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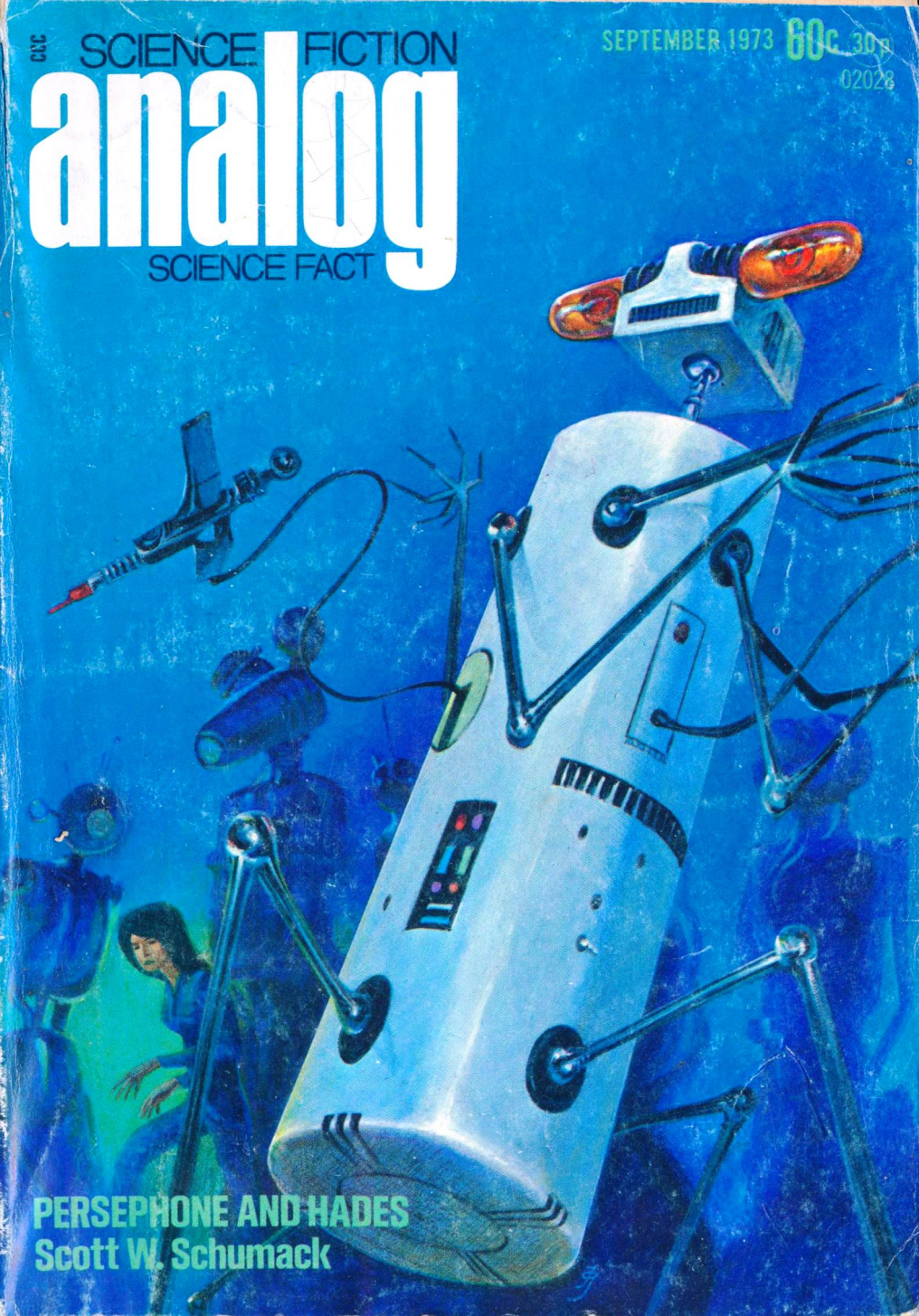

PERSEPHONE AND HADES
Scott W. Schumack

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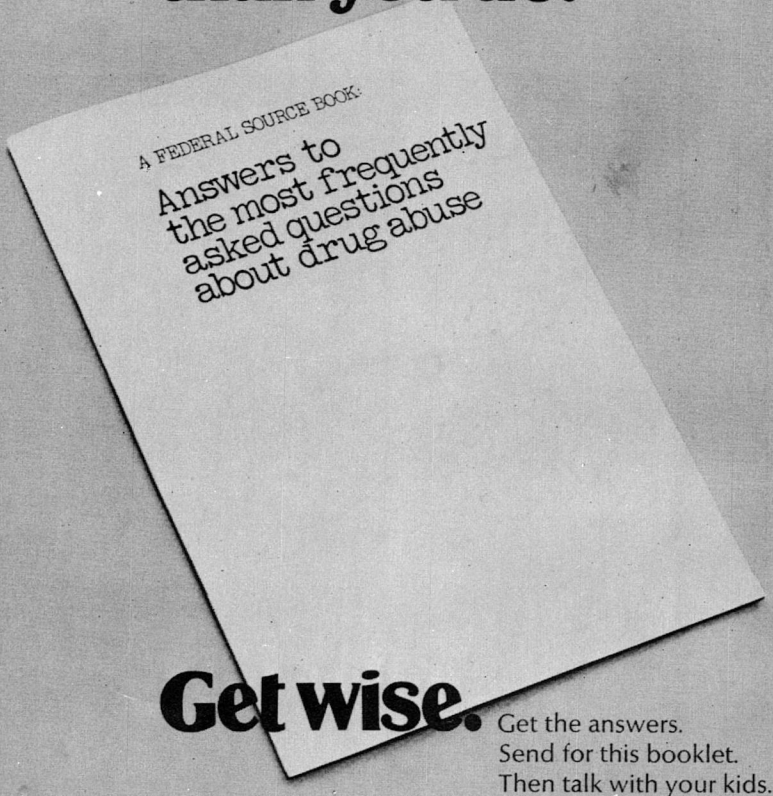

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Next Issue On Sale September 11, 1973
$6.00 per year in the U.S.A.
60 cents per copy
Cover by Jack Gaughan

Vol. XCII, No. 1 / SEPTEMBER 1973

Editorial and Advertising offices: 420 Lexington Avenue, New York, N. Y. 10017

Subscriptions: Analog Science Fiction/Science Fact, Box 5205, Boulder Colorado 80302

There's an old catch phrase about some things being "as clear as the nose on your face." But most people can't see their own noses, unless they make a special effort to do so.

Nothing can be clearer than the fact that our society must change, in many ways. And the changes must be made quickly, if we're to avoid a worldwide collapse of civilization. But most people—including those in high places—are resisting any major changes. Especially those in high places, for they have the most to risk by assisting these changes to come about. Corporation presidents, Congressmen, high officials in government and industry, many of them seem to be having a very difficult time locating their own noses.

There's nothing quite so obvious to most Americans today as the energy crisis. Already there have been electrical power blackouts in most parts of the nation. Here in New York, blackouts and brownouts are part of the summer's festivities in Fun City. Gasoline prices are spiraling upward, as shortages in oil and its by-products manifest themselves. The oil industry is saying, on the one hand, that prices at the gas pump this summer will be around sixty cents per gallon—or higher. On the other hand, they're hinting broadly that if they could build the pipeline from Alaska's north slope oil fields down to the

Pacific Ocean ports of southern Alaska, we'd all have cheaper and more abundant oil.

Is the energy crisis merely a political hassle between the big, bad corporations and the "eco-freaks"? In part, yes. The Alaska pipeline situation might go down in history as a classic example of power politics, on both sides. There's no reason why a pipeline can't be put through in such a way that the local ecology won't be badly damaged. There's no way that a pipeline can be put through without any damage to the ecology whatsoever. And until that pipeline is finished, the oil companies seem to be saying, we're going to have to pay higher prices for oil.

Meanwhile, there are scientists and engineers roaming the country, trying to get people to listen to their ideas on solving the energy crisis. For although part of the crisis is a political confrontation, there is a deeper and more dangerous reality behind the politics: we *are* depleting the world's resources at a gluttonous rate. The end of our oil and natural gas stores are in sight. Not merely for the United States, but for the entire world.

There are many ways around this problem, and most of them involve new and virtually untested technology.

The Atomic Energy Commission is pushing for the Fast Breeder Reactor: a nuclear fission system that takes in low-grade uranium or thorium as fuel, and produces not only electrical power, but enriched uranium or plutonium, for fueling other fission reactors. Frankly, Robert A. Heinlein had the best idea about breeder reactors, back in the 1940's: put 'em in orbit. Then if they blow, as they could, all we lose is the reactor system itself.

Plasma physicists around the world are tremblingly close to producing a sustained thermonuclear fusion reaction, after more than a quarter-century of research. The new director for fusion programs of the AEC has set a goal of demonstrating a practical and sustained fusion reaction by the mid-1980's. That means that working fusion power plants could begin to go on the line by the end of the century. If this happens, the energy crisis is beaten for all time.

But can we wait until the end of the century?

As the science article in this month's issue shows, there's a more immediate answer to the energy crisis. It also involves using hydrogen. But in the so-called "Hydrogen Economy" idea, hydrogen is burned as a chemical fuel. It is used in place of coal, oil, or natural gas. Hydrogen could be used as the fuel for automobiles, for example.

Whenever someone seriously suggests using hydrogen this way, someone else is sure to blanch and

scream, "My God! The *Hindenburg*!"

The *Hindenburg* disaster—in which the hydrogen-filled German zeppelin exploded and burned before a horrified crowd at Lakehurst, New Jersey in 1937—is one of the most spectacular and publicized accidents of all time. A large turnout of press and radio reporters were on hand to watch the docking of the giant dirigible.

A spark of static electricity ignited the craft's highly flammable hydrogen. In an instant, the stately zeppelin was a sheet of flame. Of the ninety-seven people on board the *Hindenburg*, sixty-two survived.

That spectacular disaster has fixed most people's minds firmly, when it comes to discussions of hydrogen as a fuel for anything. They "know" that hydrogen is too dangerous to use, especially as a fuel, and even more especially as a fuel for a vehicle that bears human lives. Most people are surprised to learn that there were *any* survivors of the *Hindenburg* disaster.

They ignore the fact that the Apollo astronauts rode to the Moon on hydrogen-fueled rockets. NASA worked out the problems of handling hydrogen-oxygen rockets, and even solved the added problems of handling both the O_2 and H_2 as cryogenic liquids—frozen down to temperatures of 90.1 and 20.4 degrees Kelvin, respectively. (That's –297.3 and –423.0 degrees Fahrenheit.)

The people who want to use hydrogen as a fuel have bumped their heads against the *Hindenburg* syndrome time and again. The mental picture of that exploding dirigible effectively ends most discussions before they really get started.

So they have formed *The H_2indenburg Society,* in an effort to confront the problem squarely. The society has no real structure, there are no dues, no newsletters, no meetings. The only requirement is that the members honestly feel that hydrogen might be a significant part of the answer to the energy crisis—so the members will face up to the frozen-minded attitudes of the heathen and attempt to get

them past the emotional block that has stoppered their thinking when it comes to hydrogen as a fuel.

The hardest thing in the world is to change a person's mind. Yet many minds must be changed, a whole world society's joint mind must be changed, if we are to avert a *real* energy crisis in the next few years.

As Bill Escher's article on page 28 shows, hydrogen has much to recommend itself as a fuel. Mainly, it is clean, cheap and abundant. Its recycling time is ludicrously short, compared to the hundreds of millions of years it takes to turn the exhaust products of hydrocarbon flames back into coal, oil, or natural gas.

It *is* dangerous. Hydrogen ignites much more easily than gasoline. And if we are to go into a "Hydrogen Economy," and use our existing pipeline systems (built to handle natural gas) to pump hydrogen around the country, then we've got to learn how hydrogen affects the metals of those pipelines. There's a lurking problem with hydrogen embrittlement that hasn't been squarely faced as yet; and hydrogen will sneak through pumps and joints to escape into the atmosphere much more readily than natural gas.

But we live in a dangerous world. In my old neighborhood in South Philadelphia, there were more playgrounds created by the house-destroying explosions of leaky gas mains than by the city administration. By at least an order of magnitude. Yet today we pipe natural gas all across the nation with little harm. And we cart poisonous gases such as chlorine and methane through city streets and over the countryside in trucks and trains.

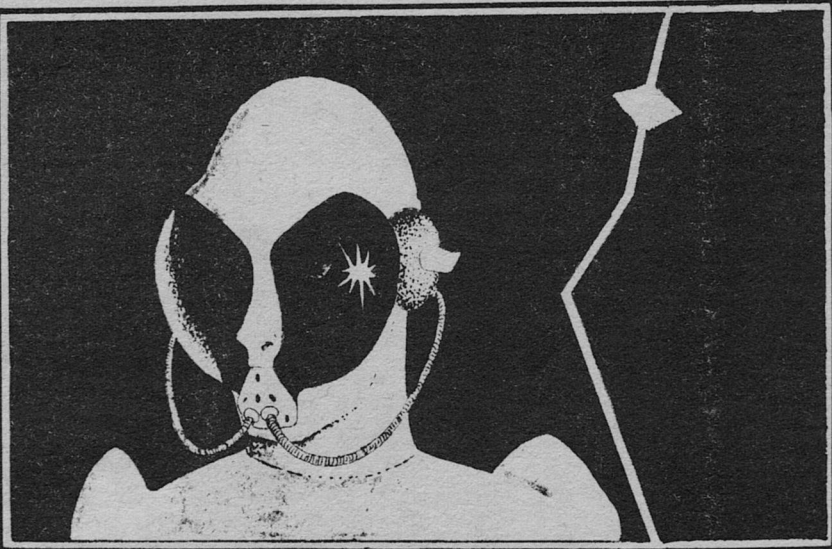
On balance, it would seem that the possible advantages of using hydrogen as a fuel make it imperative that the unsolved questions be examined fully. And quickly. The problems—especially the safety problems—must be resolved. They appear to be solvable.

But who is going to solve them?

The electrical utilities industry seems blithely unaware of the need to spend money to solve the problems of the energy crisis. Until a few years ago, their research budgets were ludicrously low. More recently, they have begun putting up some serious R&D money, mainly channeled through the industry's Edison Electric Institute. But although the research budgets of the utility companies are now much higher than they were a scant five years ago, they are nowhere near high enough to get the job done.

Naturally, when faced with the prospect of risking profits, the utilities industry has turned to the Federal government. Responsibility for research on energy sources and

continued on page 176



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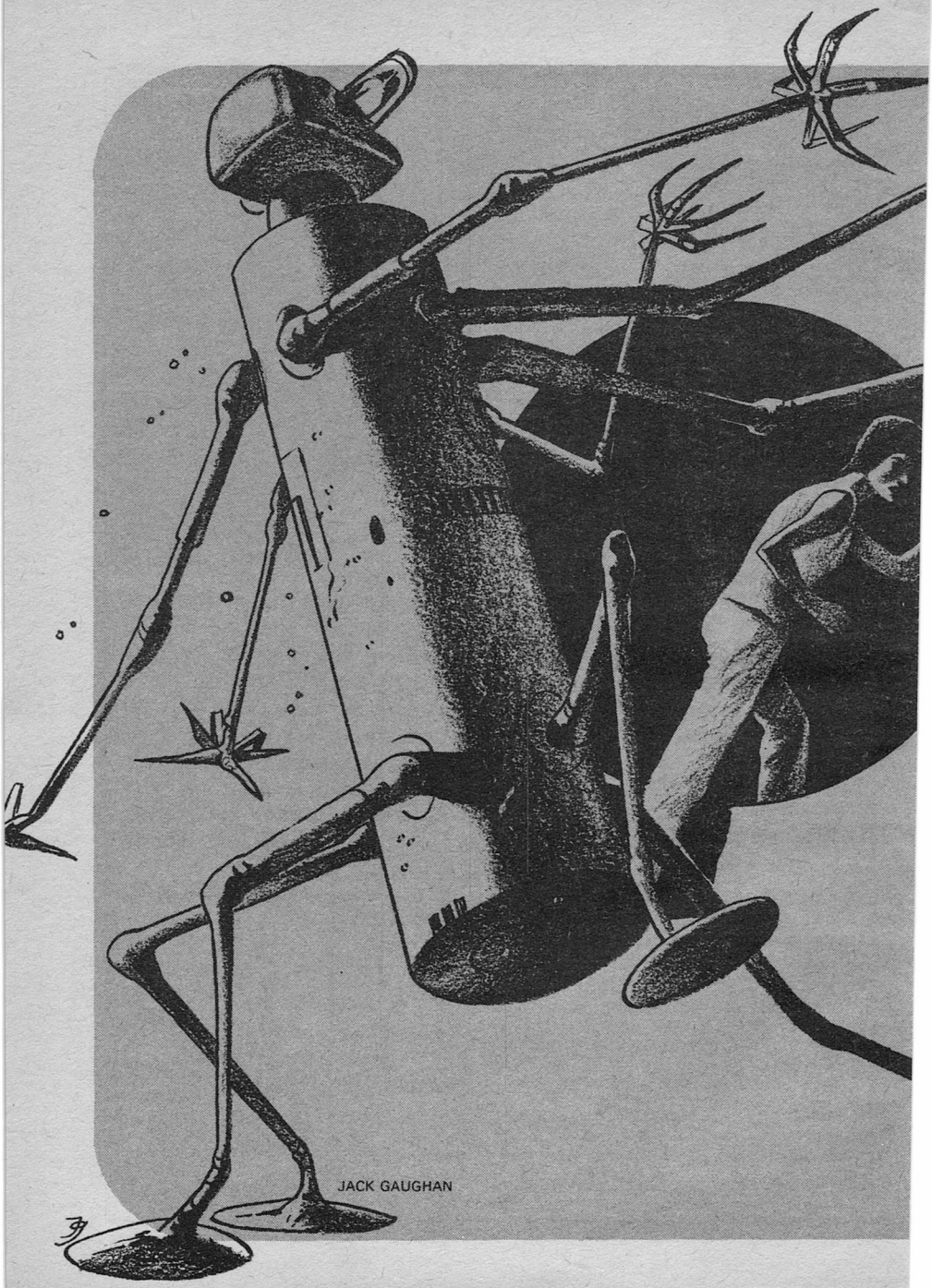
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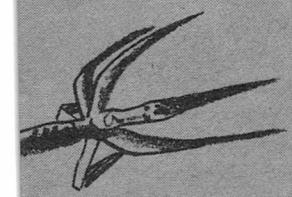
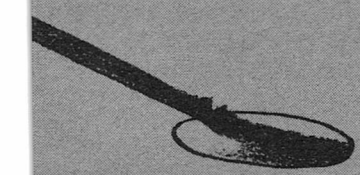


Persephone and Hades

Technology can be used to kill or preserve life. But can it preserve the essential spark of humanity?

Scott W. Schumack



This is the way legends are born.

Twenty-three hours out of twenty-four Carver hunted her. He crept silently through the labyrinthine corridors and artificial caverns of the Necropolis, armed, wary of ambush, and above all, hating her.

Today, a week after her revival and two days after their war had started, he searched the habitation level that had once housed the center's resident staff. An attempt had been made to make this section homey and pleasant with soft colors and potted plants. The dim lighting Carver used in dormant sections mocked the colors, and the war had killed flowers as well as people. So the habitation level was a ghost town of empty living units, cafeterias, and recreation rooms; another might have been chilled by the drifting memories, but Carver had been alone in the Necropolis for two years, and all he feared was failure.

He moved down a corridor, stopping to press a microphone against each door to listen for any sound that might indicate her presence. The first seven held silence, but the eighth, the main lounge, responded with faint clattering and a hint of movement. It might have been a maintenance robot, mindlessly keeping the chamber in order for the humans who would never again use it, but when Carver increased power he heard breathing. There

was only one thing in the Necropolis that breathed.

Controlling himself tightly, he readied his stungun—which was preset to wide beam and high power, and broke the door control beam with one hand. The door dilated, and he rushed into the room, his rubber-soled feet silent on the tiled floor. She had turned up the lights in this room, but his eyes adjusted instantly. He ignored the empty tables and chairs, the dark holovision cube, the small bar, and focused his attention and the gun on her.

The last woman on Earth sat at a long table in the center of the room, eating. "Hello, Bob," she said calmly; she made no move to escape or avoid his line of fire.

"Don't move, Miss Armendez." Carver's voice was cold and flat as he walked to the table.

"How many times have I asked you to call me Carol? Pull up a chair and sit down."

He stood motionless on the other side of the table.

"Oh, that's right," she said. "You can't. Sorry."

Carver looked down on the small dark woman from his two-meter height, and said, "Get up slowly." He scanned the table and found no weapons; the tray, utensils, and water carafe were plastic, and the food didn't interest him.

"You want to dance?" she said as she rose. "I'm sure we could arrange something."

"Be quiet, please." She was wearing dark blue coveralls of cordcloth, but when he ran his metal detector over her he found nothing.

"Can I sit now?" she said as he withdrew the detector. She didn't wait for permission, and Carver almost shot her before he saw her return to the food. He caught himself and put the weapon away; she must be conscious for questioning, and she couldn't escape—much less harm him.

"Miss Armendez—"

"Carol," she said around a spoon of rice.

"Where is the tape?" There was steel in his voice, sharp and hard.

Suddenly she was serious. She put down the spoon, leaned back in the plastic chair, and looked up at him. "You get the tape when I get what I want."

"Miss Armendez, I have told you repeatedly that what you ask is impossible. That tape is vital to the Plan. Tell me willingly, or I will force you to."

She lifted one dark eyebrow. "Drugs?" Her left hand gripped the rim of the tray.

"I have no choice," he said. The table was a meter wide, but Carver's number-three arm was a hundred and fifty centimeters long when fully extended. Unfolded, it swept in a gleaming silver arc toward her right shoulder, a spray hypo in its six-fingered spider-hand. It never reached her.

The instant he finished talking she jumped up from the table, her chair clattered against the wall, and her left hand lifted the tray and threw it at his moving arm; the thin metal limb smashed down onto the plastic tabletop. Her right hand held the water carafe, and as she dived around the end of the table toward the door she threw it at his cylindrical white body.

It bounced off the tight metal framework that supported his six arms and other attachments, spilling clear fluid over his arms and legs. His shoebox head jerked around on its thin, tubular neck to follow her. "You can't escape." His voice rang from the speaker set below his red photocell eyes.

He reared up on his four multijointed legs and shambled after her, reaching with all five remaining arms—number three swung limp—to grab her as the door dilated. After three steps his front two legs went slack, and he collapsed forward to crash on the floor. His number-two arm fumbled at the stunner in its holster on his framework, but he couldn't control his fingers, and the door shut on her slim, running form before he could fire. Hypersonics played uselessly over the door, and then the gun fell from his limp hand.

He tried to rise. His gyros strained, but all he did was knock over a table when one of his legs skidded from under him. Back on the floor with overheated servomotors, he brought his number-one hand up to his sensor-crowned head and saw that his wrist and finger joints were dissolving.

Acid, he thought. His body was sheathed in tough ceramic, and his limbs were corrosion-proof alloy, but the joints of his legs and arms were thin, sensitive, metal cloth. Damning her silently, the last man on Earth began pushing himself to the door with his remaining arms and legs.

The Third World War had lasted for two months of unparalleled carnage. It had destroyed almost all life on Earth, all life on Luna, and nearly every human artifact in the solar system. For weeks afterward Robert Carver had been in contact with one of the few remaining satellites, an unmanned resource surveyor. Through its wide-spectrum sensors he had seen the craters that marked cities, the burning forests, and the scum-covered oceans. He had satisfied himself that, of all man's works, only the North American Suspended Life Storage Center had survived intact, and that, of all men, only he lived.

In the two years he had been alone in the miniature city buried under northern Nevada he had started calling it the Necropolis—the city of death. Once that name would have been inaccurate, for while the fifty thousand humans who had slept in the womb-tombs bathed in liquid nitrogen at sev-

enty-eight degrees Kelvin had been far from life, they had been equally far from death. But the sick who awaited medicine's advance, the criminals exiled to the future, the adventurers waiting for new worlds to evolve, all had died permanently with the rest of humanity when the center's master computer had been driven temporarily insane by the electronic scrambler bomb smuggled in during the war.

The sleepers had died without even thawing when the tormented brain had ordered mass crash revival without the proper safeguards. The center's resident staff had died when another bomb had released nerve gas into the ventilators; the computer failure had paralyzed the filtration system.

