and down for Jimmy while his other hand clamped a knob of rock. "Come if you're coming, boy."

Jimmy caught Corley's hand, his boot a brief agony on Carl's out-thrust hip as the student pushed off. Then there was only the doubled weight being transmitted through Corley. Carl locked hands with Bjornholm, less for mutual support than for commiseration of the sharp leather soles cutting to their

collar bones. Then Jimmy cried, "Okay, okay, I'm getting there," and half the weight was gone. In relief as if he were wholly unburdened, Carl flexed his shoulders.

"Hold on, I'm coming down," said Corley. He jumped, falling to hands and knees on the hard soil. Carl backed away, rubbing his muscles and staring up at Jimmy. The student was using minute projections and the slight tilt of the rock to climb steadily toward the exposed bone. From beneath, the watchers tensed as the student's increasingly-greater deliberation showed that he was nearing the prize.

"I've got it," Jimmy said, the chalk muffling his voice. Then, "Oh . . . . Oh."

"What is it, Jimmy?" Bjornholm demanded hoarsely.

The younger man half-turned, no longer particularly interested in keeping his position. "It's a buffalo thigh, Mr Bjornholm," he said flatly. "It must have rolled over the lip of the draw and caught here in a little crevice. I doubt it's as old as I am."

Bjornholm nodded silently, his great shoulders suddenly stooped. "Another time, then," he said. "I've searched longer and found less at other times." But the last words were spoken so softly as to be almost inaudible.

"Look out," Beadle said. He dropped the buffalo femur. It clattered twice on the gully wall before raising a puff of dust on the ground. Bjornholm's assistant eased one foot onto a lower projection, then the other. His boot soles slipped. Jimmy skidded down the side of the arroyo, boots and hips grinding away a shower of pebbles as they slowed him. Carl took a half-step to catch the sliding man, realized that the student was in control of everything but his speed, and got out of the way lest interference cripple both of them. Beadle hit the ground with his legs bent at the knees. His feet flew out from under him at the

shock and he sprawled. Bjornholm and Carl both reached out to help the slender man up. "Well, that's it for this pair," Jimmy said glumly, sticking his hand through the hole the rock had abraded in his trousers. "The others haven't been washed in six weeks, neither."

Claudius Bjornholm was not listening to him. The burly man had knelt, his mouth open and his tongue absently exploring his cracked lips. He brushed his left hand over the surface of the ground where Beadle's boots had scarred it. After a moment he slipped a reground oyster knife from his hip pocket and began scraping. Jimmy looked down and his own jaw dropped. "Oh, oh . . . ," he whispered, kneeling as if joining the older man in prayer.

Corley thrust his narrow shoulders between his two companions. "God damn," he said, "that sure's hell *is* a skull!"

"It's more than a skull," Bjornholm said, his big index finger pointing along the gully floor. Regular projections were visible against the chalk, now that they had been pointed out. They were bony knobs running for twenty feet in a straight line. It was as if the tips of a huge saw blade were sticking up above the gully floor. "I think we have—everything here. Just below the surface. Those are the upper processes of the vertebrae of a mosasaur, unless I mistake what I can see of this skull. If none of it has been lost by weathering, it will be as perfect . . . more perfect than anything I've—I've." The big man paused, blinking back tears. "As anything I've found in thirty-seven years of searching."

"Gentlemen," Professor Erlenwanger said, "would you object to my taking a photograph?"

Carl looked around in surprise and saw that Erlenwanger really had set up his camera. How he had brought the cases down the slope without disaster was more than the boy could imagine.

"Of the find in place?" said Bjornholm, edging back so as not to block the field of view. "Of course, of course."

"No," said the Professor sharply. He gestured the three bone-hunters closer together with both hands. "These bones have been in the ground a hundred million years. Others like them will still be there to be found in another hundred million years. But your like, with the whole of the past fresh under your fingertips—that will pass with your generation."