The sole survivor was Dr. Robert Wayne Carver, research director, cyborg ATS-495, who hadn't breathed in five years, and whose only irreplaceable parts, his brain and spinal column, were encased in an almost indestructible ceramic sphere just over his nuclear "heart." Carver had managed to "lobotomize" the maddened brain, but only after it had done great damage to the center. He'd spent the next two years making repairs and plans—making *the* Plan. Considering the end of the world had taken place, things were going quite well, or so he had told himself before the arrival of Carol Armendez.

Things had gone properly the first five days after her coming; Carver had installed her in the habitation level, fielded her ridiculous questions, and done his best to ignore her.

At the end of the fifth day he returned to the cell banks, after making repairs to the secondary fusion plant, to find his only tape for the sperm revitalization sequence missing. After almost tearing apart the section looking for it, he remembered that he wasn't alone, and immediately he realized that she had taken it, probably out of jealousy of what he'd told her of his dream—the Plan.

She failed to answer the intercom in her room, and he'd been about to go to the control center, to use the complex's security system to locate her, when *his* intercom started to buzz.

Her brown face was cool and calm in the thirty-centimeter screen, and her short-clipped black hair went well with the dark maroon blouse she wore, but Carver didn't notice. "Miss Armendez, where is that tape?"

"Calm down, Bob," she said. "It's in a safe place where you'll never find it. Let's talk business."

His artificial voice almost cracked. "Business! That tape is vital to the future of humanity, and I must have it back immediately. Are you insane?"

"Is it insane to want to live?"

"Are you bringing *that* up

again?" As he spoke, Carver's mind raced; the wall behind her was painted dark green—that meant she was on the cell bank level. The door he could see at the edge of the screen bore the number "73." That meant she was only a five-minute walk away. "I don't have to listen to this," he said, and shut off the intercom. She called back immediately, as he had hoped, and he accepted the call. This time he kept visual transmission from his end turned off.

"Don't I get to see your lovely red eyes? No matter. As I was about to say: you are responsible for my situation, so is it too much to ask that you help me?"

As she spoke Carver took a miniature radio transceiver from his equipment pouch and attached it to his intercom panel. Using the transceiver as a relay they could continue talking while he moved anywhere on the level, and she would never know that he had left the cell bank.

Trying to keep the triumph from his voice, he said, "I am trying to make allowances for your condition—that's why I decided to talk to you, but we've been over this before." As he left the cell bank he broke out a spray hypo of tranquilizer and activated his personal transmitter. "I've told you before: I had no idea that any of the new, self-contained freezer capsules had been put into service before the war, so I couldn't have known that one capsule did survive the computer failure." He moved down the tunnel toward her, careful to be quiet.

"When I put the revival program through the computer I didn't know there were any sleepers left to revive. I was merely using it as an exercise to test the circuitry I had repaired." He had to keep her at the intercom, and lull her into carelessness.

"Nevertheless, you did revive me," she replied. "You doomed me." It was a statement of fact, not bitterness.

"There was no one more surprised than I when the computer informed me that the last sleeper had been revived successfully, and was waiting for me in the hospital section. If I had known about you, Miss Armendez, I never would have revived you." There were only a few more meters and a few corners between them.

"I'll take that as a sign of consideration." Her voice was slightly tinny over his receiver. "But I still expect you to help me stay alive."

"That I cannot do." He stopped; she would be just around the next corner, still talking into the intercom wall panel, never suspecting that he was so close. "I've seen your file, Miss Armendez. Your biochemistry makes you highly susceptible to cancer viruses; within the next five years it is likely that you will develop a serious—a lethal—cancer. Nothing less than a

brain transplant to a new body could save you, and that's impossible." He checked the hypo and tensed his leg springs for the leap around the corner that would bring him to her.

"You can't be refrozen; no human has ever survived it a second time, and I can't cure you. I would have been willing to let you live here in comfort. I'd have even let you use the robosurgeon in the cell bank to ease your pain when the time came. But no—" He prepared to jump. "You had to get in the way of the Plan. You had to fight me."

"Yes, I did."

He jumped like a white-bodied hunting spider, silver arms spread wide to grab her or block her escape, and his number-five arm ready to slam home the hypo like a boxer's hook. He saw the corridor clearly in the split second he hung in mid-air; the long green hall dwindling into darkness; the door to Laboratory 73, still firmly locked; the intercom panel, dark and unused; but there was no sign of Carol Armendez.

"Where are you?" he shouted over radio and audio systems as he landed. The corridor echoed to the sound. She couldn't have switched to another intercom without his noticing.

"I'm with your precious tape, Bob. You'll find both of us when you're ready to help me."

"I wouldn't save you even if I could." He strode to the door and opened it, glanced inside at the dark laboratory, and moved to the next one. "You are an inferior specimen of low intelligence; I knew when I read your file, and this stupidity confirms it. Do you actually think you can defy me and stand in the way of human destiny?" He scanned the rest of the corridor with his infrared sensors, but there was no trace of her.

"Yes," she said quietly, and broke the connection.

Carver went to the conveyor terminal at the end of the passage and programmed a pod to take him up to the main control room. As the pod accelerated through the vacuum tube on its magnetized tracks he brooded over what had happened.

The girl was a fool to think she could escape him with brave talk and tricks; physically and mentally he was her superior, and he had the resources of the Necropolis behind him. It had been a mistake to try to capture her alone, for there were millions of hiding places in the center, and, he admitted, she had an animal cunning. From the control center it would be a moment's work with the security system's infrared trackers to find her, and another to have the small army of robot tenders hunt her down using the drone control. An injection of truth serum and she'd tell where the tape was. Then he'd dispose of

her—painlessly of course—to avoid future trouble, and then the Plan would go on.

The first thing he noticed when he entered the control center was that it had been destroyed. Display screens had been shattered into plastic shards, control banks torn out of shape, and delicate circuitry scattered across the floor. Evidently there had been an explosion.

It had to have been her, but that was impossible. The door was set to allow only Carver and the maintenance robots entrance; she couldn't even program a conveyor pod to take her here.

He strode through the wreckage and kicked a useless memory core. The control room had been makeshift since the war; it would take months to repair it, and who knew what she might do in the meantime? The Necropolis itself wasn't harmed, for the partially restored master computer would keep the complex in order, and the robots would continue their maintenance cycles. What was gone was Carver's ability to master all the Necropolis' powers.

His hopes of an easy capture dissolved. In the hour since he'd discovered the theft of the tape she had deposed him as king of the Necropolis, made a fool of him, and reduced him to her level, for without the controls to reprogram the robots, he was as alone as she.

Worst of all, she was holding up the Plan, and all because she wouldn't die quietly. With shock he realized that he was starting to hate her; how long had it been since he had hated anything?

His dimly glowing photocells wandered across the room, and there, in the ruins of his power, he resolved to hunt her down, tear the tape out of her, and kill her.

He had been hunting her ever since.

After he dragged himself to the storage levels and repaired his damages from the center's vast store of spare parts, Carver returned to the cell banks. He had made his headquarters there both because the control center was useless and because that section was vital to the Plan.

In its freezers were stored billions of sperm and ova, not just human, but from almost every animal species that had existed before the war. In addition to these there were plant cells suitable for cloning or hydroponic growth. The section's laboratories were equipped for exogenetic, or "test tube," birth; given time and labor this one complex might be able to reseed all Earth with human, animal, and plant life.

The Plan: he would wait until the surface was again fit for life; it would take perhaps a hundred years or more for the radioactive dust scattered around the world to decay, for the tormented atmosphere to calm, and for the unbal-

anced crust to cease its roiling. Then, after a century of plans and preparations, the return of life on Earth would begin.

Without parents, the first generation of the new human race would know no mentor but Robert Carver. The rebuilding of Earth would be a great task; discipline would be needed, strong leadership, and superhuman will and intelligence. Carver knew only he could supply these things. He was virtually immortal and indestructible; his atomic energy cell could be recharged indefinitely from the center's fusion reactor, and in the chemically controlled environment of the life-support sphere his brain was ageless.

He would be the father of mankind, the guide, the oracle, and (who could say?) perhaps ultimately the god. Generation after generation would know no stable element but him. He would return life to Earth and mankind to greatness. Nothing could stop the Carver Plan, least of all Carol Armendez.

There was a call waiting for him on the intercom in the cell bank control room when he entered. The flashing light on the communications board infuriated him, and he almost broke the switch in activating the screen. "What the hell do you want?" he said as her head and shoulders faded into view. The wall behind her was unfinished black stone—the new tunnels? he wondered vaguely.

"Good heavens, don't blow a fuse! I just wanted to see if you were all right; after all, we need each other." Her manner was the same flippant carelessness he had come to know and abhor.

He longed to smash the screen with a metal hand, but he kept on talking; he had known no such rage in years, and he had to release it. "Miss Armendez, I assure you that I need no one less. I wouldn't spare you if you gave me that tape."

"Really? Why not?"

He almost started quivering. "Because you are inferior, unproductive, degenerate, consigned to death, and a deterrent to my plans."

She became serious, pursed her lips soberly, and said, "I'll grant you part of that—the 'death' business. I'm living on borrowed time, which is why I'm spending it this way.

"But the rest!" She smiled again. "Raw sewage. Mister, for the past two days I've done nothing but walk all over you, and you still insist I'm stupid. What you really mean is I'm a woman, half Mexican-Indian, and not a tin scarecrow like you.

"You know what I think, Bobby? Two years alone in this graveyard with only machines and the fate of mankind on your six shoulders has driven you a little crazy. You're so high on your own omnipotence, omniscience, and omni-whatever

that you can't think straight. Take the glorious Plan for–"

"What about it?" he snapped, angry with himself for becoming interested in her words.

"You said I was deterring it. How?"

"You stole a tape it would take me years to replace, years I need for other tasks. Don't try to deny it."

"I don't, but what's your hurry? You have to wait a century or so for Earth to become inhabitable again. If you were rational you'd spend a month or so repairing the security system and then capture me in a few hours, but you aren't rational; you want that damned tape *now.*

"Those years alone, Bobby, have really fouled you up." She leaned forward so her face grew in the screen. *"You think you are a god.* You can't stand having anything go wrong with your great Plan–if something does you go to pieces."

"Shut up," he said. "Shut up."

"Admit it, Bobby," she said softly. "If you were half the superman you claimed to be when you preached about your glorious vision you'd have me drawn and quartered by now. You've been out of the human race so long you've totally lost sight of the capability of a normal human. You're lucky *I* don't decide to destroy *you."*

"You damned bitch, now I will kill you. I don't need the security system or anything else. Human fate is in my hands, destiny is on my side, and I will triumph."

"Heil!" she said, and cut the connection. The room was filled with Carver's screams of cold rage. He had to pace around the circular control room for several minutes to calm himself, and the prospect of sleep had never seemed less comforting.

He didn't drink, eat, eliminate, or rest, but sleep was still necessary for his sanity. The electronic circuitry that connected his sensors and effectors to his brain could also control his sleep center to induce an hour of dreaming the equivalent of eight hours sleep. He always spent this hour in the cell bank, the one place in the Necropolis he wholly trusted. This time his dreams were all nightmares of one theme: what if she were right?

There was no night or day in the Necropolis, only the cold steady glow of the chemilites, or the brighter shine of neon, but for convenience Carver called his dream hour midnight, and dated each new day from his awakening. On the third day of World War Four he sealed the cell bank behind him and returned to the habitation level to complete his search.

He knew it was unlikely she'd be there after their encounter yesterday, but what was she more likely to do than the unexpected? At least that's what he told himself as he stalked the dim corridors. Now he

carried a laser gun instead of a stunner—he was out for blood. Searching would find the tape later—he wanted *her.*

He didn't find her.

There were plenty of traces, a fantastic quantity of food was missing from the lunchroom, tools were gone from the workshops, and clothing had been taken from the storerooms. Evidently she was preparing for a siege.

The shock came when he searched the room she had occupied for five days after her revival. A pile of audiovisual tapes lay on the table, and when he examined one he found, not the cheap fiction he had expected, but a tome entitled "Thermoactive Properties of Plastic Explosives." There were perhaps two dozen tapes from the center's library, maps of the center, electronics and chemistry texts, and "Basic Principles of Insurgent/Counterinsurgent Warfare."

The worst was hidden beneath her pillow: a manual for the ATS cyborg. Running it through the bedside player he found electronic bookmarks recorded into the text marking the weak points of his body, the neck, the back of the head, the joints . . . for the first time in two years he felt nervous.

Perhaps he had underestimated her; she had been preparing for this conflict from the start. He had to admit the possibility, if only for his own survival. Profoundly disturbed, he left the room, looked up from the blue-tiled floor, and froze.

On the wall opposite him was painted in big black letters, probably from a paint sprayer, the word *"Snooper!"* The paint was still wet. He glanced left and right down the hall with infrared and telescopic lenses, and saw nothing. Slowly his gaze rose to the ventilator grille on the wall above the message and three meters off the floor. In all his hunting he had never examined them, never even considered them, because they were too small for *him.*

He slashed the grille across with the laser, and then played the photonic sword over the shaft for a few minutes on high power until the metal flowed a red slightly brighter than the beam's ruby. Extending arm number six, which had a miniature TV camera tuned to his visual system on its tip, he stood on "tip-toe" and surveyed the vent's interior. It was a molten ruin of pipes and fused, sparking wiring, but there was no burned flesh, and he realized how futile it had been.

The ventilators were a rat's warren; in minutes she could reach any spot in the center without using the conveyors or even registering on a sensor. She could follow him anywhere undetected in a subworld he could never enter.

It was a useful, obvious trick, but he had forgotten it. *How much else have I forgotten?* he wondered.

Now he knew she was right—he had lost touch with humanity. For

all his knowledge, power, and immortality he wasn't a match for a single woman. She could kill him at any moment . . .

Why didn't she? What could she want of him? She knew he couldn't save her from eventual, irrevocable death. "We need each other," she'd said. He couldn't imagine why.

As he rode the conveyor car back to the depths of the Necropolis and the cell bank he recast his thoughts. He still had to capture her, if only for the tape, but it had to be alive; if he pushed her she might change her mind about needing him.

Within him hatred was giving ground to fear, and a germ of respect.

Days became weeks, and still he could not find her. He probed every level of the center, and then probed again. He found many traces of her presence, a room she had slept in, a storeroom she had looted, or a power outlet where she had recharged batteries, but she stayed a step or more ahead of him.

His roamings took him places he had not been in months, and something began to happen to his perception of himself and his environment; he remembered why he had named the center 'the Necropolis'. Without people the complex was a ghost town, an impression heightened by the half-light, and the signs of damage from the war. The Necropolis: what were the giant freezer caverns but open graveyards, their coffins empty and the bodies added to the center's stores of organic matter in sterile necrophagy. The radioactive desert above had more life than this cemetery.

Only the robots moved here, mindlessly following the orders left by dead men. Carver began to see them as walking corpses, ghosts of what the center had once been, caricatures of living things, and, worst of all, some of them resembled him.

Once he caught his reflection in a glass partition in the administration level, and he had been shocked by his insectile inhumanity. What had he become but a steel monster with a dead man's brain pursuing the last woman through the city of death?

He longed to glimpse her, if only to refresh his memory of the human form.

Such morbidity had not bothered him since the war, and he knew why. Over the two years he had had the Plan to occupy him, that and his mastery over the center. Now his work on the Plan was halted, and without the control center he could no longer consider himself an extension of the complex's machinery. He was a small human in an immense empty shell.

He had two new defenses against these feelings. First he intensified his belief in his destiny; perhaps he

had made mistakes—that didn't matter, for he alone had evolved the Plan, and he alone would fulfill it. He alone would save mankind. No amount of doubting, nothing *she* could say, would take that from him. Second were his activities the rest of the day.

Twenty-two hours a day he hunted her, and then he returned to the cell bank for an hour of dreams, and an hour of listening to her. Sometime after the first week she had started calling him over the intercom to talk, and he had listened. At first he told himself it was to trace her movements—she called from a different locale every time, and to argue her into surrender. Gradually he admitted, only to himself, that he simply longed to see and hear another human.

At first she spoke of the future, making suggestions about his plans, and bringing up things he hadn't considered. "Are you sure we're all that's left? You should search the surface, and even if you didn't find anything you could try repairing the computer centers and robot factories up there. You could use the time you have to wait to put the whole planet's resources behind you." He had stopped arguing with her long ago. Now he listened and valued her suggestions. The Plan, however, remained his alone.

One day she began talking about herself. He wanted to turn off the intercom, but, for some unfathomable reason, he didn't. He had known only what was in her memory bank file; she showed him her life, and he wondered how he could have called her inferior.

She had survived twenty-eight years in New York City at the end of the Twentieth Century. She had lived through the hunger riots, the race war, and the temperature inversion of '88. Somehow she had kept her life and her sense of humor in one of the harshest environments in human history, but she asked for no sympathy, only for recognition of her ability to survive with a measure of dignity. Mutely he granted it.

She had gotten an education and training in computer work—monotonous drudgery, but useful—at one of the emerging international business firms, the cosmocorps. At twenty-five, with over half her life gone according to statistics for lower-class Americans, doctors identified her as one of the incurably cancer prone.

For three years she had begged, borrowed, cheated, earned, and stolen the money needed to buy and bribe a berth in the new Life Suspension Center being established by North American Bionics. Frozen, she could await the development of medicine that would cure her before her body began to devour itself.

Her luck held: the center survived the war, her capsule survived the computer failure, and she sur-

vived revival. She would take whatever came next as it came.

(He wanted to ask her what came next; what was she trying to do, and what was she after? But she hadn't given him time.)

She admitted to crimes, to the perversions and vices born of boredom and squalor, but she asked no forgiveness, gave no excuses. She presented her life without comment, and silently he began to admire her.

She asked Carver to talk about himself. He resisted lightly, and gave in when reminded that she had been frozen before his case gained publicity.

Born and raised in one of the new cities that had grown on the West Coast on atomically desalted water, he had never lacked for anything. His parents had been executives at Pacific Northern Fusion Power, and he had received the best education possible, entered the exploding field of biophysics, won a Nobel, made a million, taken a coveted position at North American Bionics, and at the age of twenty-five had developed radiation cancer after a freak laboratory accident.

He had gotten into NAB's government-sponsored cyborg project, and his healthy brain was transplanted to a potentially immortal body. He became a cyborg, a cybernetic organism, a "man-machine." From there he rose to his greatest glory as director of research at the Life Center.

He created the cell banks, humanity's last line of defense. The frozen germ plasm meant that no species need go extinct again, and that human heredity was safe from the mutating influence of drugs and radiation. He had become the most famous of the world's twenty cyborgs: Dr. Robert Wayne Carver, the immortal, the life master, the supreme symbol of man's conquest of life and death. Then came the war.

"Poor child prodigy; no wonder you developed a god complex," she said after he finished. "You're eager to reclaim all that fame and power."

Then he did push a hand through the screen. "Damn you," he whispered. He had suddenly recalled that one of the tapes in her room had been a popular biography of Robert Carver. She had been playing on his ego, and his emotions. He still had emotions, even though his glands had died with his body. He had memories and conditioned responses—"fossilized feelings"—that could be restimulated and re-experienced. He had forgotten them during his years alone, but talking to her, thinking about her, was re-awakening them.

Is that so bad? he wondered. What he had just felt was an honest fit of temper, vastly different from his earlier cold, verbose rages. Wasn't it good to become human again? His hatred and fear of her was already alloyed with respect,

even admiration, and vaguely, almost unconsciously, he wondered if he could still love.

He worked away the remains of his anger in setting traps. He planted stun bombs at intersections in the tunnels with electric eye triggers. He welded cages and hung them from the ceilings of larger chambers, rigged to fall if she broke another infrared beam. He even dug pits in the passages and covered them with plastic sheets to match the surrounding floor. All were connected to alarms in the cell bank control room.

All he wanted to do now was talk to her face to face, find out what she wanted, and, if possible, win her help. The traps never caught anything, except on two special occasions.

He repaired his intercom the day after he broke it, and they resumed their routine as if nothing had happened, except that now there were dialogues.

"I've never been able to figure out how you blew up the control room. Couldn't you tell me now?"

"Sure. I put a bomb on a maintenance robot before it went up on the conveyor. The poor dumb gadget carried it in and went up with it."

"How about that trick with the intercom by Lab 73?"

"Easy. I was at 63, just a level above you. A little paint was all it took."

"Did you really read all those tapes?"

"Nope. Just the ones on you and the center, a bit on explosives and electronics so I could pull some tricks to impress you, and the rest was just window dressing."

He laughed along with her, even when the humor was directed at himself. After practice his voice box could produce quite acceptable laughter.

They played chess over the intercom, and he always won. They switched to poker, and things reversed. He found that he had memorized every centimeter of her strong brown face.

He never did ask her about her plans—he didn't want to ruin what they had. He was enjoying himself more than he had in years, and when she died, as he knew she must, the memories would sustain him for decades. When he finally reached his ultimate triumph, when he had fathered the new humanity, he would remember her still.

He seldom left the cell bank now, and spent his time in his plans, his dreams, and her. He went for walks occasionally, unarmed and without stealth, and it was on one of these excursions that he finally found her.

He had been wandering through one of the great caverns, a dome of rock hundreds of meters across, that had been blazed out of the earth with nuclear fire to accommodate the freezer capsules. A

great geodesic metal network filled the cavern, like a silver jungle or a three-dimensional spider web. At each intersection of the metal strands was one of the black cylindrical capsules. The cables that had carried liquid nitrogen from the reservoirs and control impulses from the computers hung like broken vines, and the occasional forms of the robot tenders only made the chamber seem lonelier.

Standing in the center of the cavern and looking up into the web, Carver was struck by all the sadness he had denied since the war. Here had been man's first halting step to immortality, and war had shattered it like so many other human dreams.

From the corner of one photocell he saw a slim, blue-clad form dart from behind a dormant handling machine into the exit tunnel. He whirled after her and cried, "Miss Armendez! Stop! Please!" He charged through the tunnel's mouth, almost tripping over the python bulk of a circulator cable.

"I won't hurt you!" He plunged around a corner in the dark passage. *"Aaaggghhh!"*

He fell into one of his own pits, suffering a bent arm and several sprung joints. Righting himself, he saw her standing at the edge looking down on him. "Miss Armendez," he called. "Why did you run? I couldn't harm you." He saw the rope hanging from the ceiling, out of his grasp, which she'd obviously used to swing over the pit. "What do you want of me?"

For almost a month he had seen only her face over a telescreen; now he remembered how beautiful the human body had been. But when she spoke, her face and voice might have been modeled after his. "I want life, Dr. Carver."

"I don't see how I can give you that," he said helplessly. "Nothing but a totally new body could save you, and even if we had one for a transplant it would only reject your brain. Come with me; my robo-surgeon can't cure you, but it could make things easier." Now he begged. "Help me plan the future of man. Carol, I love you." He was shocked, and then overwhelmed with joy. He had said it and it was true. He'd hated the name in the files, feared the enemy, respected the person, and now he loved the woman. "Carol, I love you."

"And I love you. You can give me life: life in a body that won't reject my brain. You can make me a cyborg like you." She knelt at the lip of the pit. "Robert, I want to share your immortality. I want to help you recreate humanity."

"What?" His new-found feelings reeled around him.

"You can assemble a new body out of spare parts and program your surgeon for the operation. I know you can. It was obvious all along, but you were too close to the solution to see it."

He didn't hear her, for she had

reached the last barrier between them. "No! It's mine. I built the cell bank; this is my world. It's my right to be . . . the savior, only me. Why should I share it with you?"

She moved back out of his sight. "You tell me," she said, and tossed something down to him.

He caught it, saw it was the tape, and threw it aside. He had forgotten it days ago; he had been a fool to think it irreplaceable. All he wanted was her. "Carol, come back! I'll give you anything but that!" All he heard were her fading footsteps.

An hour later he had scrambled out of the pit. She didn't call that evening, or any evening after that. For three days he brooded over her words, never leaving the cell banks. Finally he answered his own question.

Two years alone in the Necropolis had nearly driven him mad; what would a century do? Wouldn't he become an inhuman monster, unfit to teach his children? He needed a companion, an immortal like himself, another cyborg who could understand his cold feelings. Two people would be able to save each other's sanity and plan the future. He needed someone—he needed her.

He began to dream. After they had rebuilt the world together, in a thousand or five thousand years, he would return to genetic research. Aided by their children, he would learn to grow bodies that would not reject their brains, bodies that could touch, feel, and love. They would become human again in the world they had built.

He wanted to run to her and tell her of his dream—a dream that could sustain them for centuries, but he couldn't.

He had rejected her, and now she was gone. He'd never find her, and she'd die alone in some dark tunnel never knowing how much he wanted her.

I've lost her, he thought. *I've lost my soul. I had to be a god, and for my vanity humanity is lost. I can only spend eternity thinking of her.* He longed to weep, but his immortality denied that.