"But you don't want *us*, then," Jimmy Beadle said with a puzzled frown. He was still kneeling. "You want a picture of the real greats . . . . Well, Dr. Cope is gone now, but Dr. Osborne or Milius of Tubingen."

Erlenwanger flicked his eyebrows back a millimeter in utter denial. "Did you shoot that antelope yesterday in the chest?" he asked.

"Huh?" said Jimmy. "No, it wasn't but fifty yards away, so I shot it through the head."

"That ruined the trophy, didn't it?"

"Trophy?" repeated the student. "I don't understand. I didn't want a trophy, I wanted meat."

The Professor's smile was beatific. "So do I," he said, and he bent back over the camera. The rim of the arroyo still hid the morning sun. The three oddly-assorted bone-hunters linked arms and stared back at Erlenwanger, the triumph bright in their faces.

"I don't know why anybody'd want to live like those cowboys in the line camp yesterday," Carl said, staring through the side windows at the increasingly rugged terrain below.

Molly was at the helm while Professor Erlenwanger sent what he said was a 'wireless message' back to his associates in Boston. She said, "It's not that they want to, I think . . . any more than I wanted to be in service with the O'Neills. But I was willing—for a while. And those fellows were willing to live

their lives in a little hut, ride fences while the weather lets them and spend three months of the winter reading the catalog pages pasted to the walls. Someday they won't do that. They'll get a few cows of their own and marry, or they'll move in town and work at a feed store. But for now, they're willing."

Carl looked over at the Professor. Erlenwanger's eyes were open but unfocused. His thumb and index finger made a muted tapping on the brass key he had set on the ledge in front of the buoyancy controls. "Did he take a picture of you too?" Carl asked quietly, still looking at the older man.

"Oh, yes—right there on the street before he bought me a meal," the girl replied. "He—oh! Carl! Look at this!"

Both men jumped to their feet, their eyes following Molly's pointing finger down to the gullier foothills below. The scale was deceptive. The beast could have been a dun-colored hog rooting through mesquite until Carl took his thousand feet of altitude into account. "My goodness!" gasped Professor Erlenwanger, his wireless gear forgotten, "It's a grizzly bear. I *must* get it!"

The Professor threw open the dunnage locker in the rear bulkhead. Carl expected him to draw out an express rifle, but instead it was the pair of camera cases again. "Carl," he said as he unlatched the equipment, "will you take the helm and bring us up to the bear dead slow? And Molly, since you're more experienced with altitude correction, can you drop us to twenty feet and hold us there?"

Molly throttled back and handed the wheel to Carl. "You're going to take a picture from the doorway, Professor?" she asked in some concern. Her fingers began playing with the gas chamber controls.

"Well, from this instead, I think," Erlenwanger said. He lifted a ladder of ropes and wooden battens from the locker and fastened the ends to staples set in

the floor for that purpose. Then he slid the door open and tossed the ladder out to twist and dangle, blown sternward despite their present slow speed. "I think I will need the greater field of view, since the bear may have its own notions about being photographed. And—well, this keeps *The Enterprise* herself a little further from the ground in case something . . . untoward happens." His tongue touched his lips. Molly, keeping a close watch on the terrain which they now had approached so closely, blinked but said nothing.

The Professor fitted the strap of the bulky camera over his left shoulder. He looked down at the dangling ladder. "Well . . .," he said, and paused. He turned and opened a drawer beneath the engine control panel which Carl had not noticed before. From it he took an angular handgun. He stuck the weapon into his hip pocket where the tails of his tweed coat hid it. "Well," he repeated, and he began to climb carefully down the ladder.

They were barely moving forward now. The bear was a hundred feet ahead, ambling between dwarf cedars with an odd, sidelong gait. It looked very large. Molly bit her lip and made an infinitessimal adjustment to a pair of her controls. The airship dipped. Carl thought the girl had overcorrected, but they recovered and stabilized with the ground just twenty feet below them as the Professor had directed. Carl eased on a little more throttle and started his final approach.