On the fourth day after he had last seen her he began to doubt.

The next day she walked into one of his traps.

After disconnecting the alarm he walked slowly to the storage level, to the chamber where she waited. She stood quietly in the cage that had dropped from the roof in the clear space amid the crates and cylinders of supplies. She stared at him blankly as he stood before her like an extension of the metal and plastic around them.

"You planned all this, didn't you?" he said at last. She didn't answer. "This whole grotesque game has been a gambit to return me to human feelings, to force me through hate, fear, laughter and love; to make me do what you

want out of reliance and love. You planned it this way from the very beginning."

"I had to live somehow, Robert," she said quietly. "I do love you, and I do want to help you."

"That business with the pit was the last stroke, wasn't it? You had to see me face to face to pound home the last nails." He sighed. "I see it now, but you've still won. I don't care if you're sincere or not. Maybe you're still manipulating me, or maybe all you've said is true. All I know is, I can't live without you." He shuffled his disc-shaped feet like a nervous schoolboy, and said, "I'll get a torch and cut you out."

"Never mind," she said, pulling a miniature laser cutter from beneath her sweater. As she sliced through the bars (his traps never seemed to catch anything but him, he noticed) she talked. "There're some things I want to do before the operation, take a last bath, eat some good food, and stuff like that. Next week should be soon enough. I'll be able to help you with the programming and assembly; I've been studying the manuals."

"Of course," he said.

She reached through the hole she'd cut and grasped his strong metal framework for support as she stepped through. Then she stood next to him, looking up at him. "You know, Robert," she said, "this is the first time we've touched each other."

He pulled her against him. Soon it would be metal against metal, but someday it would be flesh upon flesh.

Well, Carver thought, *at least the next hundred years should be interesting.*

Hell, Armendez thought, *with god parents like us the new human race is really going to be something else.*

They were both right.

And this is the way legends are born. ■

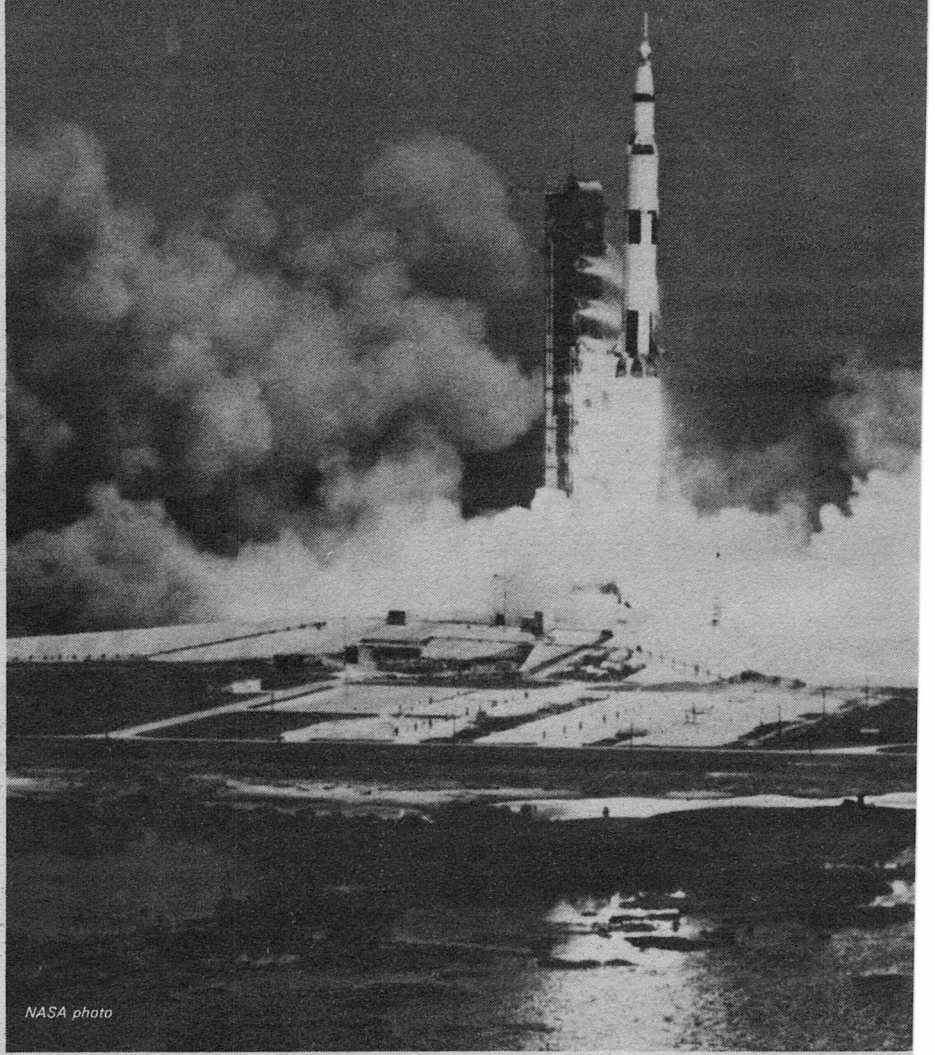
THE ANALYTICAL LABORATORY *JUNE 1973*

PLACE	TITLE	AUTHOR	POINTS
1.	Notebooks of Lazarus Long	*Robert A. Heinlein*	1.92
2.	Chester	*Bernard Deitchman*	2.31
3.	Sword and Scepter (Conclusion)	*Jerry Pournelle*	2.38
4.	Time Cycle	*Saul Snatsky*	3.60
5.	The Whimper Effect	*J. R. Pierce*	3.92

THE CASE FOR THE HYDROGEN-OXYGEN CAR

Remember the legend about turning water into an efficient fuel for automobiles? Well, here it is—and it produces no pollution, as well!

William J. D. Escher



NASA photo

This nation *does* have an energy problem. In the face of exponentially escalating consumption of energy forms of all kinds, principally oil, natural gas, and coal, our domestic capability to produce these is rapidly falling behind our energy appetite. The situation with petroleum energy, our largest source of energy, is shown in the supply and demand chart on page 31 (Figure 1). The situation with natural gas is the same, despite all our efforts to gain supplemental supplies. Only coal remains in relative abundance, but it is far less flexible in its use and often has high sulfur content. Our major hope is to gasify and liquefy coal into synthetic natural gas (or hydrogen) and petroleum-like products, and extract the sulfur from the fuel at the same time. Coal gasification is an area of priority research and development, as announced in the Presidential Energy Message of June 4, 1971.

Since this article deals with transportation, which relies about ninety-five percent on petroleum, we will focus on oil-products and a potential successor to petroleum which has recently surfaced. This successor is *hydrogen*. I will discuss two specific ways in which future automotive transportation systems could utilize hydrogen fuel in lieu of today's gasoline and diesel fuel. The familiar gasoline-fueled automobile of today will be our base of departure in this conjecture. But first, how does our present and projected use of petroleum figure into what is rapidly developing into the proportions of an energy crisis in this country?

As shown in Figure 1, our national energy-appetite for petroleum is increasing out-of-balance with our domestic production of oil. Also shown in Figure 1 is the fact that from now until about 1985 the resolution of the U.S. supply and demand imbalance reduces to just the one we are forced to accept even now: *importation.*[1] From our present importation of a quarter of the total demand, by 1985 we will be relying on foreign imports (basically from the Middle East and North Africa) for well over half of our national petroleum supply. By 1980, transportation alone will use an amount equal to the total projected domestic production of petroleum.

The effect on the U.S. balance of international payments will be most dramatic. From the current annual sum of four billion dollars, the deficit for petroleum imports alone will climb to the order of twenty billion dollars by 1980. This dependence on foreign oil will have far-reaching political significance as well. For the first time in history,

1. A considerable potential for expanding domestic oil production capability exists. (See John G. McLean and Warren B. Davis, "Guide to National Petroleum Council Report on United States Energy Outlook," Presentation made to National Petroleum Council, December 11, 1972.) But, even if carried out, this cannot be really effective in reducing importation in the time period stated.

Hydrogen-oxygen engines are already being used for transportation of highly-valuable people and cargo, as in the upper stages of the Saturn V booster.

the U.S. will lose its "energy self-sufficiency." We will be joining Western Europe and Japan as major powers with potentially interruptible supplies of energy.

One early effect which will be readily noted is the higher price we will be paying for gasoline. As pump prices begin to stick up around ceiling prices, and as the ceilings inch up, the day of the "gas war" may become only a memory, and we may even be visited by the wartime specter of gas rationing.

There are some alternatives to this rather gloomy picture. These break down into (1) energy-conserving measures, and (2) alternative fuels. We will likely be taking actions in both categories. Certainly, in the long run we will be going to a *non-petroleum*-based fuel for transportation. For the little petroleum which will remain after a few more decades will be far too valuable to the petrochemical industry (plastics, medicines, et cetera) to burn up as a fuel.

The Hydrogen Economy

One of the longer-term alternatives is the "Hydrogen Economy" concept.[2] Various aspects of this concept, illustrated on page 32 (Figure 2), have been assessed by an expanding number of workers in the energy field. The basic objective is to produce a universal *synthetic fuel* using domestic facilities (to stem the importation trend) and resources *not* in short supply.

Hydrogen produced from water is for many reasons favored as the candidate synthetic fuel. Energy is applied to water in order to split it into its constituent elements of hydrogen and oxygen. A proven long-haul approach for this is nuclear-electric-based electrolysis. Some researchers have proposed the *direct* use of nuclear heat in complex thermochemical step reactions for splitting water, in order to improve the efficiency limitation of the nuclear-to-electricity conversion (electrolysis itself can be performed at rather high efficiency). Hydrogen can also be produced from coal and water, probably at lower cost in the near term.

Once produced, by whatever means, the hydrogen can be transmitted in long-distance underground pipelines as is natural gas presently. Hydrogen can be similarly stored to meet peak demand periods in underground rock formations such as depleted gas and oil fields, or in aquifers (from which water must be initially displaced as gas is injected). Hydrogen can also be liquefied and stored at very low temperature, as is natural gas in the form of LNG (liquefied natural gas). Million-gallon liquid hydrogen tanks can be found at the Kennedy Space Center (although these are small by LNG standards). After all, liquid hydrogen is our

2. See Derek P. Gregory, "The Hydrogen Economy," *Scientific American*, January, 1973.

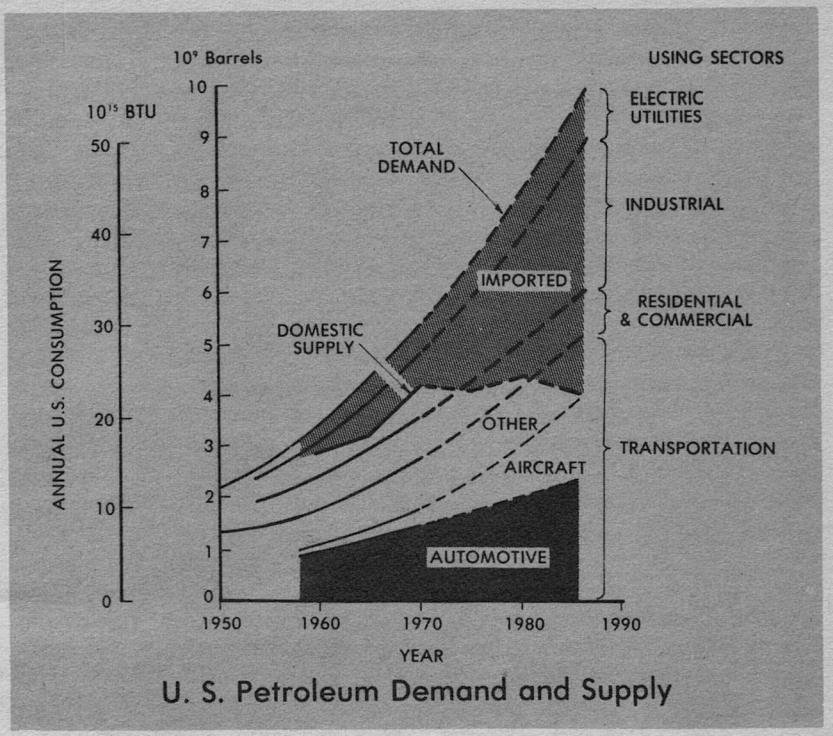
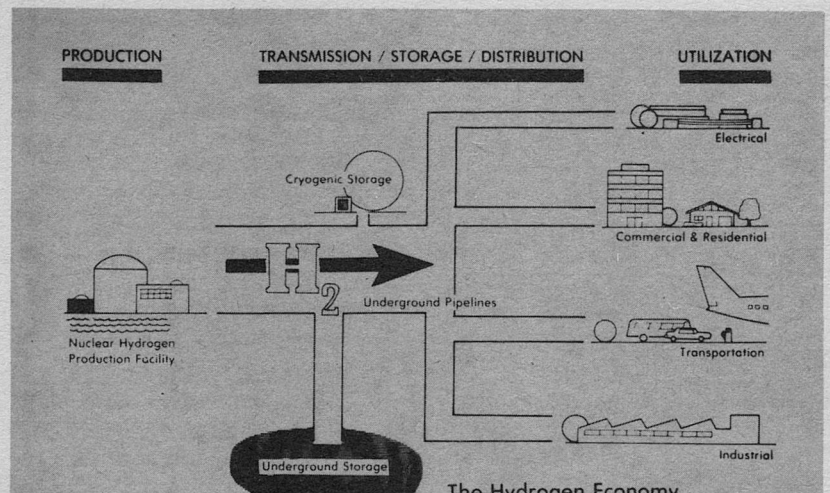


Figure 1. Transportation consumption of petroleum in the U.S. is about half of the total used, which continues on an exponential rise. About sixty-five percent of this is needed to operate the nation's automotive vehicles. Domestic supplies of oil are being rapidly outstripped, leading to an unfavorable dependence on foreign imports.

best rocket fuel from a performance standpoint.[3]

Following the Hydrogen Economy diagram in Figure 2 further, hydrogen can be taken from storage or direct transmission and distributed to several using sectors. Like natural gas, hydrogen can be served to industrial, commercial and residential users, and to electrical utilities for the generation of electricity. Unlike natural gas (except for some demonstration systems reflecting its environmental appeal), hydrogen can conceivably be used to fuel the *transportation* sector for most modes of service, including the automobile. Not all advocates of the Hydrogen Econ-

3. See Joseph Green and Fuller C. Jones, "The Bugs that Live at -423°, The Problem of the Centaur Development," Analog, January, 1968.



omy will agree completely with this last statement. And I would tend to concur that the automobile, particularly the privately operated vehicle, may be the *last place* where a conversion to hydrogen will take place. Yet it *will* happen, in my view. I will be focusing on this application area in this discussion.

Figure 2. In a prospective "Hydrogen Economy," free of fossil-fuel dependence, nuclear (or solar) energy is used to produce hydrogen fuel (and oxygen) from water. Hydrogen, as a synthetic "energy carrier" is transmitted in underground pipelines and stored as is today's natural gas. Distributed to the various using sectors of the economy, hydrogen can be a flexible, clean fuel with many special advantages. As liquid "cryohydrogen" (possibly in other forms as well) it can be used to power virtually all forms of transportation—including, of course, the automobile.

What About All the Oxygen?

The schematic view of the Hydrogen Economy in Figure 2 does not indicate what is to be done with all the oxygen resulting from hydrogen extraction from water. For every pound of hydrogen produced, eight pounds of oxygen will be liberated. Or for every thousand standard cubic feet of hydrogen, there will be produced five hundred standard cubic feet of oxygen.

It is usually tacitly assumed that the oxygen will be a credit by-product, to be sold as an industrial chemical (oxygen is presently the

third largest tonnage industrial chemical produced in the United States). And oxygen can be used to clean up our streams, rivers, and lakes, or in sewage processing. I would agree with these possible dispositions of the oxygen, but point out that we may more fruitfully use it generally across *all sectors* of utilization as depicted on the right side of the diagram in Figure 2.

In my view, much—if not most—of the oxygen produced may be locally recombined with the hydrogen in very efficient, clean energy conversion devices of all kinds. This includes, as we will soon see, the *automobile engine*.

Referring again to the Hydrogen Economy schematic in Figure 2, which can be characterized as a "single-pipeline" system, that is, only hydrogen delivered, I propose that we add a second pipeline in parallel with that shown. In short, the Hydrogen Economy should be a "twin-pipeline" system. With hydrogen-oxygen, the customer may not have to purchase as much energy to begin with, hence he may pay less in the end for it than just hydrogen alone. The reason for this is that, in many instances, the energy conversion process can be made *significantly more efficient* with hydrogen-oxygen than with hydrogen-air.

Further, hydrogen-oxygen produces *zero* air pollution. Environmental impact will be *absolutely* minimized: the only exhaust possible is water, and the rejection of heat will be as low as technology can provide for (because of the high efficiency). Hydrogen combustion in air, in engines as well as in open flames, produces oxides of nitrogen (NO_x). This will have to be controlled by innovative design or—hopefully not required—sophisticated exhaust clean-up devices such as we are getting into for the 1975 and 1976 model automobiles.

Where thermal rejection poses problems of an environmental nature, the step-up in energy conversion efficiency with hydrogen-oxygen signals a decrease in specific thermal rejection. In brief, more of the fuel energy is converted into useful work and less into waste heat.

In this article we will examine the automotive vehicle, which now consumes about sixty-five percent of the energy we feed into the transportation area. Presently this is as petroleum; in the future I believe it will be hydrogen energy. A hydrogen-converted conventional automobile constructed by students at UCLA made a good showing in the recent Urban Vehicle Design Competition.

Whether the automobile will have an air-breathing engine, as does the UCLA car and a number of other such conversions, or a *non-air-breathing* hydrogen-oxygen energy conversion system, is the point of contention. I am trying to

make a case here for the latter.

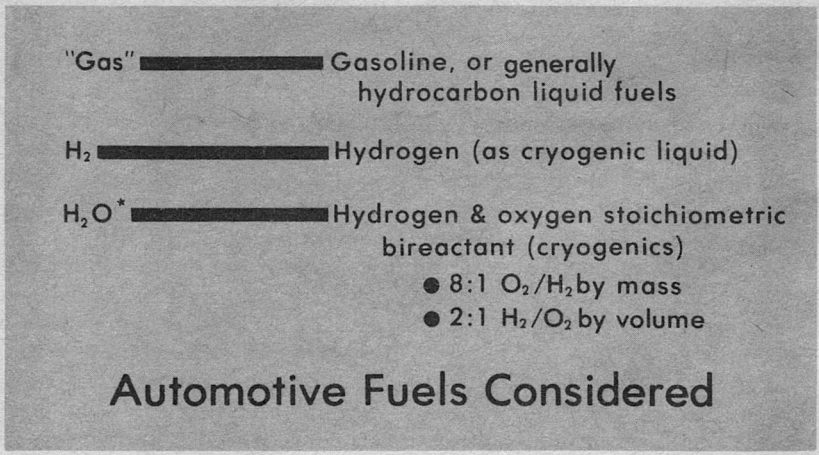
H_2O—The Higher Energy Form of Water*

I feel that it will simplify the comparison to be made to refer to the hydrogen-oxygen bireactant combination as a single item, in short as a "fuel," as opposed to treating the two elements separately. In this way we can talk about one density of fuel, and one cost per unit contained energy, et cetera. For that is traditionally how the air-breathing-engine man conducts his technical conversations.

Ultimately, the hydrogen and oxygen elements will be consumed at the chemically correct, or stoichiometric ratio. In combustion, there will be exactly two molecules of hydrogen reacting with one of oxygen. Neither excess hydrogen nor oxygen will be exhausted to the atmosphere. Water *only* will be produced. This is, of course, the exact same ratio which will be produced as water is "taken apart" at the production facility.

I like to view the stoichiometric "mix" of hydrogen and oxygen (in separate containers, of course!) as the *higher energy form of water* for this reason. Familiar H_2O, then, by definition becomes the *lower* energy form of water. I label the higher form as H_2O* referring to it as "water-star." It is listed in Figure 3 with liquid hydrogen and gasoline.

Figure 3. Actually two *basic possibilities exist: hydrogen, by itself, in an air-breathing engine, or* hydrogen and oxygen *in non-air-breathing systems. This latter bireactant combination, referred to as H_2O*—"the higher energy form of water"—is focused upon in this article. Both forms of hydrogen energy are compared with gasoline.*



For H_2O^*, note once again the physical match of the hydrogen and oxygen constituents. Although oxygen outweighs hydrogen by a factor of eight, it normally occupies only half the volume of the hydrogen. Of the two tanks we must put aboard a vehicle using H_2O^*, one will be twice the size of the other. Also, it is noted that the *cryogenic* form of H_2O^* (that is, cryogenic liquid hydrogen and oxygen) is to be considered in this presentation. There are other technical possibilities, though, particularly for hydrogen.

Cost of Automotive Fuels, Now and in the Future

The cost of gasoline will be going up rather steeply in the years ahead. How will its cost stack up with that for H_2 and H_2O^*? Figure 4 (page 36) presents a comparison of estimated fuel costs.

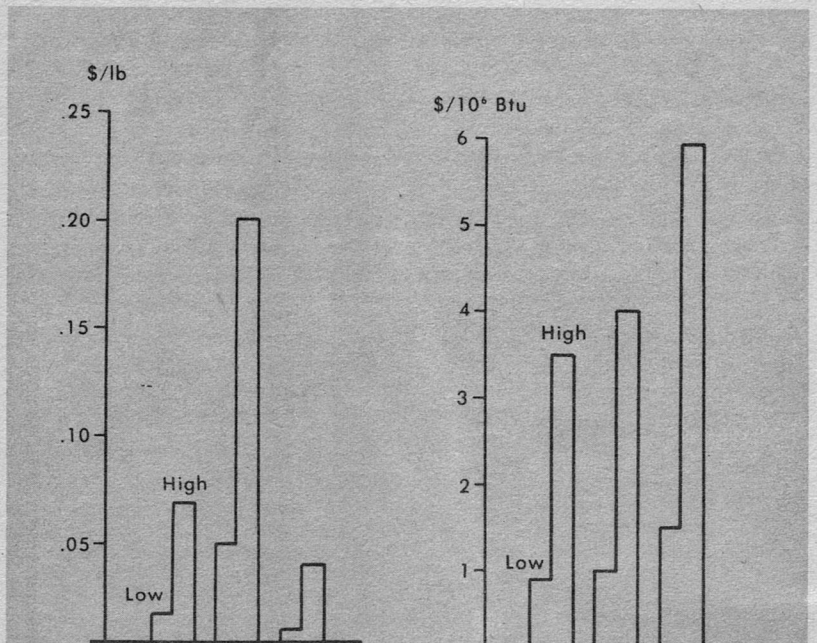
Notice that "cents per gallon," the usual measure of automotive fuel price, does not appear on the two bar-charts. We can no longer equitably measure fuel cost on a volumetric basis when comparing fuels of radically different density (liquid hydrogen has one-tenth the density of gasoline). Cost per unit mass as shown in the left-hand group of vertical bars is the conventional way hydrogen and oxygen are priced. Actually, price per unit energy content (right-hand group) is really the ultimate measure of a fuel's worth.

The "low" and "high" bar lengths represent a four-to-one range of fuel costs providing a wide-range bracketing of possibilities, and allowing for various bases for estimates. For instance the "low" price of gasoline at 0.017 dollars per pound accords to about 10 cents per gallon, roughly the untaxed wholesale price of gasoline prior to present escalating trends. On the other hand, the "high" price is that retail price we find on the pump today of 40 cents per gallon.

Again, it is the *cost per unit energy* that really counts. Using the Btu (British thermal unit) as a measure of energy content, and referencing the lower heating value of the fuels, which assumes that the energy of condensation of water vapor produced in combustion is not recoverable, the energy-price ranking of the fuels is presented on the right-hand side of the diagram in Figure 4.

Here we see that gasoline and hydrogen are roughly at the same price. This reflects hydrogen's superior gravimetric heating value, about 2.75 times that of gasoline. H_2O^* is projected to be half again more expensive than either gasoline or cryohydrogen. This is because oxygen, which brings along no Btu's, must be purchased over and beyond the hydrogen.

The higher price of H_2O^* may be reduced significantly depending on how the "free" oxygen pro-



duced along with hydrogen from water is to be costed into the total delivery system of the "twin-pipe" Hydrogen Economy cited earlier. Despite a possible zero production cost for oxygen, one must still pay for the transportation, storage, and distribution of the oxygen component of H_2O^*. The oxygen cannot, therefore, be at a net zero cost.