The only sound *The Enterprise* made was the minute whistle of the air curling around it, and that was lost in the rustle of the trees. When their sharp-edged shadow fell across the grizzly, however, the brute paused and turned with its snout raised. Erlenwanger was steadying himself with his arms through the loop of the ladder as if it were the sling of a rifle. His camera was ready. The bear coughed and charged without hesitation.

Carl's heart leaped as he saw through the port in the gondola floor that the grizzly was rearing onto its hind legs. The beast slashed the air with its claws, black and worn by use to chisel edges instead of points. The gondola lurched as the Professor jerked his knees up to his chest, supporting his whole weight on his arms. Then they were safely past. Carl turned to call something to Erlenwanger, and five thousand feet above them a cloud passed before the sun. The hydrogen cooled and shrank. The airship lost buoyancy almost as suddenly as if Carl had dumped a tank. *The Enterprise* dropped ten feet to a new equilibrium. The end of the rope ladder clattered on the ground. The gondola itself was well within the range of claws that could rip open trees to get at the honey within.

The grizzly coughed again and charged, as quickly as a cat sighting prey. Professor Erlenwanger had pulled his torso into the gondola. Carl leaped from the controls to drag him the rest of the way to safety. The older man, gripping the jamb with his left hand, drew his pistol. The shots rattled like a dozen lathes cracking, sharp but overwhelmed by the blasts of the bullets themselves bursting on the ground beneath. Shards of rock sang off the underside of the gondola. One bit hummed through the doorway to sting Carl's outstretched hand. The snarl deep in the bear's throat *whuffed!* out instead as a startled bleat. The Professor laid his pistol on the gondola floor. "Now, Carl," he gasped. "If you would."

Carl grasped the older man under both armpits and hefted him aboard. Molly had slammed all her levers upward when she realized what was happening. The airship was soaring and already near its normal cruising altitude. Beneath them the grizzly sat back on its haunches, washing its face with both paws.

Professor Erlenwanger unstrapped his camera and slid the door shut. He was breathing heavily. Carl had

returned to the helm but kept only steerage way, uncertain of what the Professor would want to do. Molly had leveled them off at a thousand feet again. She was beginning to regain some of her normal color. "I think we can resume course," Erlenwanger said at last. He picked up the little handgun and extracted the magazine from its grip.

"You shot the bear?" Carl asked, watching the older man. He was thumbing brass cartridges into the magazine from a box that had shared the drawer with the pistol.

Professor Erlenwanger looked up sharply. "I fired into the ground in front of the bear," he said. "That was sufficient." He slid the reloaded magazine back into the butt of the pistol, his lips silently working as he considered whether or not to continue. "I dare say it is sometimes necessary to kill," he said finally. "In order to stay alive, or sometimes for better reasons. But it isn't a decision to be taken lightly or as anything but a last resort."

Erlenwanger shook his head as if to clear it of his present mood. He set the weapon and the box of ammunition back into the drawer and closed it. Smiling he added, "It's an automatic pocket pistol of European manufacture. And I suppose you're familiar with the use of explosive bullets in hunting dangerous game?"

Carl nodded. "I've heard of that."

"Well," the Professor said, "I had a—Belgian gunsmith of great ability make up some explosive rounds for the pistol. On stony soil they produced quite a startling effect, don't you think?"

Molly took a deep, thankful breath. "More to the point," she said, "the bear thought it was startling."

"Goodness," said the Professor, noticing that his wireless apparatus still sat out on the ledge, "I'd best complete my report, hadn't I? Especially now that I've had a real adventure!" Chuckling, he sat down at

the key again as the airship swept steadily westward through the calm air.

Professor Erlenwanger looked at the altimeter, frowned, and glanced over at Molly's bank of controls. They were all uncomfortably close to the top. Despite that *The Enterprise* was within five hundred feet of the ground. The dry snow blew like fog around the trunks of the conifers marching up the slopes. "Between the thin air at this altitude and the film of ice we're gathering," the Professor said, "we need maximum lift. And I'm afraid that there's enough condensate in several of the chambers that we aren't getting the lift we should be."