Finally, in comparing H_2 and H_2O^* as above, it should be remembered that both require the *same* production facility and input

Figure 4. Estimated cost of fuels (today's dollars) is presented on both a per-unit-mass and a per-unit-energy basis in these bar charts. The stepped bars reflect a four-to-one bracketing of possibilities. All fuels will be getting more expensive, but petroleum costs are skyrocketing. Fuel taxation schedules will have a dominating significance, and may be an effective means of steering our national energy economy toward domestically-produced hydrogen, or other clean fuel equivalent.

energy in the context of the Hydrogen Economy. The difference really boils down to what one chooses to do with the oxygen constituent of water once it is produced. The automobile covered in this discussion is one utilization case in point. Will it be fueled with H_2 (air-breathing), or H_2O*? Let's look further into technical aspects of this question.

Technical Nature of the Candidate Fuels

So much for the rough cost estimates of the fuels we are examining. We will come back to them at the conclusion in terms of the price we will have to pay to "fill up" at our local service station in the Hydrogen Economy era. What about the physical and fuel-chemistry aspects of the competing fuels? Figure 5 lists the significant numbers for gasoline ("gas"), H_2, and H_2O*. Also, for reference purposes I have listed water (the lower energy form!), and cryogenic O_2 as a constituent of H_2O*.

The right-hand column tells us that gasoline is significantly superior to both H_2 and H_2O* in terms of energy per gallon. The implication is clear: vehicles which operate on hydrogen-energy will have *much larger* fuel tanks than we are presently used to. These tanks will be much more sophisticated, and for both reasons, much more expensive to manufacture.

Our only apparent recourse for

Figure 5. Liquid hydrogen's gravimetric heating value advantage of 2.75 to one partly compensates for the fact that it is about one-tenth as dense as gasoline. Its eight times as much addition of dense liquid oxygen brings H_2O up to the density of LNG (a cryogenic fuel used in cars). However, its energy content is thereby diluted to one-third that of gasoline.*

FUEL (OR REF.)	SPECIFIC GRAVITY	DENSITY LB/FT³	DENSITY LB/GAL	HEATING VALUE 1000 Btu/LB (LOWER)	HEATING VALUE 1000 Btu/LB (HIGHER)	1000 Btu/GAL
H_2O	1.00	62.4	8.35			
GAS	0.72	44.9	5.87	19.1	20.3	112 (LHV)
H_2	0.071	4.42	0.59	51.5	61.0	30.4 (LHV)
O_2	1.14	71.2	9.52			
H_2O^*	0.42	26.2	3.51	5.73	6.79	24.2 (HHV)

Fuel Characteristics

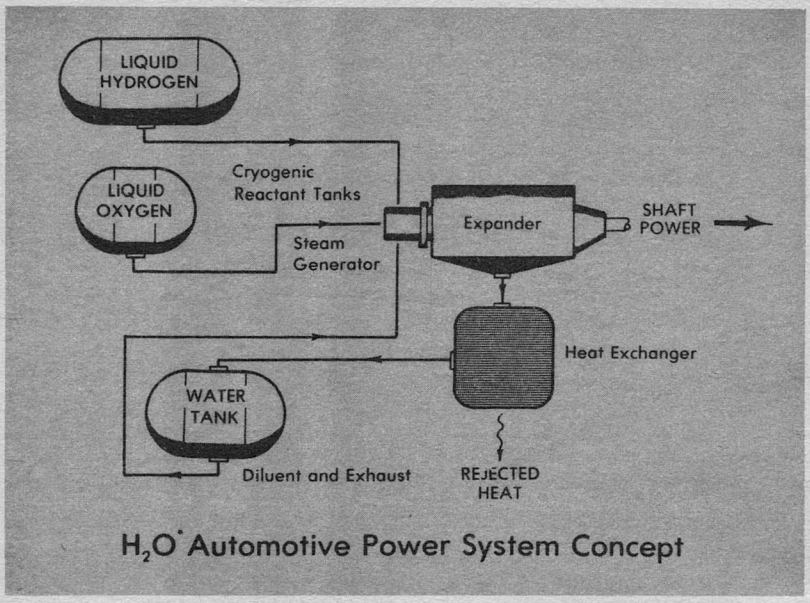


Figure 6. Here is a unique H_2O cycle with no (conventional) intake or exhaust. It uses non-boiler-produced steam working fluid and, in a compact and lightweight device, is able to reach extremely high brake thermal efficiencies provided unprecedented steam temperatures (3,000–4,000°F) can be achieved. It produces only water as exhaust and can be virtually silent.*

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the large tank problem is to make each unit of fuel energy go farther than it does now in our gasoline-fueled vehicles. One way to do this, which the energy crisis will probably force upon us anyway, is to reduce the size and output of our engines, taking a lead from European manufacturers. The other way, perhaps to be used in combination, is to raise the net thermal *efficiency* of the engine and final drive. This latter route is the only way we will be able to conserve fuel energy (and reduce the tankage volume in hydrogen-using systems), while maintaining present levels of performance.

It is just this last point, in my own view, that argues for an H_2O* as opposed to an H_2-based automotive power system. Not so much the reduction of tankage volume (I believe that designers will be innovative enough to design a car around a big hydrogen tank), it is the ultimate *conservation of energy* which is of compelling importance.

Unique H_2O-fueled Automotive Power System*

Presented in Figure 6 is a schematic diagram of a unique and most interesting H_2O*-fueled engine. It converts the bireactant hydrogen-oxygen into water exhaust, yielding shaftpower and rejecting heat through a radiator-like condenser. Looking at it in our special terminology, it processes the higher energy form of water (H_2O*) into the lower energy form (H_2O), converting as much of the energy thereby given up into useful shaftwork (the remainder is rejected waste heat at low temperature levels).

The ratio of the useful work produced by the engine to the heating value of H_2O* consumed (which is that assigned to its hydrogen component) is the efficiency of the power system, a general definition. It is the higher efficiency of this new engine concept which argues for the H_2O* approach. For the hydrogen-fueled air-breathing engines of conventional design, a number of which have been successfully demonstrated, will have approximately the *same efficiency* as they develop on hydrocarbon fuel.

How does this H_2O* engine work? Noting that Figure 6 is very much simplified and does not show pumps, valves, controls, and ancillaries or accessories, the power system operates as follows: Liquid hydrogen and oxygen from the tanks are pumped to high pressure by small cryogenic pumps and injected into the steam generator where combustion takes place at controlled stoichiometric conditions. This requires an ignition system such as a spark plug, a glow plug or a catalytic igniter. So far all of this will be recognized by those familiar with the liquid rocket field as well-established technology. A recent review of this area has been done by John Gregory and Paul Herr.[4]

However, the 5,500° Fahrenheit steam (roughly; there is considerable dissociation of the constituents of the combustion products, the degree of which affects the actual temperature resulting) is *too* hot to be processed through the engine even assuming considerable advancements in the state-of-the-art of high-temperature machinery.

To handle this situation, water will be injected into the steam generator to moderate the working fluid temperature down to practical levels. A line leading from the third (lower) tank in the diagram provides for this; again, the pump which will be necessary is not shown. Addition of water not only reduces the outlet steam temperature to a desired level (the more water added, obviously, the lower the temperature), it adds to the

4. See John W. Gregory and Paul N. Herr, "Hydrogen-Oxygen Space Shuttle ACPS Thruster Technology Review," Presented at the AIAA/SAE 8th Propulsion Joint Specialist Conference, New Orleans, November 29-December 1, 1972. (AIAA Paper No. 72-1158).

mass of working fluid being produced as steam. At a given inlet pressure of the expander or "work-producer," an increase in the size of the hardware is implied by this.

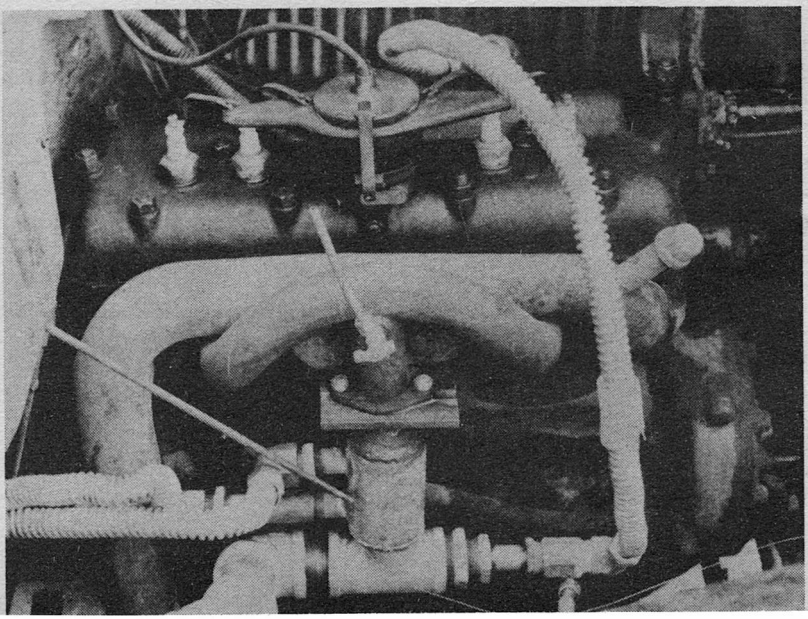
The expander could be of any of a number of types, a piston-cylinder layout, a turbine, or any of several types of rotary positive-displacement devices. Steam working fluid enters the expander at high temperature and pressure, and exhausts into a condenser ("heat exchanger") at greatly reduced temperature and pressure.

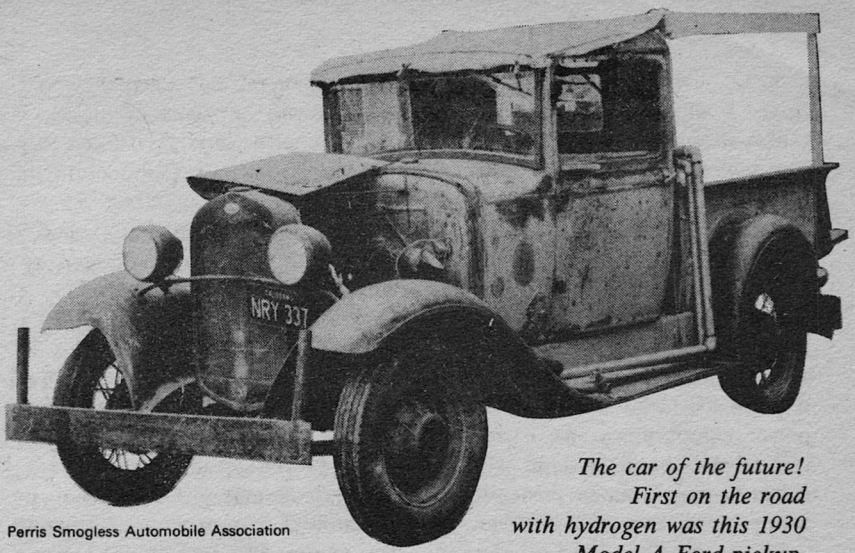
As to the origins of this H_2O* power system, it is by no means a new idea. The basic steam generation approach was patented by Ernest E. Tucker of New York City as early as 1924 (Patent number 1,483,917).

Various versions of the entire power system concept itself have appeared in both the general technical and patent literature frequently, with a number of related patents being granted in the early, mid-Sixties. In 1971 Reese and Carmichael of MIT presented some engineering aspects of the system applied to the operation of submersibles.[5]

5. See R. A. Reese and A. D. Carmichael, "A Proposed Hydrogen-Oxygen Fueled Steam Cycle for the Propulsion of Deep Submersibles," Presented at the Intersociety Energy Conversion Engineering Conference, August 3-5, 1971, Boston.

Detail of the right side of the Model A engine (from the 1930 Ford pictured opposite) shows the mixing chamber, recirculating pipe, breather blowby connections, and gas supply connections. The stub tube on the manifold was for pressure and vacuum gauge connections.





Perris Smogless Automobile Association

The car of the future! First on the road with hydrogen was this 1930 Model A Ford pickup.

Though the concept has clearly been around for quite a while, I do not know of actual hardware developments along these lines. I suspect that (1) until the advent of the technological capability of handling hydrogen and oxygen routinely, as in Apollo, together with (2) an established *need* for what the power cycle has to offer (namely high efficiency, zero pollution), the incentives for development have been lacking. Conversely, the energy and environmental crisis we face at this time, particularly in transportation, may be the initiation means for getting the H_2O* system going.

By the way, the specific engine system described is by no means the *only* way to power a vehicle on H_2O*. Impressive work has been carried out on a hydrogen-oxygen powered series of experimental vehicles by a group of Californians who refer to themselves as the Perris Smogless Automobile Association (for Perris, California). The third of their series of vehicles, a modified Ford pickup truck (shown in the photographs) was equipped with cryogenic hydrogen and oxygen tankage (standard shipping containers from Linde). It was successfully tested in 1970, just failing to get into the Clean Air Car Race that year. The PSAA power system is a cleverly modified conventional gasoline engine operating strictly on tanked hydrogen and oxygen in a fuel-rich mode (to control temperature), but stoichiometric overall.

Considerably earlier, the General Motors Corporation demonstrated the H_2O*-fueled "Electrovan" which used hydrogen-oxygen fuel

cells to power basically an electric drive. Fuel cells remain an interesting alternative to the heat-engine for vehicle propulsion because of their quite high energy conversion efficiency, the order of fifty-five to sixty-five percent. The technology has been considerably forwarded by the space effort.[6] Basic problems remain in the areas of size and weight, and manufacturing cost. Also, one must add associated power conditioning and drive motors to the overall system, whereas a heat engine can, in principle, be connected directly to the wheels.

But among these and other alternatives which can utilize H_2O^*, it is my belief that the unique power cycle which I have described is an outstanding system for future vehicle propulsion. The compelling feature is its potential for an unprecedented (for heat engines) level of energy conversion efficiency in a compact, low-cost machine. The key to this feature is the potential for high temperature operation.

Two Hydrogen-based Power Systems Compared

With the H_2O^* engine features thus roughed out, and noting that the H_2-fueled conventional internal combustion power plant is otherwise self-evident (I have pointed out that it will have about the same efficiency), let us now make a comparison between the two. I will attempt to do this in two steps. First a general and qualitative comparison will be made of the H_2O^* engine with *any* H_2-fueled air-breathing power system employing a heat engine (excluding, for example, hydrogen-air fuel cells). This would pick up hydrogen gas turbines, Stirling cycle systems, et cetera. Secondly, the hydrogen-fueled *conventional* automotive engine, which is already pretty well defined, will be contrasted in quantitative terms with the advanced H_2O^* power system.

Figure 7 makes the general and qualitative comparison. I remind the reader that *both* the H_2O^* and H_2 air-breathing systems are compatible with the larger view of the Hydrogen Economy. But the former system suggests a "twin-pipe" (hydrogen *and* oxygen) version of the schematic shown earlier in Figure 2.

With high working fluid temperatures being the key to the achievement of high engine efficiencies, important in overall energy conservation, we see the H_2O^* engine as having a significantly

Figure 7. The unique H_2O^* power cycle is contrasted to the H_2-fueled but otherwise conventional automotive power plant in terms of their principal engineering features. At the expense of carrying along liquid oxygen in addition to hydrogen, one gains a much more efficient, smaller and lighter unit which is truly non-polluting.

6. See Derek P. Gregory, *op. cit.*

higher potential than an air-breathing H_2 engine of whatever design.

The payoff of its superior upper temperature limit, its much higher operating pressure, and its very low backwork requirement allow the H_2O^* power system to be designed for extremely high overall efficiencies in a compact, lightweight engine package. It should be a fraction of the size and weight of a modern V-8 engine, although its condenser may equal the size of the radiator in today's automobile.

The specifics here must await actual engineering detail design efforts yet to be performed. However, to provide some idea of the compactness achievable in a small high-pressure steam turbine in the automotive horsepower class, I have examined a 300-horsepower design roughly six inches in diameter and eight inches long. Such a turbine operates at very high shaft speeds necessitating a step-down gear train over and beyond the transmission and final drive for the vehicle. I understand that the Lear Motors steam bus employs a system of this general type.

The fact that the power unit will be lightweight and of small size in the H_2O^* system is indeed fortunate, because this will do much to compensate for the much bulkier and heavier fuel tanks *vis-à-vis* our

CYCLE FEATURES	H_2O^*	H_2
Maximum Temperature:	Highest	Limited (1)
Maximum Pressure:	Highest	Limited (2)
Internal Backwork:	Low	High (2)
Thermal Efficiency:	Highest	Limited (3)
Size & Weight:	Lowest	Limited (4)
Polluting Emission:	None	Oxides of Nitrogen (5)

H_2O^* Vis-à-Vis H_2 Engines

(1) N_2 DILUENT (2) AIR COMPRESSION (3) TEMPERATURE, PRESSURE & BACKWORK (4) EFFICIENCY & PRESSURE (5) AGGRAVATED BY TEMPERATURE

present-day gasoline and diesel fuel tank. (Comparison numbers will be illustrated in Figures 8 and 9.)

Unfortunately for the H_2-fueled air-breathing engine, it is not clear how any significant reduction in engine weight or size will come about in comparison to conventionally fueled engines of one type or another. Thus the hydrogen air-breather will be stuck with a fuel tank even larger, if not heavier, than those required for the advanced H_2O* system: a point to be made.

The final point made in Figure 7 has been suggested at several points in the discussion: the H_2O* engine can be a *zero pollution* device—its exhaust is water, and only water. The H_2-fueled air-breathing engine will be a very clean engine by today's standards; but it will still produce oxides of nitrogen. Unfortunately, those things to be done to raise engine efficiency such as increased compression ratios and higher temperatures are in the *wrong direction* for reducing the production of NO_x.

Another point, not listed, but certainly worth noting nevertheless: having no intake and no exhaust in the conventional sense, the H_2O* engine can be made to operate virtually in silence. Automobiles with factory-equipped mufflers are not usually offensive from a noise standpoint. But what about the big highway tractor-trailers? With this engine, engineers will have only tire-noise to concentrate on in automotive noise alleviation.

Tanked Energy, Mass, Volume, and the Cost to Fill Up

With the aid of the bar-charts in Figures 8 and 9 (pages 46-47) I will present a more detailed and quantitative comparison of these three systems: (1) the advanced H_2O* system which has been described, (2) the H_2-fueled conventional automotive engine system, and (3) as a baseline for comparison, today's gasoline-powered automobile (noted as "Gas" on the charts).

The comparison will be presented in the following terms:

(1) Fuel energy tanked for a typical driving cycle equivalent to that achieved on 20 gallons of gasoline.

(2) Fuel mass required.

(3) Fuel volume required.

(4) Estimated cost to fill up the tank, assuming that hydrogen becomes generally available as a fuel.

Figure 8 (left-hand side) shows tanked energy for the same driving cycle. For the gasoline comparison case, we show about 2.3 million Btu's of tanked energy. Since the hydrogen-converted, but otherwise conventional automotive engine will develop about the same level of efficiency as it would on gasoline, the hydrogen vehicle will have to have tanked aboard the same amount of fuel energy.

Not so with the high-temperature H_2O* engine we have examined. As indicated by the third bar (in

each of the final four groups of bars), this system requires only about half the tanked energy of the others. The calculated figures are 1.12 to 1.19 million Btu's for the 4,000 and 3,000° Fahrenheit versions of the H_2O^* systems at 20 and 50 pounds per square inch (psia) exhaust conditions respectively. This range is indicated by the hatched ends of the bars in each presentation.

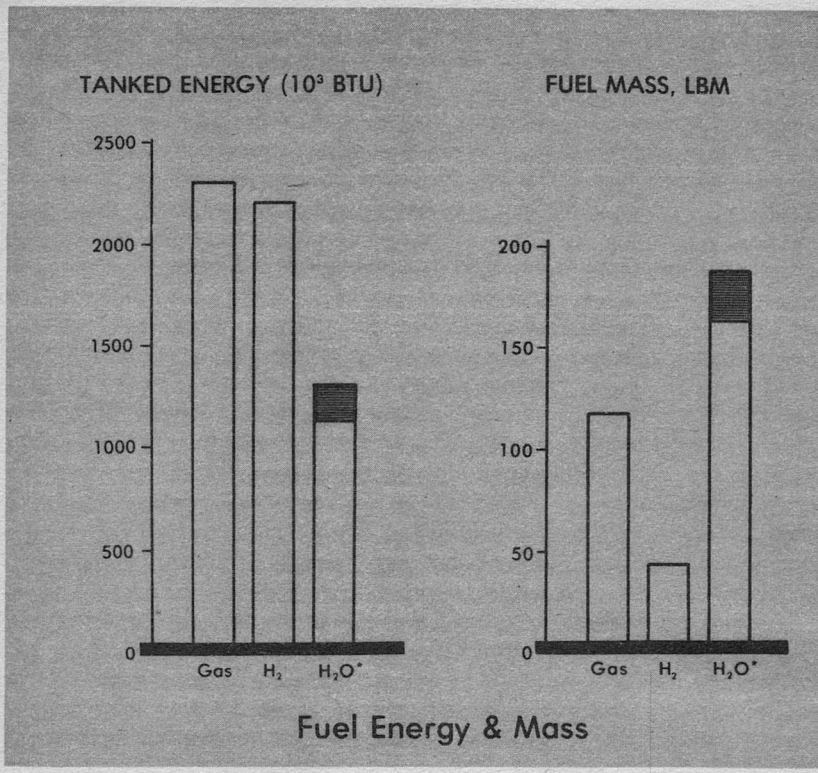
The payoff of the resulting high net thermal efficiency from H_2O^* is most evident in the very much reduced tanked energy requirement shown here. Remarkably, this suggests that the energy consumption of the transportation sector of our economy could potentially *be halved* in comparison to either today's gasoline-fueled vehicles, or to hydrogen-converted versions of these.

This is a pretty exciting result in the view of our pending energy crisis situation. It also suggests that there might be vast capital investment and operating cost savings by way of the reduction of production, transmission, storage, and distribution facilities as we build up into the Hydrogen Economy era. These savings would likely far outweigh the incremental cost of delivering the oxygen component of H_2O^*, along with the hydrogen as planned now.

The second bar chart of Figure 8 (right side) shows the mass of fuel which must be put aboard to match the 20 gallons of gasoline used in the baseline. Here the superiority of hydrogen with regard to its gravimetric heating value really becomes apparent. Compared to 120 pounds of gasoline, only about 45 pounds of liquid hydrogen is needed for an equivalent drive. The heaviest fuel load for the three cases is that for H_2O^* at 160 to 190 pounds, for both hydrogen and oxygen together. Although less hydrogen-energy, hence hydrogen mass, is needed because of the high efficiency, the eight times as much liquid oxygen requirement brings the total mass up to this level.

Fuel volume requirements are displayed on the left side of Figure 9. Despite its much lower mass, liquid hydrogen's factor-of-ten bulkiness over gasoline demands a much larger tank of almost 75 gallons (compared to 20 gallons for gasoline). Adding a nominal 10 percent for ullage space, which is common practice for cryogenic storage, brings this volume to just over 80 gallons—four times the size of present fuel tanks.

Somewhat surprisingly, the two cryogenic tanks for H_2O^* together come to about 45 to 55 gallons, recalling that the oxygen tank will be half the size of the hydrogen container. We could, for instance, have a 15-gallon oxygen tank mounted in the rear of the vehicle and a 30-gallon hydrogen tank up front. The compact H_2O^* power system equipment should provide for ample room under the hood for



this size tank. On the other hand, the H_2/conventional engine vehicle is hobbled with both a large and heavy power plant *and* the largest fuel tank of all!

The final point to be made is the cost to the driver of filling up each of the candidate vehicles at the service station (right side of Figure 9). Reference is made to the estimated fuel prices given in Figure 4; these are applied to the fuel needed to fill the tanks as just described. Once again the four-to-one brack-

Figure 8. Efficiency gains are reflected in the total fuel-energy (Btu's) which must be put aboard the vehicle for a given driving cycle (left-hand series of bars). Where the H_2O^* system halves this requirement, note that a conventional hydrogen engine is only slightly superior to a gasoline version. On the other hand, the mass of fuel required (right-hand bars) is least for H_2 and highest for H_2O^*. The latter's high fuel mass is expected to be compensated by its lighter power plant.