Carl frowned back. "Are we in danger?" he asked, carefully controlling his voice. He did not want to sound as though he were on the edge of panic—but five hundred feet was a long way to fall, and the ground beneath looked as hard as a millstone.

"Oh, goodness," the Professor said, blinking in concern at the impression he had given. "Oh, not at all. I just propose to land in a suitable location—I'm sure there must be one." He squinted through the forward windows. The cabin heat kept the center of each pane clear. The edges, where the aluminum frames conveyed the warmth to the outside more swiftly, were blind with frost. "I'll vent and dry Tanks Three and Seven—they seem to be the wettest—and recharge them. It may not be the most attractive country on which to set down, but I think I can promise you that we will do so gently."

"There's a clear hill over there," Molly said, pointing so that her finger left a smudge on the glass. "But you'll need water to refill the tanks, won't you?"

"Oh, that's quite all right," Erlenwanger explained, already swinging the helm. "We can melt the snow for electrolysis, and goodness knows there's enough snow. See if you can bring us down just a little

above the tallest trees, my dear."

Despite the gusty winds and the lack of anyone on the ground to set their grapnel for them, Professor Erlenwanger brought them to the smooth landing he had promised. Twigs, poking through the crust of snow which had come early even for the mountains, snapped beneath the weight of *The Enterprise.* "Well," said the Professor, "I think the first order of business is to clear the chambers, don't you?" He gripped one of the vent levers and tried to slide it to the side. It did not move. All three people looked momentarily blank. "Of course," Erlenwanger said, "the ice! The valve mechanism must be frozen shut."

"Something we can fix?" asked Carl, frowning again but without the immediate concern that the prospect of crashing into the ground had raised in him.

"Well, yes," agreed the older man, "but it means climbing up to chip the valve loose, and I'm afraid it's really too near dusk to do that now. I had hoped to have the chambers refilling overnight."

Carl shrugged. "No problem," he said. "I'll take a lantern up with me and do it now."

Erlenwanger frowned. Then he, too, shrugged and said, "Well, that's all right, I suppose. But don't even think of getting above any other airship with an open flame. Blocking the percolation of hydrogen through the very atoms of the skin was perhaps the greatest of the advances incorporated into *The Enterprise*—" his grin flashed—"though it isn't one I would expect an investigator of the present time to note."

Carl drew on the sheepskin jacket and cowhide work gloves the Professor had bought him at a rail siding the night before. Molly handed him the kerosine lamp she had just lighted. It whispered deep in its throat, and the yellow glow it cast was friendlier and more human than that of the chilly electrical elements. Carl stepped outside, bracing himself

against the expected eddy of wind-blown snow. The lantern rocked in his hand but did not go out. He slammed the door and began to climb the open ladder just astern of it, up the side of the gas compartment. There was a slick of ice crackling on the rungs, and the lamp in his left hand made climbing harder; but Carl had carried shingles to the roof of the barn in a drizzle, and this was nothing beyond his capacity.

The snow and the twilight made the evening seem bright, but the vents were deep in a shadowed recess. A catwalk ran along the airship's spine. Without the lantern the trip would have been vain, though the yellow light paled everywhere but where it was needed. Carl set the lamp down on the walk and rapped the valve with the bolster of his clasp knife. He took the glove off his left hand and opened the blade to scrape the joints in the brass.

Movement at the woodline caught the corner of Carl's eye. A pair of steers bolted into the open. One had horns which had been cropped to stumps shorter than its ears. Carl stared, squinting into the failing light. "Professor!" he called, just as the light on the gondola's prow spread its broad fan down the hillside. The floodlight glared red from the eyes of the cattle and the three horses following them. The nearest of the three riders was wrapped in a dark-colored blanket. Even his hands, gripping a long-barreled rifle across the saddle-bow, were hidden. Trotting his pinto just behind the first rider was a second whose straight black hair fell to his shoulders. A youthful whoop died in his throat at the blaze of light. His left arm, upraised with an unstrung bow, jerked down as his right hand sawed the pinto's reins back.

The third Indian was far the oldest, though his twin braids were still so black as to give the lie to a face wrinkled like walnut burl. He wore a buffalo robe—as old, perhaps, as he was—pinned at the shoulder but

open down the front to display a buckskin shirt. The old cap-and-ball revolver thrust through his waistband was nickeled. It sparkled like a faceted mirror in the instant before the rider slid it out and down into the shadow of his horse's neck.

The gondola door rumbled open, thumping against its stop. Carl peered over the side. The curve of the buoyancy chamber hid the Professor until the older man stepped out in front of his floodlight. His shadow flashed suddenly toward the Indians. Its outline was mishappen with the angles of camera and tripod.

"Professor!" Carl called, "Those aren't reservation cows!" If the older man heard Carl, he did not understand. He continued to walk downhill toward the Indians, calling to them in a language unfamiliar to Carl. Carl swung down the ladder, leaving skin from the palm of his left hand frozen to the top rung. He was muttering an unconscious prayer.

The steers had shied from the light, disappearing again into the trees. The eldest of the riders spoke. The rifleman swung his weapon clear of the blanket. The knob of its bolt handle, polished by decades of wear, winked. As Carl jumped into the gondola, a trick of the breeze brought Erlenwanger's words up the hill: "Why, my goodness, a Dreyse needle gun here!"

"Where's the lantern!" Molly cried.

"Jesus Christ, I left it!" Carl shouted, slamming open the pistol drawer. The cartridge box flew out, spilling the deadly brass to roll in a shifting pattern on the floor. Carl leaned out the doorway, leveling the unfamiliar pistol.

Molly vented Tank Three. The hydrogen bathed the lantern and ignited in a blue glare spraying a hundred feet in the air. The pinto reared, spilling its young rider. The rifle muzzle wavered from Erlenwanger to the airship, then back into the woods as the leading rider wheeled his mount. Molly opened Tank

Seven. The eldest Indian fought his horse for an instant, the flare from his revolver no harsher than that of his eyes. Then he gave the beast its head to gallop into the forest, followed by the pinto and the third of the cattle thieves. That last Indian was holding the pinto's reins with both hands and running along beside it. A steer bawled from a distance. Then the night was silent again, leaving the Professor poised awkwardly in the light of his own airship.

Erlenwanger turned and began trudging up the hill. Molly cut the floodlight. Carl lowered the pistol which he had not fired. It apparently had a safety catch somewhere, like a hammerless shotgun. His left palm was burning and he noticed the blood for the first time.

Professor Erlenwanger slid the door shut behind him and set down his camera carefully. "One can get carried away and make mistakes," he said softly. "They were doing something illegal; and of course we frightened them." He looked from Carl to Molly and back again. "When one does something foolish, as I just did, it's important that one have friends with better sense and quick minds. Thank you both, for my life and for much more."

Carl set the pistol down to take and squeeze one of the hands the older man stretched to both of them.

"Less than fifty years old," the Professor said, apparently to himself, "and look at it even now."

Molly leaned forward for a better look. She had stared down on Boston, however, and the skeletal mass of lights in the pre-dawn did not impress her. Carl had never seen anything like San Francisco in his life. "Oh, if Dad could only be here," he said. "He wouldn't brag on his trip to Kansas City ever again."

"You can follow the veins of the city out beyond the lighted heart," Professor Erlenwanger said. "Every one of those blue sparks is the collector arm of a

trolley, bringing the late shifts home, carrying the earliest workers in to their jobs. Some times I think that cities live too, and that one day they will send travellers back in time to record their own births."

The airship had met a mass of cold air over the bay and dropped to about five hundred feet. Molly started to nudge a pair of levers up, but the Professor's hand stayed her. "No," he said. "I'm going to land here."