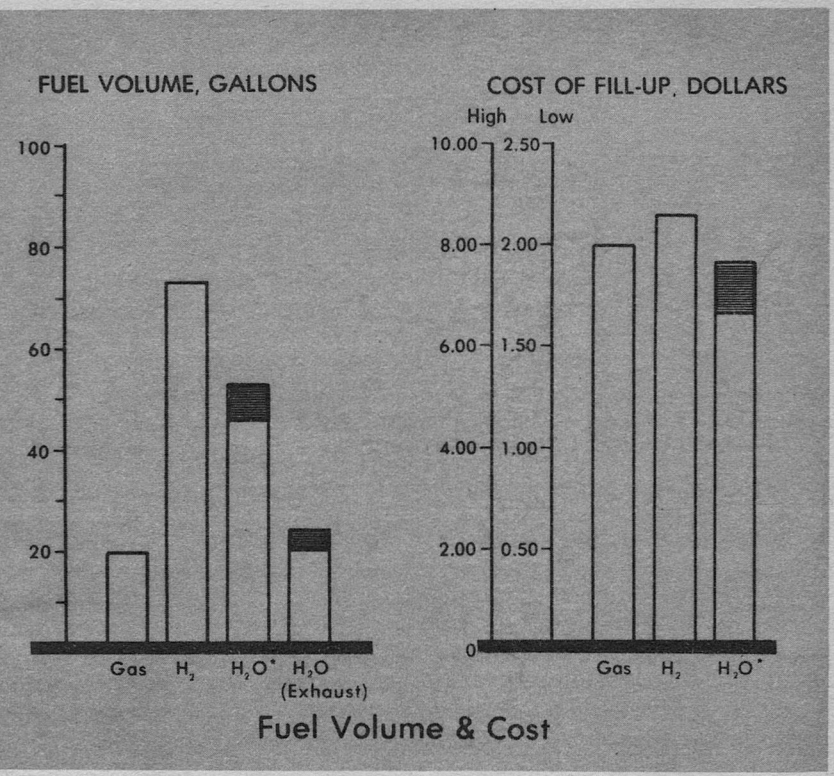


Figure 9. Tanked volume requirements show yet another picture: gasoline is the most compact fuel and liquid hydrogen the most voluminous. The total number of gallons for H_2O^* (in separate hydrogen and oxygen containers) plus a third tank for water exhaust would add up to about the same as that required for the hydrogen air-breather.

eting of prices is used resulting in the two scales, "high" and "low."

As can be seen, for either scale, there is no great difference in cost to fill up the vehicles. The most economical case being the more advanced of the H_2O^* systems.

Some Qualifications: Synthetic Gasoline, Other Hydrogen-fueled Engines, Problems of Oxygen

Before summarizing, I would like to note several important qualifications for the arguments I have made for the hydrogen-oxygen-powered automobile.

First, we have been using our

present-day gasoline-fueled automobile as a point of departure, meaning this rather literally, as we sense the ending of our fossil-fuel hydrocarbon energy era. This ending is, of course, the curtain-raiser for the Hydrogen Economy's advent, as many view the scene. Nevertheless, we should point out that an equivalent to gasoline could also be made available *synthetically,* initially from coal, as our hydrocarbon supply runs out. Ultimately, carbon could conceivably be extracted from limestone (essentially calcium carbonate) or from atmospheric CO_2; the approximately 320-ppm concentration of this gas in the air constitutes some 2.5 x 10^{12} tons altogether. To extract this carbon would require significant quantities of energy, as well as sizable capital investments in facilities. Also, given the carbon, we must *still* have hydrogen. As a matter of fact this could be provided in the context of the Hydrogen Economy as pipelined hydrogen industrial feedstock (see the earlier schematic, Figure 2).

But, I have personal doubts that continuing on synthetic hydrocarbons will be either very practical or even desirable, once a general shortage of natural petroleum products has reached the crucial stage, and the Hydrogen Economy, hopefully, begins to pick up the load. After all, departing from carbonaceous fuels is *entirely desirable* from an environmental standpoint. Elimination of the very large numbers of deaths and physical impairments due to carbon monoxide poisoning alone would be a very considerable blessing. No; when the time comes to make a general transition to hydrogen, the automotive vehicle will make its move, I believe.

Second, the discussion has really concentrated on two very specific hydrogen-oriented power systems, although other alternatives have been mentioned, for example, the hydrogen-oxygen fuel cell and the Perris Smogless Automobile Association system, both candidate H_2O* systems. The emphasis given to the H_2-fueled *conventional* automotive engine as the air-breathing candidate may be somewhat unfair in the sense that other still-conventional air-breathing engines are, in one respect or other, superior to the familiar spark-ignition piston or rotary combustion engine. All of these alternatives, such as the gas turbine and the Stirling, can be operated on hydrogen, with definite advantages to some. For instance, a hydrogen-fueled gas turbine will be not only cleaner than its hydrocarbon counterpart, it can be designed for higher turbine inlet temperatures because of hydrogen's superior combustion and cooling characteristics.

But for the purpose of this presentation, I have not attempted to develop a case for the alternative hydrogen air-breathers. Yet their

cases must certainly be developed; I leave this as an open issue . . .

The third area of qualification I wish to make concerns *oxygen.* After all, the essential contrast developed here, in hydrogen systems, is an air-breathing versus non-air-breathing situation. We have measured the H_2-conventional engine against the prospective H_2O* advanced, and as yet undeveloped, high-temperature power system. The latter requires that oxygen be supplied to and contained within the vehicle, in addition to the hydrogen.

A significant problem area is safety. As must be emphasized in any prospective use of oxygen, there are definite and peculiar safety problems associated with this chemically very active material. Oxygen is virtually intolerant of dirt or most lubricants, as well as a number of basic materials of construction on the designer's "prohibited" list.

Spontaneous fires and even detonation in confined spaces have resulted in oxygen mishandling or out-of-specification situations which are well known to those in the oxygen business. I am myself very much concerned with what we do about the potential hazard of an oxygen spill on highly combustible asphalt, a situation we will have to face up to, since this material is ubiquitous in the world of automotive transportation.

Yet, once again as demonstrated by not only our *current* space program, but by decades of liquid rocket activities dating back to Peenemunde and to the days of Dr. Goddard's research, liquid oxygen can be safely handled given the proper equipment and adherence to established procedures.

It is nevertheless ironically recorded that the two major disasters experienced in Apollo, the fire on the pad which killed three astronauts and the aborted Apollo 13 mission, were *oxygen*-associated accidents. This is sobering evidence. The Aerospace Safety Research and Data Institute, located at the NASA Lewis Research Center in Cleveland, has compiled the facts on these mishaps as well as most others which involve oxygen. This will be a definitive "data bank" to be exploited in future engineering efforts involving oxygen.

I trust that the above has not disillusioned any would-be advocates of H_2O* for future transportation systems! Perhaps a few heartening words about the *practicability* of working with liquid oxygen in the everyday world should be added to take away any tinge of pessimism which might have been generated by this attempt to inject realism with regard to oxygen.

To demonstrate for yourself the fact that oxygen is in fact amenable to down-to-earth handling and processing by ordinary people, the next time you pass near a medium to large hospital, look around for

the sizable tank, usually surrounded by a chain-link fence, marked "Liquid Oxygen" and somewhere, of course, labeled "No Smoking." Hospital administrators have long known that the cryogenic liquid form is far more economical and practical to store and process for patients' breathing supplies than the high-pressure storage method.

Similarly, most military aircraft carry liquid oxygen for high-altitude breathing requirements of the crews. This saves considerable weight and space aboard the aircraft. As a result, liquid oxygen handling by enlisted personnel of the Air Force and the Navy has been performed in very large quantities over a number of decades with success.

Summing up; Some Suggested Directions for Research

With these qualifications noted: (1) the possibility of synthetic gasoline, (2) the fact that there are many more hydrogen-using engine options than the two types discussed here, and (3) the special precautions necessary with the oxygen component of H_2O^*, let me attempt to sum up my discussion.

First, we have shown that *either* candidate hydrogen-oriented automobile can have "vehicle acceptable" fuel volume and weight characteristics, whether on hydrogen (air-breather) or hydrogen-oxygen. In both cases the tank volume will be the item which may take getting used to. The cost and weight of these cryogenic tanks will also be significantly higher than the simple single-wall sheet metal gas tank we are familiar with.

Also, the cost we will have to pay for H_2, H_2O^* and gasoline (whose price is going to consistently escalate; the day of one dollar per gallon is on the horizon) seem to be "reasonable." They do not depart from one another radically, as I view trends in energy cost.

The real point of the argument carried out here is simply this: in the era of the Hydrogen Economy, there are *two* distinct paths we may follow with regard to automotive transportation system fueling with hydrogen-energy. These are (1) the hydrogen air-breathing vehicles which require filling up only with hydrogen, and (2) the hydrogen-oxygen systems (we have used the H_2O^* nomenclature) which must be fueled with both of these.

The selection of one or the other will have significant impact on the configuration for energy delivery which the Hydrogen Economy will take on. For this reason, we should give early heed to the question of which it will be. Or, if both systems will find application, what will be the balance in the resulting "mix"? And how will this balance shift in time, if at all?

In other words, will the Hydrogen Economy deliver only hydrogen as schematized at the beginning of the article, or will it be a

"twin-pipe" system capable of delivering hydrogen and oxygen to the using sectors? The vote of the automotive vehicle segment of transportation, though but *one* of a number of consumers-to-be of hydrogen energy, must be heard in the decision-making.

Right now, the two candidate approaches, that is, H_2 and H_2O*, are by no means equally well known, or otherwise obvious to even experts in energy and transportation, much less the layman. The hydrogen-converted conventional automobile engine is technically straightforward and is already fairly well demonstrated. One example is the UCLA car. This is not the case with the more advanced hydrogen-oxygen system.

With the architects of the Hydrogen Economy already beginning to formulate our energy system of tomorrow,[7] we will need to determine reasonably soon whether our vehicles will be operating on *just* hydrogen in air-breathing engines, or on hydrogen and oxygen in a "no intake, no exhaust" mode yielding zero pollution and little sound, and capable of cutting our energy bill for automotive transportation in half. For, if the latter system is to be ultimately selected, the Hydrogen Economy's "second pipeline" should be laid in the same trench and buried unobtrusively underground right along with its companion hydrogen pipeline.

7. See Derek P. Gregory, *op. cit.*

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BIBLIOGRAPHY

Gregory, D. P., et al., "The Hydrogen Economy," from *The Electrochemistry of Cleaner Environments,* Bockris, J. O. M., Ed., New York, Plenum Press, 1972.

Proceedings of the 6th and 7th Intersociety Energy Conversion Engineering Conferences held in Boston and San Diego in August, 1971 and September-December, 1972, respectively.

Escher, William J. D., "On the Higher Energy Form of Water (H_2O*) in Automotive Vehicle Advanced Power Systems," Presented at the 7th Intersociety Energy Conversion Engineering Conference, San Diego, September, 1972.

Escher, William J. D., "No Intake, No Exhaust!" Escher Technology Associates Publication PS-2, June, 1971.

Scott, R. B., et. al., Ed., "Technology and Use of Liquid Hydrogen," Pergamon Press, 1964.

Jones, L. W., "Liquid Hydrogen as a Fuel for the Future," *Science,* October 22, 1971.

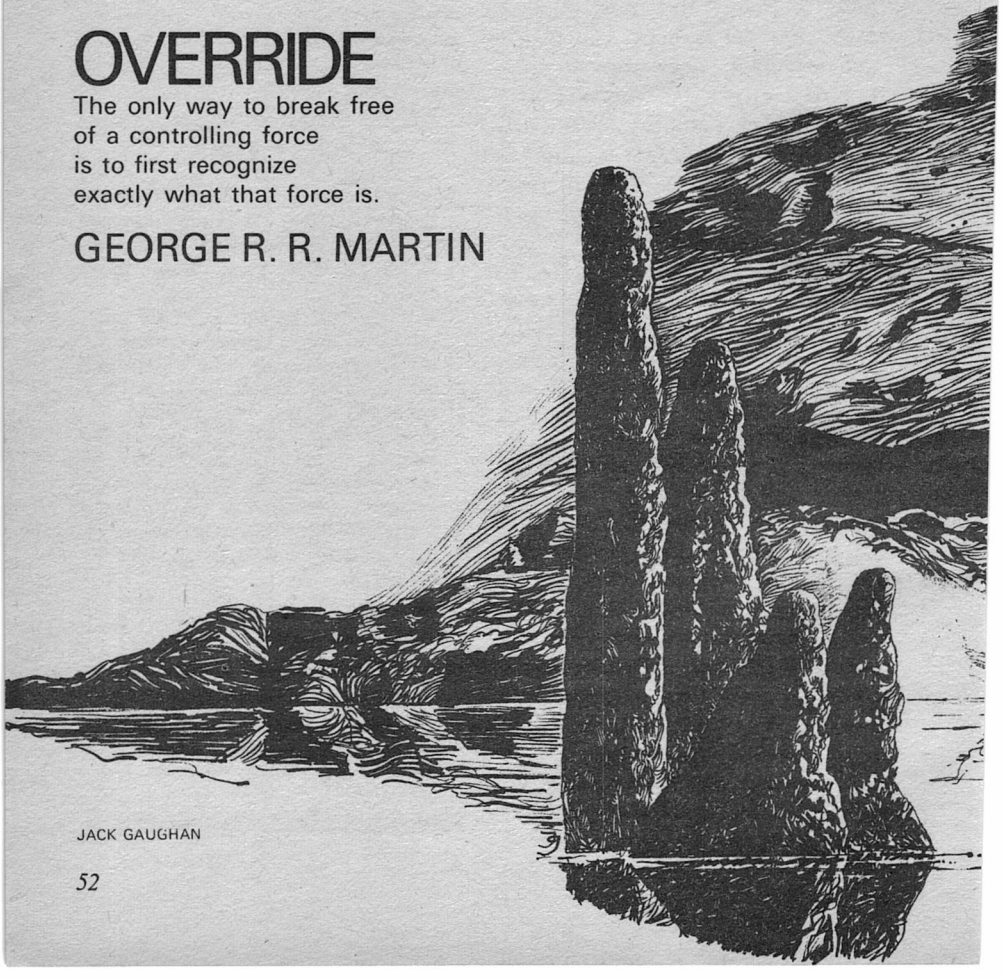
OVERRIDE

The only way to break free
of a controlling force
is to first recognize
exactly what that force is.

GEORGE R. R. MARTIN

Dusk was settling softly over the High Lakes as Kabaraijian and his crew made their way home from the caves. It was a calm, quiet dusk; a twilight blended of green waters and mellow night winds and the slow fading of Grotto's gentle sun. From the rear of his launch, Kabaraijian watched it fall, and listened to the sounds of twilight over the purring of the engine.

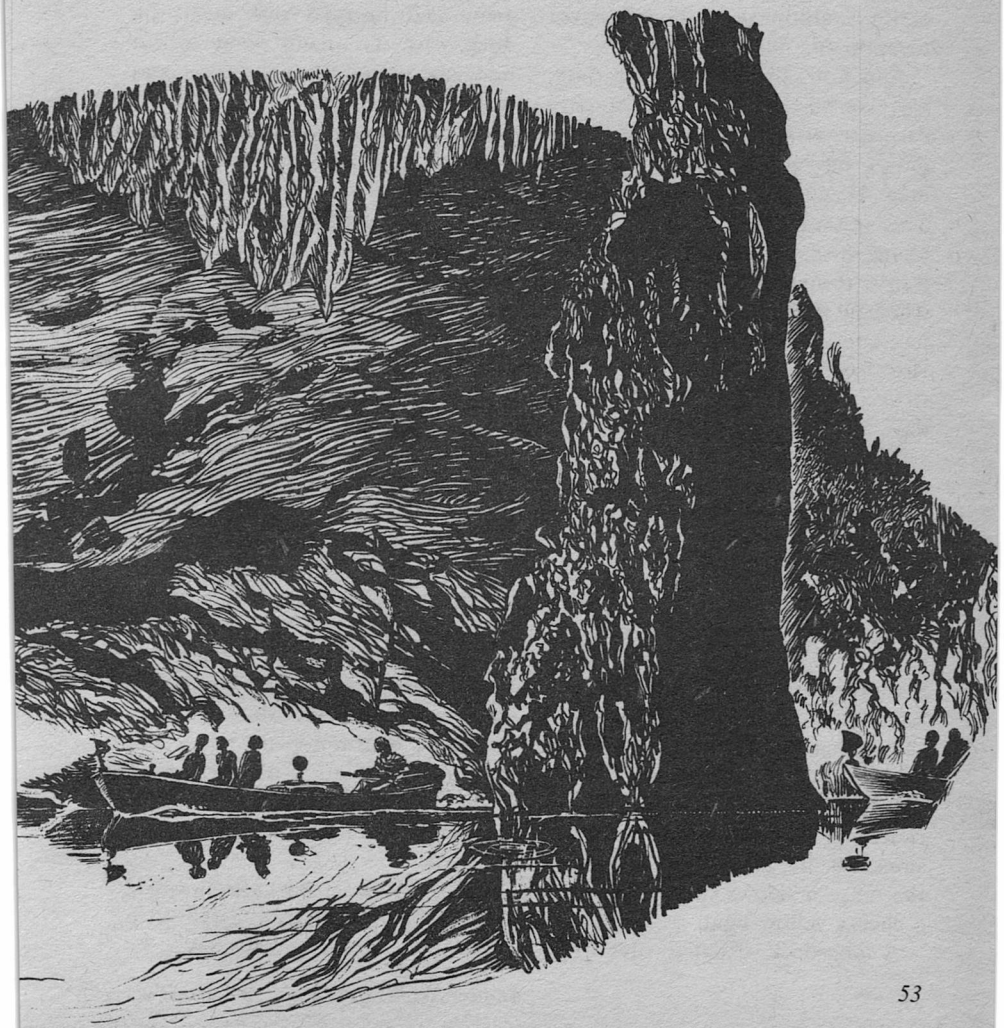
Grotto was a quiet world, but the sounds were there, if you knew how to listen. Kabaraijian knew. He sat erect in the back of the boat, a slight figure with swarthy skin and long black hair and brown eyes that drifted dreamy. One thin hand rested on his knee, the other, forgotten, on the motor. And his ears listened; to the bubbling of the water in the wake of the



JACK GAUGHAN

launch, and the swish-splash of the lakeleapers breaking surface, and the wind moving the trailing green branches of the trees along the near shore. In time, he'd hear the nightflyers, too, but they were not yet up.

There were four in the boat, but only Kabaraijian listened or heard. The others, bigger men with pasty faces and vacant eyes, were long past hearing. They wore the dull gray coveralls of dead men, and there was a steel plate in the back



of each man's skull. Sometimes, when his corpse controller was on, Kabaraijian could listen with their ears, and see with their eyes. But that was work, hard work, and not worth it. The sights and sounds a corpse handler felt through his crew were pale echoes of real sensation, seldom useful and never pleasurable.

And now, Grotto's cooling dusk, was an off-time. So Kabaraijian's corpse controller was off, and his mind, disengaged from the dead men, rested easy in its own body. The launch moved purposefully along the lake shore, but Kabaraijian's thoughts wandered lazily, when he thought at all. Mostly he just sat, and watched the water and the trees, and listened. He'd worked the corpse crew hard that day, and now he was drained and empty. Thought—thought especially—was more effort than he was prepared to give. Better to just linger with the evening.

It was a long, quiet voyage, across two big lakes and one small one, through a cave, and finally up a narrow and swift-running river. Kabaraijian turned up the power then, and the trip grew noisier as the launch sliced a path through the river's flow. Night had settled before he reached the station, a rambling structure of blue-black stone set by the river's edge. But the office windows still glowed with a cheery yellow light.

A long dock of native silverwood fronted the river, and a dozen launches identical to Kabaraijian's were already tied up for the night. But there were still empty berths. Kabaraijian took one of them, and guided the boat into it.

When the launch was secure, he slung his collection box under one arm, and hopped out onto the dock. His free hand went to his belt, and thumbed the corpse controller. Vague sense blurs drifted into his mind, but Kabaraijian shunted them aside, and shook the dead men alive with an unheard shout. The corpses rose, one by one, and stepped out of the launch. Then they followed Kabaraijian to the station.

Munson was waiting inside the office—a fat, scruffy man with gray hair and wrinkles around his eyes and a fatherly manner. He had his feet up on his desk, and was reading a novel. When Kabaraijian entered, he smiled and sat up and put down the book, inserting his leather placemark carefully. "'Lo, Matt," he said. "Why are you always the last one in?"

"Because I'm usually the last one out," Kabaraijian said, smiling. It was his newest line. Munson asked the same question every night, and always expected Kabaraijian to come up with a fresh answer. He seemed only moderately pleased by this one.

Kabaraijian set the collection box down on Munson's desk and opened it. "Not a bad day," he

said. "Four good stones, and twelve smaller ones."

Munson scooped a handful of small, grayish rocks from inside the padded metal box and studied them. Right now they weren't much to look at. But cut and polished they'd be something else again: swirlstones. They were gems without fire, but they had their own beauty. Good ones looked like crystals of moving fog, full of soft colors and softer mysteries and dreams.

Munson nodded, and dropped the stones back into the box. "Not bad," he said. "You always do good, Matt. You know where to look."

"The rewards of coming back slow and easy," Kabaraijian said. "I look around me."

Munson put the box under his desk, and turned to his computer console, a white plastic intruder in the wood-paneled room. He entered the swirlstones into the records, and looked back up. "You want to wash down your corpses?"

Kabaraijian shook his head. "Not tonight. I'm tired. I'll just flop them for now."

"Sure," said Munson. He rose, and opened the door behind his desk. Kabaraijian followed him, and the three dead men followed Kabaraijian. Behind the office were barracks, long and low-roofed, with row on row of simple wooden bunks. Most of them were full. Kabaraijian guided his dead men to three empty ones and maneuvered them in. Then he thumbed his controller off. The echoes in his head blinked out, and the corpses sagged heavily into the bunks.

Afterwards, he chatted with Munson for a few minutes back in the office. Finally the old man went back to his novel, and Kabaraijian back to the cool night.

A row of company scooters sat in back of the station, but Kabaraijian left them alone, preferring the ten-minute walk from the river to the settlement. He covered the forest road with an easy, measured pace, pausing here and there to brush aside vines and low branches. It was always a pleasant walk. The nights were calm, the breezes fragrant with the fruity scent of local trees and heavy with the songs of the nightflyers.

The settlement was bigger and brighter and louder than the river station; a thick clot of houses and bars and shops built alongside the spaceport. There were a few structures of wood and stone, but most of the settlers were still content with the plastic prefabs the company had given them free.

Kabaraijian drifted through the new-paved streets, to one of the outnumbered wooden buildings. There was a heavy wooden sign over the tavern door, but no lights. Inside he found candles and heavy, stuffed chairs, and a real log fire. It

was a cozy place; the oldest bar on Grotto, and still the favorite watering hole for corpse handlers and hunters and other river station personnel.

A loud shout greeted him when he entered. "Hey! Matt! Over here!"

Kabaraijian found the voice, and followed it to a table in the corner, where Ed Cochran was nursing a mug of beer. Cochran, like Kabaraijian, wore the blue-and-white tunic of a corpse handler. He was tall and lean, with a thin face that grinned a lot and a mass of tangled red-blond hair.

Kabaraijian sank gratefully into the chair opposite him. Cochran grinned. "Beer?" he asked. "We could split a pitcher."

"No thanks. I feel like wine tonight. Something rich and mellow and slow."

"How'd it go?" said Cochran.

Kabaraijian shrugged. "O.K.," he said. "Four nice stones, a dozen little ones. Munson gave me a good estimate. Tomorrow should be better. I found a nice new place." He turned toward the bar briefly, and gestured. The bartender nodded, and the wine and glasses arrived a few minutes later.

Kabaraijian poured and sipped while Cochran discussed his day. It hadn't gone well; only six stones, none of them very big.

"You've got to range farther," Kabaraijian told him. "The caves around here have been pretty well worked out. But the High Lakes go on and on. Find someplace new."

"Why bother?" Cochran said, frowning. "Don't get to keep them anyway. What's the percentage in knocking yourself out?"

Kabaraijian twirled the wine glass slowly in a thin, dark hand, and watched the dream-red depths. "Poor Ed," he said, in a voice half-sadness and half-mockery. "All you see is the work. Grotto is a pretty planet. I don't *mind* the extra miles, Ed, I enjoy them. I'd probably travel in my off-time if they didn't pay me to do it. The fact that I get bigger swirlstones and my estimates go up—well, that's extra gravy."

Cochran smiled and shook his head. "You're crazy, Matt," he said affectionately. "Only corpse handler in the universe who'd be happy if they paid him off with scenery."

Kabaraijian smiled too, a slight lifting at the corners of his mouth. "Philistine," he said accusingly.

Cochran ordered another beer. "Look, Matt, you've got to be practical. Sure, Grotto is O.K., but you're not gonna be here all your life." He set down his beer, and pulled up the sleeve of his tunic, to flash his heavy wristlet. The gold shone softly in the candlelight, and the sapphires danced with dark blue flame. "Junk like this was valuable once," Cochran said, "before they learned how to synthesize it. They'll crack swirlstones, too, Matt. You know they will. They already have people working on it.