"Are we staying in San Francisco?" asked Carl, a little surprised because of the Professor's previous avoidance of populous areas. But after all, they were on the West Coast, now; there was nowhere further to go.

The Professor cocked the helm slightly, searching the terrain below so that he did not have to look at his companions. The sky beyond the hills was metallically lighter. "I'm going to land you here and go on," he said. "I've enjoyed your company more than I can tell you; but it is time for me to leave. I am not—" he swallowed—" simply abandoning you; I will leave you with five hundred dollars in gold pieces—"

"Professor, *no*!" Molly cried, her hand shooting out to touch but not grip his elbow. "We didn't come with you for the money—but don't leave us!"

Erlenwanger's fingers squeezed the girl's hand to his tweed sleeve briefly, then detached it. "You didn't come with me to save my life, either; but you saved it," he said firmly. "The money is something for which I have no further use anyway." He touched his lips with his tongue. "Please believe me when I say that you cannot accompany me further. It is not something I say lightly. We will meet again, I promise; though that lies still in the future."

Very quietly, Carl said, "I'm not going back to the farm. Not now."

"Bring us down to one hundred feet, please, Molly," Professor Erlenwanger said. He half-turned from the view forward. "You needn't go back, you

know," he said. "Kummel and Son, the meat canners on Market Street, will have openings for a stock clerk and a receptionist this morning."

Carl frowned. "I'm not a stock clerk," he said.

The Professor shook his head abruptly. "You're a strong young man who has worked with cattle all his life. You're bright and you're honest—and you will remind Mr. Kummel of his only son, who died last week of influenza." Erlenwanger tongued his lips again. "Kummel's is a very small firm now—only a few years ago it was a butcher shop. But if gold should be discovered on the coasts of Alaska and Canada, the inevitable rush will be supplied from San Francisco. A firm with a solid reputation will be able to expand greatly; and employees who have been trustworthy in small things . . . will be entrusted with great ones. You may live to endow your grandson's education at . . . the California Institute of Technology, for instance."

Erlenwanger trimmed his prop pitch fine. "Set us down gently, now," he said as the landing legs squealed and extended. Molly was blinking back tears, but her fingers worked the controls with practiced delicacy. The spotlight of *The Enterprise* stabbed narrowly, then flooded a barren area at a touch of the Professor's wrist. Gas standards reached up forelornly, installed but unlighted along a three-block line of vacant lots. The older man coarsened the prop to give him a touch more helm and bring the airship's nose around. Carl swallowed and slid the door open. "I don't think we will need the grapnel," Erlenwanger said. They were barely moving forward, sinking as slowly as bodies in a still, cold lake. A moment before they touched, Molly eased back on a lever. The nose tilted up minusculey and the rear landing leg cut the rank grass before the front did. They were down with less jolt that a man got stepping out of bed.

The Professor opened the sleeping compartment and handed out the two small suitcases that were all Carl's and Molly's possessions. They took them silently, Molly holding the grip with both hands and her lower lip with her teeth. Even the cases had been the Professor's gift. Erlenwanger slipped a heavy purse into the side of the girl's coat. He kissed her very gently on the cheek, just forward of her ear. "There'll be a trolley in two minutes," he said without pulling his watch from his vest pocket. "One thing," he added. "There is both good and bad in every life, every age. But always remember what—relatives of mine told me when I was very young: you must never give up on Mankind. Because Mankind never quite gives up on itself." He shook Carl's hand and turned him to the open door.