So maybe you've got two years left, or three. But what then? Then they won't need corpse handlers anymore. So you'll move on, no better off than when you first landed."

"Not really," said Kabaraijian. "The station pays pretty good, and my estimates haven't been bad. I've got some money put away. Besides, maybe I won't move on. I like Grotto. Maybe I'll stay, and join the colonists, or something."

"Doing what? Farming? Working in an office? Don't give me that crap, Matt. You're a corpse handler, always will be. And in a couple years Grotto won't need corpses."

Kabaraijian sighed. "So?" he said. "So?"

Cochran leaned forward. "So have you thought about what I told you?"

"Yes," Kabaraijian said. "But I don't like it. I don't think it would work, first of all. Spaceport security is tight to keep people from smuggling out swirlstones, and you want to do just that. And even if it would work, I don't want any part of it. I'm sorry, Ed."

"I think it *would* work," Cochran said stubbornly. "The spaceport people are human. They can be tempted. Why should the company get all the swirlstones when we do all the work?"

"They've got the concession," Kabaraijian said.

Cochran waved him silent. "Yeah, sure. So what? By what right? We *deserve* some, for ourselves, while the damn things are still valuable."

Kabaraijian sighed again, and poured himself another glass of wine. "Look," he said, lifting the glass to his lips, "I don't quarrel with that. Maybe they should pay us more, or give us an interest in the swirlstones. But it's not worth the risk. We'll lose our crews if they catch us. *And* we'll get expelled.

"I don't want that, Ed, and I won't risk it. Grotto is too good to me, and I'm not going to throw it away. You know, some people would say we're pretty lucky. Most corpse handlers never get to work a place like Grotto. They wind up on the assembly lines of Skrakky, or in the mines of New Pittsburg. I've seen those places. No thanks. I'm not going to risk returning to *that* sort of life."

Cochran threw imploring eyes up to the ceiling, and spread his hands helplessly. "Hopeless," he said, shaking his head. "Hopeless." Then he returned to his beer. Kabaraijian was smiling.

But his amusement died short minutes later, when Cochran suddenly stiffened and grimaced across the table. "Damn," he said. "Bartling. What the hell does *he* want here?"

Kabaraijian turned toward the door, where the newcomer was standing and waiting for his eyes to

adjust to the dim light. He was a big man, with an athletic frame that had gone to pot over the years and now sported a considerable paunch. He had dark hair streaked with white and a bristling black beard, and he was wearing a fashionable multicolored tunic.

Four others had entered behind him, and now stood flanking him on either side. They were younger men than he was, and bigger, with hard faces and impressive builds. The bodyguards made sense. Lowell Bartling was widely known for his dislike of corpse handlers, and the tavern was full of them.

Bartling crossed his arms, and looked around the room slowly. He was smirking. He started to speak.

Almost before he got the first word out of his mouth, he was interrupted. One of the men along the bar emitted a loud, rude noise, and laughed. "Hiya, Bartling," he said. "What are you doing down here? Thought you didn't associate with us low-lifes?"

Bartling's face tightened, but his smirk was untouched. "Normally I don't, but I wanted the pleasure of making this announcement personally."

"You're leaving Grotto!" someone shouted. There was laughter all along the bar. "I'll drink to that," another voice added.

"No," said Bartling. "No, friend, *you* are." He looked around, savoring the moment. "Bartling Associates has just acquired the swirlstone concession, I'm happy to tell you. I take over management of the river station at the end of the month. And, of course, my first act will be to terminate the employment of all the corpse handlers currently under contract."

Suddenly the room was very silent, as the implications of that sank in. In the corner in the back of the room, Cochran rose slowly to his feet. Kabaraijian remained seated, stunned.

"You can't do that," Cochran said belligerently. "We've got contracts."

Bartling turned to face him. "Those contracts can be broken," he said, "and they will be."

"You son of a bitch," someone said.

The bodyguard tensed. "Watch who you call names, meatmind," one of them answered. All around the room, men started getting to their feet.

Cochran was livid with anger. "Damn you, Bartling," he said. "Who the hell do you think you are? You've got no right to run us off the planet."

"I have every right," Bartling said. "Grotto is a good, clean, beautiful planet. There's no place here for your kind. It was a mistake to bring you in, and I've said so all along. Those *things* you work with contaminate the air. And you're even worse. You work with those things, those corpses, *voluntarily,* for money. You disgust me.

You don't belong on Grotto. And now I'm in a position to see that you leave." He paused, then smiled. "Meatmind," he added, spitting out the word.

"Bartling, I'm going to knock your head off," one of the handlers bellowed. There was a roar of agreement. Several men started forward at once.

And jerked to a sudden stop when Kabaraijian interjected a soft, "No, wait," over the general hubbub. He hardly raised his voice at all, but it still commanded attention in the room of shouting men.

He walked through the crowd and faced Bartling, looking much calmer than he felt. "You realize that without corpse labor your costs will go way up," he said in a steady, reasonable voice, "and your profits down."

Bartling nodded. "Of course I realize it. I'm willing to take the loss. We'll use *men* to mine the swirlstones. They're too beautiful for corpses, anyway."

"You'll be losing money for nothing," Kabaraijian said.

"Hardly. I'll get rid of your stinking corpses."

Kabaraijian cracked a thin smile. "Maybe some. But not all of us, Mr. Bartling. You can take away our jobs, perhaps, but you can't throw us off Grotto. I for one refuse to go."

"Then you'll starve."

"Don't be so melodramatic. I'll find something else to do. You don't own all of Grotto. And I'll keep my corpses. Dead men can be used for a lot of things. It's just that we haven't thought of them all yet."

Bartling's smirk had vanished suddenly. "If you stay," he said, fixing Kabaraijian with a hard stare, "I promise to make you very, very sorry."

Kabaraijian laughed. "Really? Well, personally, I promise to send one of my dead men by your house every night after you go to bed, to make hideous faces at the window and moan." He laughed again, louder. Cochran joined him, then others. Soon the whole tavern was laughing.

Bartling turned red and began a slow burn. He came here to taunt his enemies, to crow his triumph, and now they were laughing at him. Laughing in the face of victory, cheating him. He seethed a long minute, then turned and walked furiously out the door. His bodyguards followed.

The laughter lingered a while after his exit, and several of the other handlers slapped Kabaraijian on the back as he made his way back to his seat. Cochran was happy about it, too. "You really took the old man apart," he said when they reached the corner table.

But Kabaraijian wasn't smiling anymore. He slumped down into his seat heavily, and reached almost immediately for the wine. "I

sure did," he said slowly, between sips. "I sure did."

Cochran looked at him curiously. "You don't seem too happy."

"No," said Kabaraijian. He studied his wine. "I'm having second thoughts. That insufferable bigot riled me, made me want to get to him. Only I wonder if I can pull it off. What *can* corpses do on Grotto?"

His eyes wandered around the tavern, which had suddenly become very somber. "It's sinking in," he told Cochran. "I'll bet they're all talking about leaving . . ."

Cochran had stopped grinning. "Some of us will stay," he said uncertainly. "We can farm with the corpses, or something."

Kabaraijian looked at him. "Uh-uh. Machinery is more efficient for farming. And dead men are too clumsy for anything but the crudest kind of labor, much too slow for hunting." He poured more wine, and mused aloud. "They're O.K. for cheap factory labor, or running an automole in a mine. But Grotto doesn't have any of that. They can hack out swirlstones with a vibrodrill, only Bartling is taking that away from us." He shook his head.

"I don't know, Ed," he continued. "It's not going to be easy. And maybe it'll be impossible. With the swirlstone concession under his belt, Bartling is bigger than the settlement company now."

"That was the idea. The company sets us up, and we buy it out as we grow."

"True. But Bartling grew a little too fast. He can really start throwing his weight around now. It wouldn't surprise me if he amended the charter, to keep corpses off-planet. That *would* force us out."

"Can he get away with that?" Cochran was getting angry again, and his voice rose slightly.

"Maybe," Kabaraijian said, "if we let him. I wonder . . ." He sloshed his wine thoughtfully. "You think this deal of his is final?"

Cochran looked puzzled. "He said he had it."

"Yes. I don't suppose he'd crow about it if it wasn't in his pocket. Still, I'm curious what the company would do if someone made them a better offer."

"Who?"

"Us, maybe?" Kabaraijian sipped his wine and considered that. "Get all the handlers together, everybody puts in whatever they have. That should give us a fair sum. Maybe we could buy out the river station ourselves. Or something else, if Bartling has the swirlstones all locked up. It's an idea."

"Nah, it'd never work," Cochran said. "Maybe you've got some money, Matt, but I sure as hell don't. Spent most of it here. Besides, even the guys that have money, you'd never be able to get them together."

"Maybe not," Kabaraijian said. "But it's worth trying. Organizing against Bartling is the only way

we're going to be able to keep ourselves on Grotto in the long run."

Cochran drained his beer, and signaled for another. "Nah," he said. "Bartling's too big. He'll slap you down hard if you bother him too much. I got a better idea."

"Swirlstone smuggling," Kabaraijian said, smiling.

"Yeah," Cochran said with a nod. "Maybe now you'll reconsider. If Bartling's gonna throw us offplanet, at least we can take some of his swirlstones with us. That'd set us up good wherever we go."

"You're incorrigible," Kabaraijian said. "But I'll bet half the handlers on Grotto will try the same thing now. Bartling will expect that. He'll have the spaceport screwed up tight when we start leaving. He'll catch you, Ed. And you'll lose your crew, or worse. Bartling might even try to force through dead-man laws, and start exporting corpses."

Cochran looked uneasy at that. Corpse handlers saw too much of dead men to relish the idea of becoming one. They tended to cluster on planets without dead-man laws, where capital crimes still drew prison terms or "clean" executions. Grotto was a clean planet now, but laws can change.

"I might lose my crew anyway, Matt," Cochran said. "If Bartling throws us out, I'll have to sell some of my corpses for passage money."

Kabaraijian smiled. "You still have a month, even with the worst. And there are plenty of swirlstones out there for the finding." He raised his glass. "Come. To Grotto. It's a lovely planet, and we may stay here yet."

Cochran shrugged and lifted his beer. "Yeah," he said. But his grin didn't hide his worry.

Kabaraijian reported to the station early the next morning, when Grotto's sun was fighting to dispel the river mists. The row of empty launches was still tied to the dock, bobbing up and down in the rapidly-thinning fog.

Munson was inside the office, as always. So, surprisingly, was Cochran. Both of them looked up when Kabaraijian entered.

"Morning, Matt," Munson said gravely. "Ed's been telling me about last night." Today, for some reason, he looked his age. "I'm sorry, Matt. I didn't know anything about it."

Kabaraijian smiled. "I never thought you did. If you *do* hear anything, though, let me know. We're not going to go without a fight." He looked at Cochran. "What are you doing here so early? Usually you're not up until the crack of noon."

Cochran grinned. "Yeah. Well, I figured I'd start early. I'm going to need good estimates this month, if I want to save my crew."

Munson had dug two collection boxes out from under his desk. He handed them to the two corpse handlers, and nodded. "Back

room's open," he said. "You can pick up your dead men whenever you like."

Kabaraijian started to circle the desk, but Cochran grabbed his arm. "I think I'll try way east," he said. "Some caves there that haven't really been hit yet. Where you going?"

"West," said Kabaraijian. "I found a good new place, like I told you."

Cochran nodded. They went to the back room together, and thumbed their controllers. Five dead men stumbled from their bunks and followed them, shuffling, from the office. Kabaraijian thanked Munson before he left. The old man had washed down his corpses anyway, and fed them.

The mists were just about gone when they reached the dock. Kabaraijian marched his crew into the boat and got set to cast off. But Cochran stopped him, looking troubled.

"Uh—Matt," he said, standing on the dock and staring down into the launch. "This new place—you say it's real good?"

Kabaraijian nodded, squinting. The sun was just clearing the treetops, and framing Cochran's head.

"Can I talk you into splitting?" Cochran said, with difficulty. It was an unusual request. The practice was for each handler to range alone, to find and mine his own swirlstone cave. "I mean, with only a month left, you probably won't have time to get everything, not if the place is as good as you say. And I need good estimates, I really do."

Kabaraijian could see that it wasn't an easy favor to ask. He smiled. "Sure," he said. "There's plenty there. Get your launch and follow me."

Cochran nodded and forced a grin. He walked down the dock to his launch, his dead men trailing behind.

Going downriver was easier than going up, and faster. Kabaraijian hit the lake in short order, and sent his launch surging across the sparkling green surface in a spray of foam. It was an exhilarating morning, with a bright sun, and a brisk wind that whipped the water into tiny waves. Kabaraijian felt good, despite the events of the previous night. Grotto did that to him. Out on the High Lakes, somehow, he felt that he could beat Bartling.

He'd run into similar problems before, on other worlds. Bartling wasn't alone in his hatred. Ever since the first time they'd ripped a man's brain from his skull and replaced it with a dead man's synthabrain, there had been people screaming that the practice was a perversion, and the handlers tainted and unclean. He'd gotten used to the prejudice; it was part of corpse handling. And he'd beaten it before. He could beat Bartling now.

The first part of the voyage was

the quickest. The two launches streaked over two big local lakes, past shores lined thickly with silverwood trees and vine-heavy danglers. But then they began to slow, as the lakes grew smaller and choked with life, and the country wilder. Along the banks, the stately silverwoods and curious danglers began to give way to the dense red-and-black chaos of firebriar brambles, and a species of low, gnarled tree that never had received a proper name. The vegetation grew on ground increasingly hilly and rocky, and finally mountainous.

Then they began to pass through the caves.

There were hundreds of them, literally, and they honeycombed the mountains that circled the settlement on all sides. The caves had never been mapped thoroughly. There were far too many of them, and they all seemed to connect with each other, forming a natural maze of incredible complexity. Most of them were still half-full of water; they'd been carved from the soft mountain rock by the streams and rivers that still ran through them.

A stranger could easily get lost in the caves, but strangers never came there. And the corpse handlers never got lost. This was their country. This was where the swirlstones waited, cloaked in rock and darkness.

The launches were all equipped with lights. Kabaraijian switched his on as soon as they hit the first cave, and slowed. Cochran, following close behind, did likewise. The channels that ran through the nearer caves were well-known, but shallow, and it didn't pay to risk tearing out the bottom of your boat.

The channel was narrow at first, and the glistening, damp walls of soft greenish stone seemed to press in on them from either side. But gradually the walls moved farther and farther back, finally peeling away entirely as the stream carried the two launches into a great vaulted underground chamber. The cavern was as big as a spaceport, its ceiling lost in the gloom overhead. Before long the walls vanished into the dark too, and the launches traveled in two small bubbles of light across the gently-stirring surface of a cold black lake.

Then, ahead of them, the walls took form again. But this time, instead of one passage, there were many. The stream had carved one entrance, but a good half-dozen exits.

Kabaraijian knew the cave, however. Without hesitating, he guided his boat into the widest passage, on the extreme right. Cochran followed in his wake. Here the waters flowed down an incline, and the boats began to pick up speed again. "Be careful," Kabaraijian warned Cochran at one point. "The ceiling comes down here." Cochran

acknowledged the shout with a wave of his hand.

The warning came barely in time. While the walls were increasingly farther apart, the stone roof above them was moving steadily closer, giving the illusion that the waters were rising. Kabaraijian remembered the way he'd sweated the first time he'd taken this passage; the boat had been going too fast, and he'd feared getting pinched in by the ceiling, and overwhelmed by the climbing waters.

But it was an idle fear. The roof sank close enough to scrape their heads, but no closer. And then it began to rise again to a decent height. Meanwhile, the channel widened still more, and soft sand shelves appeared along either wall.

Finally there was a branching in the passage, and this time Kabaraijian chose the left-hand way. It was small and dark and narrow, with barely enough room for the launch to squeeze through. But it was also short, and after a brief journey, it released them to a second great cavern.

They moved across the chamber quickly, and entered its twin under a grotesque stone arch. Then came yet another twisting passage, and more forks and turns. Kabaraijian led them calmly, hardly thinking, hardly *having* to think. These were his caves; this particular section of undermountain was his domain, where he'd worked and mined for months. He knew where he was going. And finally he got there.

The chamber was big, and haunting. Far above the shallow waters, the roof had been eaten through by erosion, and light poured in from three great gashes in the rock. It gave the cavern a dim greenish glow, as it bounced off the pale green walls and the wide, shallow pool.

The launches spilled from a thin crack in the cave wall, carried by rushes of cold black water. The water turned green when it hit the light, and tumbled and warmed and slowed. The boats slowed, too, and moved leisurely across the huge chamber toward the white sand beaches that lined the sides.

Kabaraijian pulled up by one such beach, and hopped out into the shallow water, dragging his launch up onto the sand. Cochran followed his example, and they stood side by side when both boats were safely beached.

"Yeah," said Cochran, looking around. "It's nice. And it figures. Leave it to you to find a pretty place to work, while the rest of us are up to our ankles in water, clutching lights."

Kabaraijian smiled. "I found it yesterday," he said. "Completely unworked. Look." He pointed at the wall. "I barely started." There was a pile of loose stones in a rough semicircle around the area he'd been working, and a large bite missing from the rock. But most of

the wall was untouched, stretching away from them in sheets of shimmering green.

"You sure no one else knows about this place?" Cochran asked.

"Reasonably. Why?"

Cochran shrugged. "When we were coming through the caves, I could have sworn I heard another launch behind us somewhere."

"Probably echoes," Kabaraijian said. He looked toward his launch. "Anyway, we better get going." He hit his corpse controller, and the three still figures in the boat began to move.

He stood stock-still on the sand, watching them. And as he watched, somewhere in the back of his head, he was also watching himself with their eyes. They rose stiffly, and two of them climbed out onto the sand. The third walked to the chest in the front of the launch, and began unloading the equipment; vibrodrills and picks and shovels. Then, his arms full, he climbed down and joined the others.

None of them were really moving, of course. It was all Kabaraijian. It was Kabaraijian who moved their legs, and made their hands clasp and their arms reach. It was Kabaraijian, his commands picked up by controller and magnified by synthabrain, who put life into the bodies of the dead men. The synthabrains keep the automatic functions going, but it was the corpse handler who gave the corpse its will.

It wasn't easy, and it was far from perfect. The sense impressions thrown back to the handler were seldom useful; mostly he had to watch his corpses to know what they were doing. The manipulation was seldom graceful; corpses moved slowly and clumsily, and fine work was beyond them. A corpse could swing a mallet, but even the best handler couldn't make a dead man thread a needle, or speak.

With a bad handler, a corpse could hardly move at all. It took coordination to run even one dead man, if the handler was doing anything himself. He had to keep the commands to the corpse separate from the commands to his own muscles. That was easy enough for most, but the task grew increasingly complex as the crew grew larger. The record for one handler was twenty-six corpses; but all *he'd* done was march them, in step. When the dead men weren't all doing the same thing, the corpse handler's work became much more challenging.

Kabaraijian had a three-crew; all top meat, corpses in good condition. They'd been big men, and they still were; Kabaraijian paid premiums for food to keep his property in good condition. One had dark hair and a scar along a cheek, another was blond and young and freckled, the third had mousy brown locks. Other than that, they were interchangeable; all

about the same height and weight and build. Corpses don't have personality. They lose that with their minds.

Cochran's crew, climbing out onto the sand in compliance with his work orders, was less impressive. There were only two of them, and neither was a grade-one specimen. The first corpse was brawny enough, with wide shoulders and rippling muscles. But his legs were twisted matchsticks, and he stumbled often and walked more slowly than even the average corpse. The second dead man was reedy and middle-aged, bald and undermuscled. Both were grimy. Cochran didn't believe in taking care of his crew the way Kabaraijian did. It was a bad habit. Cochran had started as a paid handler working somebody else's corpses; upkeep hadn't been his concern.

Each of Kabaraijian's crew bent and picked up a vibrodrill from the stack of equipment on the sand. Then, parallel to each other, they advanced on the cave wall. The drills sank humming holes into the porous rock, and from each drill bite a network of thin cracks branched and grew.

The corpses drilled in unison until each drill was sunk nearly to its hilt, and the cracks had grown finger-wide. Then, almost as one, they withdrew the drills and discarded them in favor of picks. Work slowed. Crack by crack, the corpses attacked the wall, laboriously peeling off a whole layer of greenish stone. They swung the picks carefully, but with bone-jarring force, untiring, relentless. Incapable of pain, their bones could scarce feel the jars.

The dead men did all the work. Kabaraijian stood behind, a slight, dark statue in the sand, with hands on hips and eyes hooded. He did nothing but watch. Yet he did all. Kabaraijian *was* the corpses; the corpses were Kabaraijian. He was one man in four bodies, and it was his hand that guided each blow, though he did not touch a tool.

Forty feet down the cave, Cochran and his crew had unpacked and set to work. But Kabaraijian was barely conscious of them, though he could hear the hum of their vibrodrills and the hammering of their picks. His mind was with his corpses, chipping at his wall, alert for the telltale grayish glitter of a swirlstone node. It was draining work; demanding work; tense and nervous. It was a labor only corpse crews could do with real efficiency.

They'd tried other methods a few short years before, when men had first found Grotto and its caves. The early settlers went after swirlstones with automoles, tractor-like rockeaters that could chew up mountains. Problem was, they also chewed up the fragile, deep-buried swirlstones, which often went unrecognized until too late. The company discovered that careful hand

labor was the only way to keep from chipping or shattering an excessive number of stones. And corpse hands were the cheapest hands you could buy.

Those hands were busy now, tense and sweating as the crew peeled whole sections of rock off the broken wall. The natural cleavage of the stone was vertical, which sped the work. Find a crack—force in a pick—lean back and pull—and, with a snap, a flat chunk of rock came with you. Then find a new crack, and begin again.

Kabaraijian watched unmoving as the wall came down, and the pile of green stone accumulated around the feet of his dead men. Only his eyes moved; flicking back and forth over the rock restlessly, alert for swirlstones but finding nothing. Finally he pulled the corpses back, and approached the wall himself. He touched it, stroked the stone, and frowned. The crew had ripped down an entire layer of rock, and had come up empty.

But that was hardly unusual, even in the best of caves. Kabaraijian walked back to the sand's edge, and sent his crew back to work. They picked up vibrodrills and attacked the wall again.

Abruptly he was conscious of Cochran standing beside him, saying something. He could hardly make it out. It isn't easy to pay close attention when you're running three dead men. Part of his mind detached itself and began to listen.

Cochran was repeating himself. He knew that a handler at work wasn't likely to hear what he said the first time. "Matt," he was saying, "listen. I think I heard something. Faintly, but I heard it. It sounded like another launch."

That was serious. Kabaraijian wrenched his mind loose from the dead men, and turned to give Cochran his full attention. The three vibrodrills died, one by one, and suddenly the soft slap of water against sand echoed loudly around them.

"A launch?"

Cochran nodded.

"You sure?" Kabaraijian said.

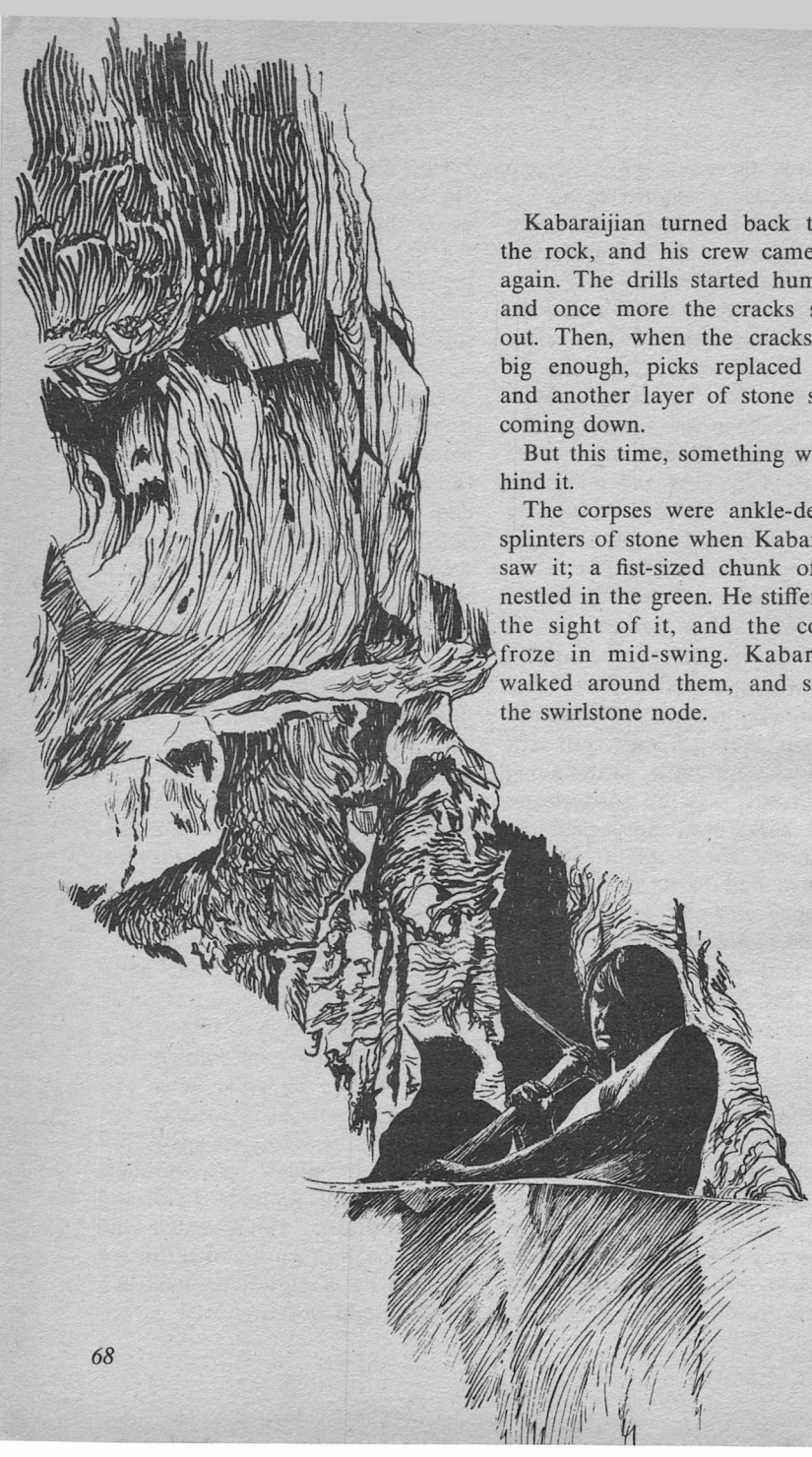
"Uh—no," said Cochran. "But I *think* I heard something. Same thing as before, when we were moving through the caves."

"I don't know," Kabaraijian said, shaking his head. "Don't think it's likely, Ed. Why would anyone follow us? The swirlstones are everywhere, if you bother to look."

"Yeah," Cochran said. "But I heard something, and I thought I should tell you."

Kabaraijian nodded. "All right," he said. "Consider me told. If anyone shows up, I'll point out a section of wall and let him work it."

"Yeah," Cochran said again. But somehow he didn't look satisfied. His eyes kept jumping back and forth, agitated. He wheeled and walked back down the sand, to the section of wall where his own corpses stood frozen.



Kabaraijian turned back toward the rock, and his crew came alive again. The drills started humming, and once more the cracks spread out. Then, when the cracks were big enough, picks replaced drills, and another layer of stone started coming down.

But this time, something was behind it.

The corpses were ankle-deep in splinters of stone when Kabaraijian saw it; a fist-sized chunk of gray nestled in the green. He stiffened at the sight of it, and the corpses froze in mid-swing. Kabaraijian walked around them, and studied the swirlstone node.

It was a beauty; twice the size of the largest stone he'd ever brought in. Even damaged, it would be worth a fortune. But if he could pry it loose intact, his estimate would set a record. He was certain of that. They'd cut it as one stone. He could almost see it. An egg of crystalline fog, smoky and mysterious, where drifting veils of mist shrouded half-seen colors.

Kabaraijian thought about it, and smiled. He touched the node lightly, and turned to call to Cochran.

That saved his life.

The pick sliced through the air where his head had been and smashed against the wall with awful impact, barely missing the swirlstone node. Sparks and rock chips flew together. Kabaraijian stood frozen. The corpse drew the pick back over its head for another swing.

Within, Kabaraijian reeled, staggered. The pick swung down. Not at the wall; at him.

Then he moved, barely in time, throwing himself to one side. The blow missed by inches, and Kabaraijian landed in the sand and scrambled quickly to his feet. Crouched and wary, he began to back away.

The corpse advanced on him, the pick held over his head.

Kabaraijian could hardly think. He didn't understand. The corpse that moved on him was dark-haired and scarred; *his* corpse. *HIS* corpse. *HIS CORPSE!?*

The corpse moved slowly. Kabaraijian kept a safe distance. Then he looked behind him. His other two dead men were advancing from other directions. One held a pick. The other had a vibrodrill.

Kabaraijian swallowed nervously, and stopped dead. The ring of corpses tightened around him. He screamed.

Down the beach, Cochran was looking at the tableau. He took one step toward Kabaraijian. From behind him, there was a blur of something being swung, and a dull thud. Cochran spun with the blow, and landed face down in the sand. He did not get up. His barrel-

chested, gimpy corpse stood over him, pick in hand, swinging again and again. His other corpse was moving down the cave, toward Kabaraijian.

The scream was still echoing in the cave, but now Kabaraijian was silent. He watched Cochran go down, and suddenly he moved, throwing himself at the dark-haired dead man. The pick descended, vicious but clumsy. Kabaraijian dodged it. He bowled into the corpse, and both of them went down. The corpse was much slower getting up. By the time he did rise, Kabaraijian was beyond him.

The corpse-handler moved back, step by slow step. His own crew was in front of him now, stumbling toward him with weapons raised. It was a chilling sight. Their arms moved, and they walked. But their eyes were blank and their faces were dead—*DEAD!* For the first time, Kabaraijian understood the horror some people felt near dead men.

He looked over his shoulder. Both of Cochran's corpses were heading his way, armed. Cochran still had not risen. He lay with his face in the sand and the waters lapping at his boots.

His mind began to work again, in the short breather he was granted. His hand went to his belt. The controller was still on, still warm and humming. He tested it. He reached out, to his corpses, into them. He told them to stand still, to drop their tools, to freeze.

They continued to advance.

Kabaraijian shivered. The controller was still working; he could still feel the echoes in his head. But somehow, the corpses weren't responding. He felt very cold.

And colder when it finally hit him, like ice water. Cochran's corpses hadn't responded either. Both crews had turned on their handlers.

Override!

He'd heard of such things. But he'd never seen one, or dreamt of seeing one. Override boxes were very expensive and even more illegal, contraband on any planet where corpse handling was allowed.

But now he was seeing one in action. Someone wanted to kill him. Someone was trying to do just that. Someone was using his own corpses against him, by means of an override box.

He threw himself at his corpses mentally, fighting for control, grappling for whatever had taken them over. But there was no struggle, nothing to come to grips with. The dead men simply failed to respond.

Kabaraijian bent and picked up a vibrodrill.

He straightened quickly, spinning around to face Cochran's two corpses. The big one with the matchstick legs moved in, swinging its pick. Kabaraijian checked the blow with the vibrodrill, holding it above him as a shield. The dead

man brought the pick back again.

Kabaraijian activated the drill and drove it into the corpse's gut. There was an awful second of spurting blood and tearing flesh. There should have been a scream too, and agony. But there wasn't.

And the pick came down anyway.

Kabaraijian's thrust had thrown the corpse's aim off, and the blow was a glancing one, but it still ripped his tunic half off his chest and clawed a bloody path from shoulder to stomach. Reeling, he staggered back against the wall, empty-handed.

The corpse came on, pick swinging up again, eyes blank. The vibrodrill transfixed it, still humming, and the blood came in wet red spurts. But the corpse came on.

No pain, Kabaraijian thought, with the small part of his mind not frozen with terror. The blow wasn't immediately fatal, and the corpse can't feel it. It's bleeding to death, but it doesn't know it, doesn't care. It won't stop till it's dead. *There's no pain!*

The corpse was nearly on top of him. He dropped to the sand, grabbed a hunk of rock, and rolled.

Dead men are slow, woefully slow; their reflexes are long-distance ones. The blow was late and off-target. Kabaraijian rolled into the corpse and knocked it down. Then he was on top of it, the rock clutched in his fist, hammering at the thing's skull, smashing it again and again, breaking through to the synthabrain.

Finally, the corpse stopped moving. But the others had reached him. Two picks swung almost simultaneously. One missed entirely. The other took a chunk out of his shoulder.

He grabbed the second pick, and twisted, fighting to stop it, losing. The corpses were stronger than he was, much stronger. The dead man wrenched the pick free and brought it back for another try.

Kabaraijian got to his feet, smashing into the corpse and sending it flailing. The others swung at him, grabbed at him. He didn't stay to fight. He ran. They pursued, slow and clumsy but somehow terrifying.

He reached the launch, seized it with both hands, and shoved. It slid reluctantly across the sand. He shoved again, and this time it moved more easily. He was drenched in blood and sweat, and his breath came in short gasps, but he kept shoving. His shoulder shrieked agony. He let it shriek, putting it to the side of the launch and finally getting the boat clear of the sand.

Then the corpses were on him again, swinging at him even as he climbed into the launch. He started the motor and flipped it to top speed. The boat responded. It took off in a sudden explosion of foam, slicing across the green waters toward the dark slit of safety in the

far cavern wall. Kabaraijian sighed . . . and the corpse grabbed him.

It was in the boat. Its pick was buried uselessly in the wood, but it still had its hands, and those were enough. It wrapped those hands around his neck, and squeezed. He swung at it madly, smashing at its calm, empty face. It made no effort to ward off the blows. It ignored them. Kabaraijian hit it again and again, poked at the vacant eyes, hammered at its mouth until its teeth shattered.

But the fingers on his neck grew tighter and tighter, and not all his struggling could pry one loose. Choking, he stopped kicking the corpse, and kicked the rudder control.

The launch veered wildly, leaning from side to side. The cave rushed past in a blur, and the walls moved in on them. Then came sudden impact, the shriek of tearing wood, and the short tumble from launch to water. Kabaraijian landed on top, but they both went under. The corpse held its grip through everything, dragging Kabaraijian down with it, still choking the life from his throat.

But Kabaraijian took a deep breath before the green closed over him. The corpse tried to breathe underwater. Kabaraijian helped it. He stuck both hands into its mouth and kept it open, making sure it got a good lungful of water.

The dead man died first. And its fingers weakened.

Finally, his lungs near bursting, Kabaraijian forced his way free, and kicked to the surface. The water was only chest high. He stood on the unmoving corpse, keeping it under while he sucked in great drafts of air.

The launch had impaled itself on a crest of jagged rocks that rose from the water off to one side of the exit. The passage from the cave was still at hand, outlined in shadow a few short feet away. But now, was it safety? Without a launch? Kabaraijian considered making his way out on foot, and gave up the idea instantly. There were too many miles to go before he reached simple daylight, let alone the safety of the river station. It would mean being hunted in the darkness by whatever remained of his corpse crew. The prospect sent a chill down his back. No, better to stay and face his attacker.

He kicked free of the corpse, and moved to the debris of his launch, still hung up on the rocks that had caught it. Shielded by the wreck, he'd be difficult to find, or at least to see. And if his enemy couldn't see him, it would be hard to send the corpses against him.

Meanwhile, maybe he could find his enemy.

His enemy. Who? Bartling, of course. It had to be Bartling, or one of his hirelings. Who else?

But *where?* They had to be close, within sight of the beach. You can't

run a corpse by remote control; the sense feedback isn't good enough. The only senses you get are vision and hearing, and them dimly. You have to *see* the corpse, see what it's doing, and what you want it to do. So Bartling's man was around here somewhere. In the cave. But where?

And how? Kabaraijian considered that. It must be the other launch that Cochran had heard. Someone must have been following them, someone with an override box. Maybe Bartling had a tracer put on his launch during the night.

Only how'd he know *which* launch to trace?

Kabaraijian bent slightly so only his head showed above the water, and looked out around the end of the ruined launch. The beach was a white sand smear across the dim green length of the huge cavern. There was no noise but the water slapping the side of the boat. But there was motion. The second launch had been pulled free of the sand, and one of the corpses was climbing on board. The others, moving slowly, were wading out into the underground pool. Their picks rested on their shoulders.

They were coming for him. The enemy suspected he was still here. The enemy was hunting for him. Again, he was tempted to dive toward the exit, to run and swim back toward daylight, out of this awful dimness where his own corpses stalked him with cold faces and colder hands.

He squelched the impulse. He might get a head start while they searched the cavern. But, with the launch, they'd make it up in no time. He could try to lose them in the intricacies of the caves. But if they got ahead of him, they could just wait at caves' end. No, no. He had to stay here, and find his enemy.

But *where?* He scanned the cave, and saw nothing. It was a great expanse of murky green; stone and water and beaches. The pool was dotted by a few large rocks rising from the water. A man might be hiding behind them. But not a launch. There was nothing big enough to hide a launch. Maybe the enemy wore aquagear? But Cochran had heard a launch . . .

The corpse boat was halfway across the cavern, heading for the exit. It was his dead man seated at the controls, the brown-haired one. The other two corpses trailed, as they walked slowly across the shallow pool in the wake of the launch.

Three dead men; stalking. But somewhere their handler was hiding. The man with the override box. Their mind and their will. But where?

The launch was coming closer. Was it leaving? Maybe they thought he'd run for it? Or . . . no, probably the enemy was going to blockade the exit, and *then* search the cave.

Did they see him? Did they know where he was?

Suddenly he remembered his corpse controller, and his hand fumbled under water to make sure it was still intact. It was. And working; controllers were watertight. It no longer controlled. But it still might be useful . . .

Kabaraijian closed his eyes, and tried to shut off his ears. He deliberately blotted his senses, and concentrated on the distant sensory echoes that still murmured in his mind. They were there. Even vaguer than usual, but less confused; there were only two sets of images now. His third corpse floated a few feet from him, and it wasn't sending anything.

He twisted his mind tight, and listened, and tried to see. The blurs began to define themselves. Two pictures, both wavering, took form, superimposed over each other. A sense tangle, but Kabaraijian pulled at the threads. The pictures resolved.

One corpse was waist-deep in green water, moving slowly, holding a pick. It could see the shaft of the tool, and the hand wrapped around it, and the gradually-deepening water. But it wasn't even looking in Kabaraijian's direction.

The second dead man was in the launch, one hand resting on the controls. It wasn't looking either. It was staring down, at the instruments. It took a lot of concentration for a corpse to run any sort of machine. So the handler was having it keep a firm eye on the engine.

Only it could see more than just the engine. It had a very good view of the entire launch.

And suddenly everything fell into place. Certain now that the wrecked launch hid him from view, Kabaraijian moved farther back into its shadow, then threw a hand over the side and pulled himself on board, crouching so he wouldn't be found. The rocks had torn a hole in the bottom of the boat. But the tool chest was intact. He crawled to it, and flipped it open. The corpses had unpacked most of the mining equipment, but there was still a repair kit. Kabaraijian took out a heavy wrench and a screwdriver. He shoved the screwdriver into his belt, and gripped the wrench tightly. And waited.

The other launch was nearly on top of him, and he could hear the purr of its motor and the water moving around it. He waited until it was next to his boat. Then he stood up suddenly, and jumped.

He landed smack in the middle of the other boat, and the launch rocked under the impact. Kabaraijian didn't give the enemy time to react—at least not the time it takes a corpse. He took a single short step, and brought the wrench around in a vicious backhanded blow to the dead man's head. The corpse slumped back. Kabaraijian bent, grabbed its legs, and lifted.

And suddenly the dead man was no longer in the launch.

And Kabaraijian, wheeling, was looking down at the stunned face of Ed Cochran. He hefted the wrench with one hand even as his other reached for the controls, and upped the speed. The boat accelerated, and dove toward the exit. Cave and corpses vanished behind, and darkness closed in with the rocky walls. Kabaraijian switched on the lights.

"Hello, Ed," he said, hefting the wrench again. His voice was very steady and very cold.

Cochran breathed a noisy sigh of relief. "Matt," he said. "Thank God, I just came to. My corpses—they—"

Kabaraijian shook his head. "No, Ed, it won't wash. Don't bother me with that, please. Just give me the override box."

Cochran looked scared. Then, fighting, he flashed his grin. "Heh. You gotta be kiddin', right? I don't have no override box. I told you I heard another launch."

"There was no other launch. That was a set-up, in case you failed. So was that blow you took on the beach. I'll bet that was tricky—having your corpse swing the pick so you got hit with the side instead of the point. But it was very well done. My compliments, Ed. That was good corpse handling. As was the rest. It isn't easy to coordinate a five-crew doing different things simultaneously. Very nice, Ed. I underestimated you. Never thought you were that good a handler."

Cochran stared at him from the floor of the launch, his grin gone. Then his gaze broke, and his eyes went back and forth between the walls that pressed around them.

Kabaraijian waved the wrench again, his palm sweaty where he gripped it. His other hand touched his shoulder briefly. The bleeding had stopped. He sat slowly, and rested his hand on the motor.

"Aren't you going to ask me how I knew, Ed?" Kabaraijian said. Cochran, sullen, said nothing. "I'll tell you anyway," Kabaraijian continued. "I saw you. I looked through the eyes of my corpse, and I saw you huddled here in the boat, lying on the floor and peeking over the side to try and spot me. You didn't look dead at all, but you looked very guilty. And suddenly I got it. *You* were the only one with a clear view of that stuff on the beach. *You* were the only one in the cave."

He paused, awkward. His voice broke a little, and softened. "Only—why? *Why,* Ed?"

Cochran looked up at him again. He shrugged. "Money," he said. "Only money, Matt. What else?" He smiled; not his usual grin, but a strained, tight smile. "I like you, Matt."

"You've got a peculiar way of showing it," Kabaraijian told him.

He couldn't help smiling as he said it. "Whose money?"

"Bartling's," said Cochran. "I needed money real bad. My estimates were low, I didn't have anything saved. If I had to leave Grotto, that would've meant selling my crew just for passage money. Then I'd be a hired handler again. I didn't want that. I needed money fast."

He shrugged. "I was going to try smuggling some swirlstones, but you didn't make that sound good. And last night I got another idea. I didn't think that crap about organizing us and outbidding Bartling would work, but I figured he'd be interested. So I went to see him after I left the tavern. Thought he might pay a little for the information, and maybe even make an exception, let me stay."

He shook his head dourly. Kabaraijian stayed silent. Finally Cochran resumed. "I got to see him, him with three bodyguards. When I told him, he got hysterical. You'd humiliated him already, and now he thought you were on to something. He—he made me an offer. A lot of money, Matt. A *lot* of money."

"I'm glad I didn't come cheap."

Cochran smiled. "Nah," he said. "Bartling really wanted you, and I made him pay. He gave me the override box. Wouldn't touch it himself. He said he'd had it made in case the 'meatminds' and their 'zombies' ever attacked him." Cochran reached into the pocket of his tunic, and took out a small, flat cartridge. It looked like a twin for the controller on his belt. He flipped it lightly through the air at Kabaraijian.

But Kabaraijian made no effort to catch it. The box sailed past his shoulder, and hit the water with a splash.

"Hey," said Cochran. "You shoulda got that. Your corpses won't respond till you turn it off."

"My shoulder's stiff," Kabaraijian started. He stopped abruptly.

Cochran stood up. He looked at Kabaraijian as if he were seeing him for the first time. "Yeah," he said. His fists clenched. "Yeah." He was a full head taller than Kabaraijian, and much heavier. And suddenly he seemed to notice the extent of the other's injuries.

The wrench seemed to grow heavier in Kabaraijian's hand. "Don't," he warned.

"I'm sorry," Cochran said. And he dove forward.

Kabaraijian brought the wrench around at his head, but Cochran caught the blow before it connected. His other hand reached up and wrapped itself around Kabaraijian's wrist, and twisted. He felt his fingers going numb.

There was no thought of fair play, or mercy. He was fighting for his life. His free hand went to his waist and grabbed the screwdriver. He pulled it out, and stabbed. Cochran gasped, and his grip sud-

denly loosened. Kabaraijian stabbed again, and twisted up and out, ripping a gash in tunic and flesh.

Cochran reeled back, clutching at his stomach. Kabaraijian followed him and stabbed a third time, savagely. Cochran fell.

He tried to rise once, and gave it up, falling heavily back to the floor of the launch. Then he lay there, bleeding.

Kabaraijian went back to the motor, and kept the boat clear of the walls. He guided them down the passages smoothly, through the caves and the tunnels and the deep green pools. And in the harsh boat light, he watched Cochran.

Cochran never moved again, and he spoke only once. Just after they had left the caves and come out into the early afternoon sun of Grotto, he looked up briefly. His hands were wet with blood. And his eyes were wet too. "I'm sorry, Matt," he said. "I'm damn sorry."

"Oh, *God!*" Kabaraijian said, his voice thick. And suddenly he stopped the boat dead in the water, and bent to the supply cache. Then he went to Cochran and dressed and bandaged his injuries.

When he reached the controls again, he flipped the speed up to maximum. The launch streaked across the glittering green lakes.

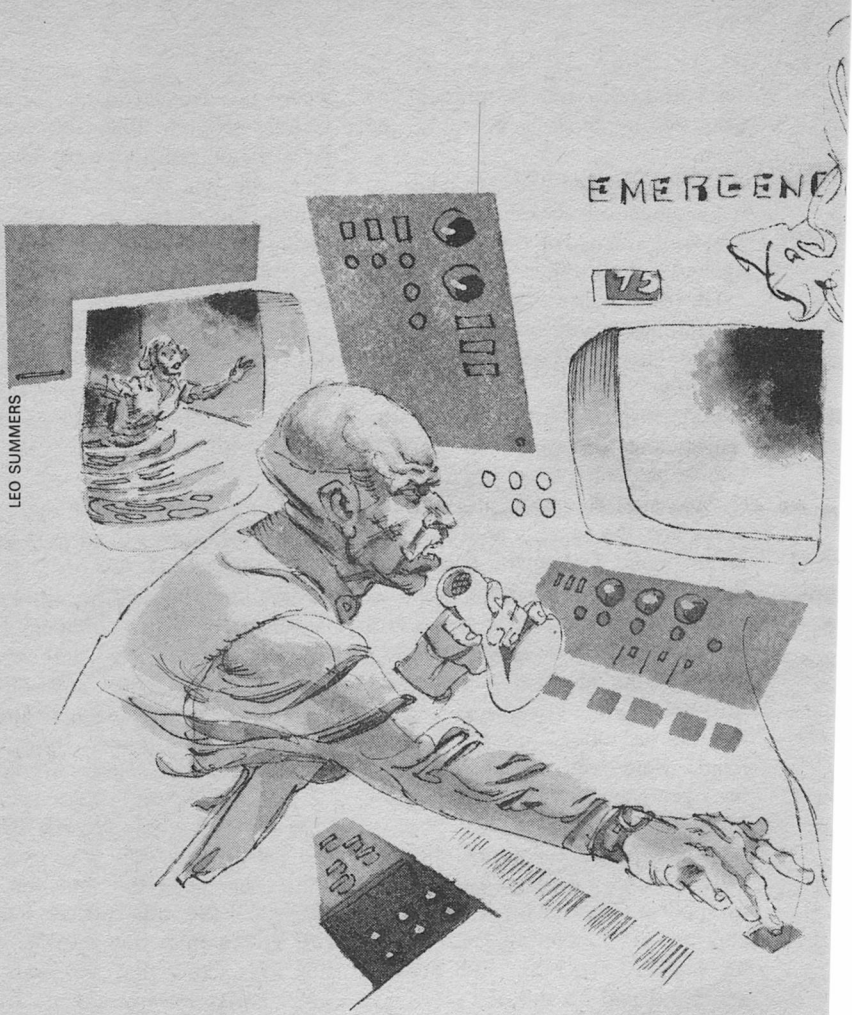
But Cochran died before they reached the river.

Kabaraijian stopped the boat then, and let it float dead in the water. He listened to the sounds of Grotto around him; the rush of river water pouring into the great lake, the songbirds and the daywings, the ever-active lakeleapers arcing through the air. He sat there until dusk fell, staring upriver, and thinking.

He thought of tomorrow and the day after. Tomorrow he must return to the swirlstone caves. His corpses should have frozen when he moved out of range; they should be salvageable. And one of Cochran's crew was still there, too. Maybe he could still piece together a three-crew, if the corpse he'd pushed overboard hadn't drowned.