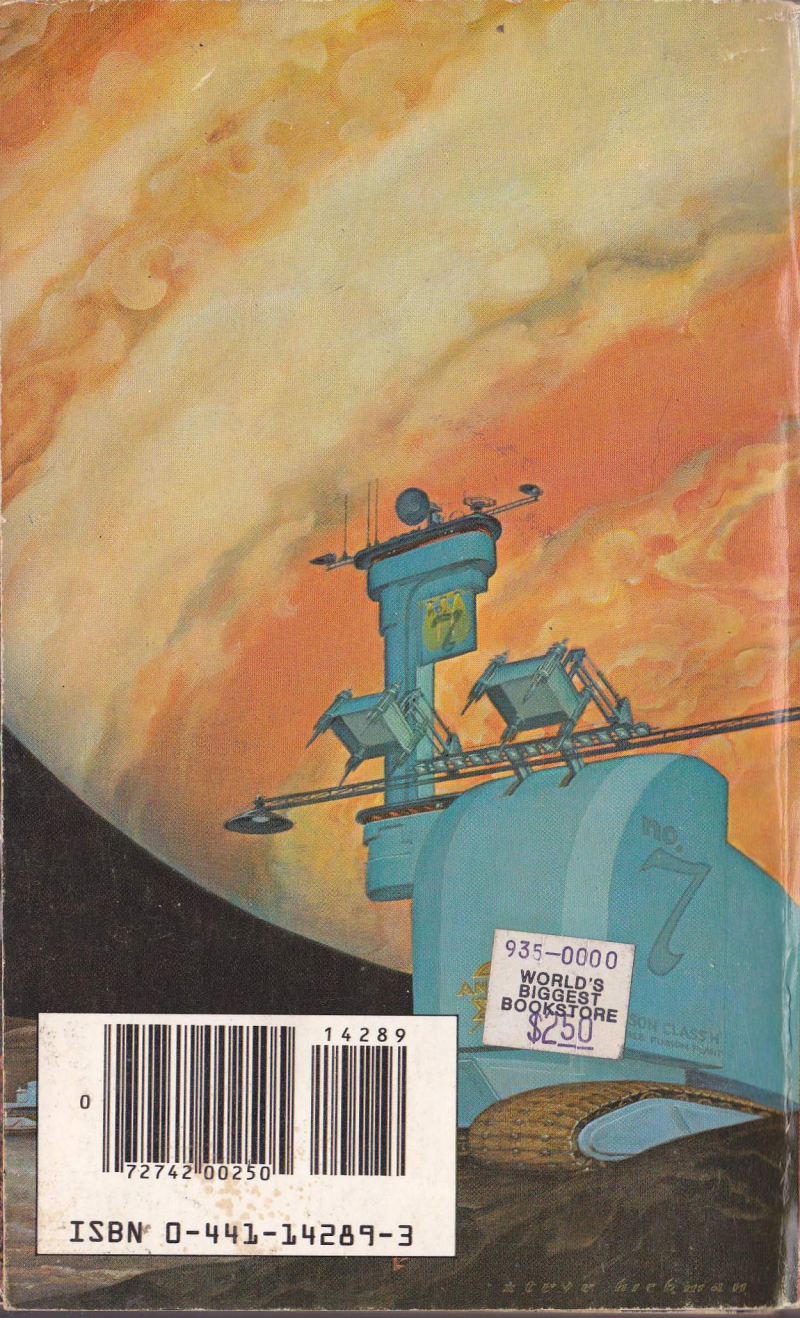
Carl stepped down. Molly followed, her head bent over. Neither of them spoke. From the gondola behind them they heard the Professor call, "Goodby, Pops. Goodby, Mama Gudeint. I'm proud to have known you."

Air billowed sluggishly as *The Enterprise* rose. Carl and Molly raised their faces to watch the airship. The great cylinder was climbing very swiftly on an even keel. A few hundred feet up it caught the sunrise over the hills and blazed like a plowshare in God's forge. The suitcases were forgotten on the ground. Molly's fingers squeezed Carl's in fear. "What's happening to it?" she demanded.

The blur of light was higher, now, and farther west, but it was growing fainter more quickly than it rose. It seemed to merge with the sky or something beyond the sky. Carl licked his lips. "Goodby," he whispered. He squeezed Molly's hand in return.

Still staring at the empty sky, he said, "It's all right. Wherever he's going, he'll get there. And so will we . . . and it'll be all right."

—David Drake



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