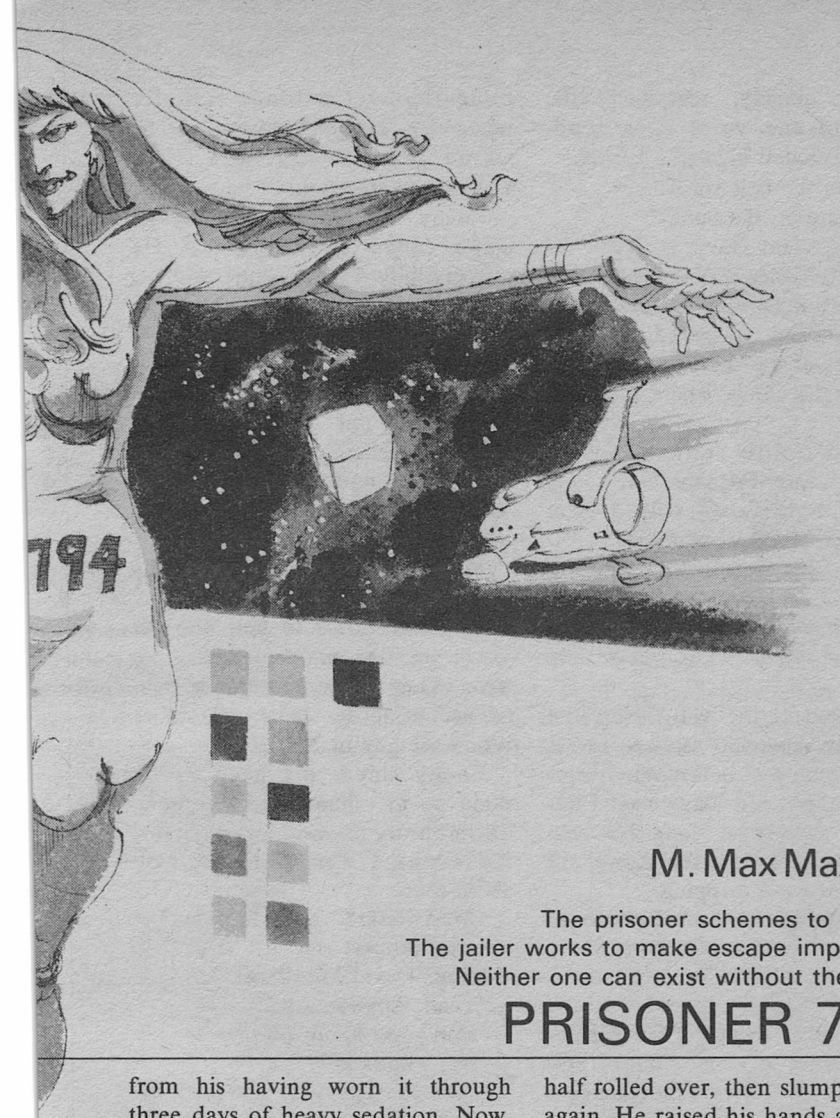
And there were swirlstones there, big ones. He'd get that egg of dancing fog, and turn it in, and get a good estimate. Money. He had to have money, all he could scrape together. Then he could start talking to the others. And then . . . and then Bartling would have a fight on his hands. Cochran was one casualty, the first. But not the last. He'd tell the others that Bartling had sent a man out with an override box, and that Cochran had been killed because of it. It was true. It was all true.

That night Kabaraijian returned with only one corpse in his launch, a corpse that was strangely still and unmoving. Always his corpses had walked behind him into the office. That night the corpse rode on his shoulder. ■



The cell was perfect, if you have any concern with the perfection of cells. It was a cube, slightly less than ten feet on a side on its interior, and fitted with practically every conceivable convenience imaginable except escape routes. It was in a stationary orbit at zero degrees latitude, with a vehicular rotation giving it an artificial gravity of one G at the cell's floor.

Davy McAllister lay sprawled unconscious on the bunk, his prison garb rumpled and soiled badly



M. Max Maxwell

The prisoner schemes to escape.
The jailer works to make escape impossible.
Neither one can exist without the other.

PRISONER 794

from his having worn it through three days of heavy sedation. Now, as he gradually came out from under, various sensors and receptors were activated, causing mysterious machine functions to operate on the cell's exterior. He groaned and half rolled over, then slumped back again. He raised his hands and covered his face, then sat up suddenly as he came awake.

"What the hell," he said.

"Was that a question, Prisoner 794?"

Davy quickly identified the source of the voice as a loudspeaker situated high in a corner.

"Where the hell am I?"

"You are on the bunk."

"Great," said Davy, correctly assuming the voice was that of a machine, not a human. He rolled off the bunk and staggered out into the center of the cell.

"All right, thing, where the devil is it?"

"Would you rephrase your request, please, Prisoner 794?"

"The bathroom, stupid. I'm filthy. Where's the bathroom?"

"Do you wish to use the shower?"

"You're damn right I do, and a couple of other things. Now hop to!"

A section of the wall facing him sank back, then slid aside to reveal a fully equipped bathroom. Everything worked, and Davy stayed under the shower so long his skin shriveled. He turned the shower off and stepped out dripping.

"Hey, thing, what am I supposed to dry off with, and how about some clothes?"

Some miles away on the surface of the planet at Penal Control Station 6, it was time for the changing of the guard. Sam Caleb, a big man with a bald head and a handlebar moustache, passed through the security system on his way to work. It was a nice day and he had nearly called in sick, but he'd never done that yet without actually being sick, and nice day or not he wasn't going to start now. He'd wait for his vacation.

Jimmy was at the console, an empty coffee cup before him. He was dutifully filling out the shift report, copying the digits from the readout displays beneath the shifting cell monitors.

"Hi, Sam."

"Anything up?"

"Not much. Got a new one in 794. Something funny about him."

"Another one! This station's overloaded as it is."

"Central claims we can handle four more."

"Central's going to find out different the first real emergency we have. They place too much confidence in those stupid optibrains. Who's the guy in 794?"

Jimmy shook his head as he stood up to relinquish the console. "Somebody named McAllister. Something I wanted to tell you about him . . ."

"McAllister?" said Sam as he lowered himself into the seat. "No kidding? David McAllister?"

"Yeah. Anyway . . ."

"Don't you know who he is?"

"No, who is he?"

"He's the guy who invented the optibrain, the optical computer. He got the Nobel prize for it. Then the idiot damn near killed the President when the government confiscated his company."

"Oh, yeah. I kind of remember.

He wouldn't sell them the rights to the machine. Unpatriotic son of a gun. That was two years ago, though."

"Yeah. They just got around to sentencing him a few days ago."

"He got exiled for not selling his brain?"

"No, for slugging the President."

"Oh. Yeah. Well, gotta go, Sam. See you tomorrow."

Sam Caleb nodded, already absorbed with shifting monitor displays, slightly disappointed at his co-worker's apathy. Jimmy never did tell him about David McAllister, that the new prisoner was the only one yet who had neither searched frantically for an escape route, nor sunk hopelessly in despair as he realized he was actually in a maximum security exile cell.

"O.K., dummy," said Davy to the cell. "How does the kitchen work? Do I get a menu or do I have to tolerate what you belch up?"

"Would you rephrase the question, please, Prisoner 794?"

"Nope. You figure it out. I know you're smart enough for that one."

"You must rephrase your request, Prisoner 794."

"Who the hell programmed you?"

"That information is not available, Prisoner 794."

"I don't doubt it. The idiot's probably too embarrassed to identify himself. Look, stupid, what are the key words?"

"Kitchen, work, menu . . ."

"What associations can you draw?"

"Food, cooking, dishes . . ."

"I think you've got the idea."

"Do you wish to eat, Prisoner 794?"

"Brilliant!"

"There is a menu, Prisoner 794. Do you wish to see it?"

"I do, you fantastic smear of cretinism."

The same section of the cell wall which had previously displaced itself with a bathroom now opaqued, then glowed to life as a holographic display screen. Soft green letters of the menu floated in three dimensions against a yellow background.

"You may visually examine any selection which appeals to you, Prisoner 794."

"Yeah? Let me see the chicken casserole and, uh, some banana pie, and a glass of cola."

Instantly the requested food appeared on the screen.

"It looks terrible," said Davy. "But I guess it'll do. Let's have it. We'll have to work on that menu."

Sam Caleb scowled at the monitor, perplexed, unable to put his finger on it, but nonetheless knowing something wasn't quite right about Cell 794. Still, there were other cells to monitor and he had spent too much time on this one already. He cursed the optibrain

for being so like the human brain, unable to rationally analyze itself.

There was a major disturbance in Cell 767, indicated by the red flashing numerals, hotly demanding his attention. And in Cell 782 there was something slightly wrong, indicated by constantly glowing yellow numbers. Sam punched the code for a visual presentation of Cell 767 and realized immediately what was wrong. The prisoner there had found the optibrain's "eyes" and covered them with towels. Luckily the eyes were removed some distance from the television camera through which Sam viewed the cell's interior. The situation no doubt seemed terribly important to Cell 767's optibrain, but it could wait. He switched to a view of Cell 782. There was nothing apparently wrong.

"Penal Control Station 6 to Cell 782," said Sam into his mike. "What's the problem?"

"Cell 782 to Penal Control Station 6," answered the optibrain. "Malfunction in oxygen recycling system, losing air pressure control. Now operating on reserve tanks."

"Good Lord! Give me visual of the oxygen recycling system."

"Unable to comply. Camera has been destroyed by intense heat. All other systems functioning properly with the exception of . . ."

"Get that man into a spacesuit! Now! Do you copy, Cell 782?"

"Message received and understood, Penal Control Station 6."

Sam switched to the Rover communications system and selected a broadcast frequency.

"Penal Control Station 6 to Rover 2. Penal Control Station 6 to Rover 2."

"Got you five-by, Station 6, What's up?"

"At coordinates alpha-six-jerry, Cell 782 has lost its oxygen. The whole system blown into space. Only reserve tanks are supplying the prisoner."

"Say no more, Station 6. We'll get him out."

"Thanks, Rover 2. Station 6 out."

Sam quickly switched back to the cell comm frequency band.

"Penal Control Station 6 to Cell 782. Is your man in his spacesuit yet?"

"Affirmative, Penal Control Station 6."

As he spoke, Sam recycled the control panel for a new view of Cell 782's interior.

"Let me have audio with the prisoner."

"That is strictly forbidden."

"I'm overriding that. Title 76, the Penal Code, Section 12, Paragraph 4, Subparagraph 1. 'In the event of an emergency threatening the life or safety of an exiled prisoner, any ground control officer currently in charge shall have the power to disregard any restriction previously imposed.' Do you understand, Cell 782?"

There was a slight pause. "Message received and understood. You

now have voice contact with Prisoner 782, Penal Control Station 6."

Sam quickly flipped through the prisoner roster and found Prisoner 782's name.

"George, can you hear me?"

"Who's there?"

"This is Penal Control Station 6. Your oxygen recycling system has been blown into space, but a rescue vessel is on its way. Pull the face plate down and clamp it shut; you're losing air pressure."

Prisoner George was visibly shaken by the stresses he was enduring. His fingers trembled so violently he could only barely get the face plate on his spacesuit clamped shut.

"All right, good," said Sam. "Are you still on this channel, Cell 782?"

"Sure, I'm here," said George.

"Affirmative," answered the optibrain.

"Get an air hose to your man from the reserve tanks, and contact me on voice channel as soon as you carry out the command."

"Message received and understood," said the optibrain.

"Penal Control Station 6 to Cell 767," said Sam. "Are you still blind to your prisoner?"

"Affirmative, Penal Control Station 6."

"*Ask* your prisoner to remove the towels."

"Roger, roger."

Sam shook his head, wondering what clown had programmed this one.

"He refuses, Penal Control Station 6."

"*Tell* him to remove the towels."

"Roger." There was a pause, then: "He does not answer."

"All right. Pass a charge through the cell, one hundred volts, one amp. Wait sixty seconds and inform your prisoner the electricity will stop when he removes the towels. If he removes the towels, stop the charge. If he does not, increase it by one amp and repeat the process every sixty seconds. Do you copy, Cell 767?"

"Rogerighto," replied the optibrain.

"Cell 782 to Penal Control Station 6."

"Go ahead, Cell 782," said Sam.

"Prisoner 782 has been supplied with an air hose. He has attached it properly to his spacesuit."

"Can you hear me, George?"

"Sure, man. When's that ship gonna get here?"

"Soon. You look O.K. How do you feel?"

"Scared. And cold."

"Good. That's the oxygen. There's a temperature control on your left shoulder. Turn it up now. I'm going to have your optibrain shut off cabin air. O.K., George?"

"Yes. I guess so."

"Cell 782," said Sam.

"Waiting."

"Shut off cabin air. Focus all monitors on your man. If anything happens, anything at all, I want you to tell me about it."

"Message received and understood, Penal Control Station 6."

"Cell 767, has interior vision been restored?"

"Affirmative, baby."

Emergency or no, Sam still had a responsibility to forty-six other prisoners. As quickly as he could he punched video coordinates and examined each of the other cells in turn. Everything was apparently all right, but, he paused a little longer when he came to Cell 794. Something bothered him, something he couldn't precisely define. What was it?

Davy McAllister lounged extravagantly on the bunk, his legs propped lazily up against the wall, a glass of sweet fizz water balanced precariously beside him.

"Hey, thing, did your programmer give you a name?"

"I am called Cell 794."

"Yeah. Original as hell. Does that mean there are seven hundred and ninety-three other slobs stuck up here like me?"

"I am not allowed to divulge that information."

"I'll bet you aren't. Well, I'm gonna change your name."

"I will answer to practically any voice signal."

"We'll have to work on that some other time. Right now we're concerned with your name. What sex are you?"

"Sex?"

"Surely they gave you a sex. Which are you, a he or a she?"

"You will have to rephrase your request, Prisoner 794."

"I think I'll make you a she. O.K., thing, project me an image of a girl. Nothing fancy, just a girl."

The optibrain complied.

"O.K. Jinx on the blond hair. Make it dark brown with red that you can't really see unless the light hits it square, and make it longer. Too long. Yeah. A little more up top. Right. Say, not bad."

"Compliment registered," said the machine.

"*That* I can hang a name on. Let's see, something simple, but pretty. Anna. I'll call you Anna. You hear that, thing? Your name is Anna."

"If that is what you wish to call me, Prisoner 794."

"Uh-huh, and that'll be the last of that. My name is David McAllister. People who don't know me call me David or Mr. McAllister. My close friends call me Davy. Everybody else calls me Mac. You call me Mac."

"Yes, Mac."

"Now about that voice . . ."

Cell 795 was activated and fully prepared when Rover 2 dropped George into his new home. Sam monitored the transfer and kept a heavy spot check on Prisoner George until he was satisfied the man was safely requartered.

With life somewhat more settled he ordered the station optibrain to

deliver him a cup of coffee. Sam eased back in the body-flexive chair, having set the console for automatic random scan, and gazed at the monitors, only half seeing them.

One of these days it wasn't going to work. The stupidity of the optibrains, the incompetence of their programmers, the fate of chance mistakes and errors of slovenliness, all these and more would add up to a stupendous disaster that the safeguard, the single human at the monitor, would not be able to avert.

Exile, when it had first been established in 1975 as an alternative to capital punishment, had seemed like a perfect solution to a serious social problem. A condemned man or woman was placed in solitary confinement, more than adequately cared for by a computer program backed up by a human at a monitor, never seeing, hearing, touching his fellow man, with no hope of reprieve. There was no pretense at rehabilitation; that was reserved for lesser criminals guilty of lesser crimes. Exile, originally, was reserved for those who must be permanently removed from society.

Then, in 1982, David McAllister patented the optical computer, a holographically based simulation of the human brain which wasn't a computer at all, but to call it that made it somehow less ominous to those who feared the takeover of man by machines.

McAllister's new company, M.I.D. (Media InDeterminants), grew so fast, and invaded so many fields, that by the end of its first year it was already the third largest industry in the United States, topped only by communications and government. Many economists attributed this growth to the unique product, but others centered on the human dynamo who owned the product, the company, and the know-how to make both of them go.

His employees were incredibly loyal, much of that loyalty traceable to the great degree of participation they all enjoyed in running the company. Besides, they were all overpaid.

But in 1983 big government clashed with big business. The U.S. wanted the optibrain, but McAllister was not willing to let them have it. In a series of brilliant legal maneuvers, his lawyers had fully protected him and the company; to take the optibrain, the government would have to commit a crime. But with only the law standing between it and the machine, the government changed the law. In an unprecedented session, both chambers of Congress met together, passed the necessary bill, and sent it directly to the President, who signed it immediately. The next day M.I.D. was a government owned and operated business similar to the U.S. Postal Service.

With the finesse and subtlety of

a rutting bull moose, the government attempted to behave as though it had done nothing wrong, as though it were operating for the good of the greatest number of people. With national television covering the event, the President, at a dinner gathering of business leaders, awarded David McAllister a medal invented for the occasion in recognition of his contributions to national defense and the median standard of living. McAllister was there, an unexpected occurrence itself, and he walked proudly from his seat to accept the medal from the President. All had assumed that McAllister had succumbed, so that what happened next came as an overwhelming shock.

Davy took the medal and the President started to step back from the microphone, but Davy stopped him with a friendly hand on his arm. Davy was smiling and the President was smiling. Dishes tinkled happily throughout the large hall, and bored businessmen belched discreetly and lighted cigars or stirred cups of steaming coffee. No one noticed the vise-like grip with which Davy held the President, no one but the President, and he was smiling.

"I reject this medal," said Davy. "With great contempt and scorn I reject this medal and the evil system which has generated it."

Davy dropped the medal on the floor and stomped his boot heel down on it. Then he turned and spat on the face of the President of the United States of America. A low rumble of shocked awe swept the hall. Davy released the President and turned to leave. Secret Service agents converged in panic toward the speaker's podium. And the President, reacting for the first time as a man and not the embodiment of a nation, reached out in anger to retaliate.

Davy's reaction was rapid and vicious. His right fist slammed into the President's middle and his left elbow arced violently against his face. Then the Secret Service agents were there and it was all over for Davy as a heavy weight closed around his consciousness.

No one knew exactly what the government was doing with the optibrain. Somehow it was tied in with the gargantuan "defense" system of the country, and there were definite indications some portions—if not all—of control of national transportation and communications systems had been turned over to optibrains.

But Sam Caleb knew of at least one other place the optibrain had found employment, and there was no telling how many other places. And Sam, along with several million other Americans, secretly thought David McAllister was somewhat justified in his symbolic defiance to a growingly supreme authority.

Yes, certainly it was more economical to orbit the cells and thus,

automatically, make them maximum security cells. But the economy was not worth a prisoner's life, not even a condemned prisoner's life, unless society was willing to revert to the barbaric practice of murdering its murderers. Too much hinged on the performance capabilities of the optibrains, and with the contempt which only familiarity can breed, Sam was questioning more and more the optibrains' ability to perform their functions.

Before Sam Caleb had returned the next day to relieve Jimmy at the console, Davy McAllister had succeeded in effecting several changes in his environment.

Cell 794's optibrain now behaved with a totally feminine personality named Anna. It talked to Davy through a holographic projection tailored to Davy's specifications, greatly modified since its original appearance. Its voice was rich and sexy. And its intelligence level, under Davy's expert tutelage, was on the rise. Neither the optibrain, nor anyone in the U.S. Penal Service, had any suspicion that Davy was modeling Cell 794 after another Anna, one who looked startlingly like the holographic image the optibrain projected.

"Anna?"

"Yes, Mac?" answered the optibrain expectantly.

"I'm bored, Anna."

"There are games, various entertainment tapes in the library . . ."

"No, Anna. Look, I'm an inventor. I like to make gadgets. Do you have anything like a supply of electronic components, maybe something I could put a few printed circuits together with? And a laser welder would be nice."

"I'm sorry, Mac. I have none of those things available to give you. I'm not even sure I could let you have them, even if I did."

"Oh. Well, look, they must resupply you periodically. How about seeing if you could get them to send up a few of those things. Tell you what; you tell them they can have anything I come up with. Tell them I've got an idea for a long-range, laser-based transceiver that will require absolutely no equipment at the remote location."

"I will ask, Mac."

"Fine, Anna. Fine." Davy's smile was genuine.

When Cell 794 transferred David McAllister's request to Penal Control Station 6, it did so in the very feminine voice of Anna. Sam Caleb, on duty at the time, did not answer at first. (Was there any possibility of the original programmers being saboteurs?) So far as he knew, it was standard procedure to give the optibrains rather blasé, neutered voices, definitely not those of mature, seductive women.

"Cell 794 to Penal Control Station 6," repeated the optibrain.

"Go ahead, 794."

"Prisoner 794 has made a special

request requiring your approval and an unusual supply of materials."

Sam checked the prisoner roster and stared at the name there, David McAllister. Too many things felt wrong here; the uneasy feeling he had had yesterday and again today, a female optibrain, and on only his second day McAllister had succeeded in getting his optibrain to relay messages for him. Sam had no way of knowing just how successful Davy had been at getting his optibrain to relay messages.

"Repeat the request, Cell 794."

And that was the turn of the key in the lock. Davy was almost as good as free. From a well-secreted location in the Andes a laser beam lanced precisely toward an orbiting maximum security cell labeled 794 by the U.S. Penal Service. Under normal circumstances the beam would have triggered an automatic alarm system that would have simultaneously notified the commanding Penal Control Station and traced the beam to its source. But in this instance Cell 794 did not recognize the beam for what it was; instead it mistook the beam for a highly sophisticated redundancy of itself. Cell 794 had no reason to suspect that its prisoner had long ago invented the device he had requested materials for earlier.

Sam Caleb denied the request.

Davy accepted the news with a yawn. "Uhm, too bad. I really wanted that stuff, too. Let's have a look at that revised menu, Anna."

"Yes, Mac."

Two hours later, his belly full, soft music playing, a double Scotch in his hand (strictly against the Penal Code, but very good booze), Davy continued the refinement of Cell 794's personality. It was rough going; he must remember everything exactly with no embellishments and no errors. It all paid off just as he was beginning to suspect he had made some error after all.

"Davy, you cad, you could at least have put some clothes on me."

The voice was all around him, and it also came from the speaker. Davy spun around and came face to face with the ghost of Anna, the real Anna, holographically projected life size in the center of the cell.

"Oh, Baby, am I glad to see you. What took you so long?"

"It was the name. You had the thing calling you Mac, and I always call you Davy. And you call me Baby and other endearments."

Davy slapped his forehead. "How stupid."

"I wouldn't say that, Davy. You remembered everything else. I'm really flattered."

What happened next was never clear to anyone, especially Sam Caleb. The plan, according to M.I.D. agents interviewed later, was to

create an artificial emergency requiring Davy's evacuation from the cell and into one of the Penal Service's Rover patrol craft. It was a laborious plan, the product of a great many people working long and hard for two years for just this moment, marred by only two mistakes, one major and one minor. The major error was Davy's assumption that any "artificial" emergency would have to be in fact real in order to get by the human sitting at the control console. The minor mistake was the general assumption that the government would not tamper with the optibrain's basic design.

The fact that the government had tampered with Davy's original design probably accounted for the high degree of unreliability experienced by people like Sam Caleb. The tampering most certainly resulted in the failure of Cell 794. The failure was destined to occur; the execution of Davy's plan only served to hasten it.

Anna was supposed to assume control of the optibrain, first by posing as its harmonic, then by force of will, bit by bit. It was precisely at the time Anna succeeded in causing the failure of Cell 794's life-support system that the optibrain failed beyond repair, its hologram bank melted beyond recovery. And at Sam Caleb's monitor in Penal Control Station 6, the danger signal went almost unheeded among two other danger signals flashing red at the same time.

Sam glared at the monitor, knowing this was it; now would be the time he would lose a prisoner.

"Penal Control Station 6 to Rover 2. Penal Control Station 6 to Rover 2."

"Go ahead, 6," answered the spacecraft.

"Emergency in quadrant alpha, coordinates seven-tango. Proceed to that location and await instruction. Cells 692 and 705 are in trouble."

"Copy," answered the spacecraft.

Sam adjusted the broadcast frequency. "Penal Control Station 6 to Rover 4. Penal Control Station 6 to Rover 4."

"Rover 4 to Station 6, we copy."

"Emergency at coordinates alpha-two-baker. Cell 794 is in trouble."

"On the way, Station 6."

"I will advise," said Sam.

Sam again adjusted the broadcast frequency. "Cell 705, what's your problem?"

"Cell 705 to Penal Control Station 6. Prisoner 705 is immobile in a prone position on the cell floor. Life systems are indicated as functional but minimal. Oxygen supply is normal and functional; no indication of pollutants."

Sam finally got a video of Cell 705's interior. The prisoner was sprawled on the floor in a messy pool of vomit.

"All right, Cell 705. Keep monitoring your prisoner and keep me advised."

"Roger, Penal Control Station 6."

"Penal Control Station 6 to 692."

"Cell 692 to Penal Control Station 6."

"What's wrong?"

But the query was unnecessary. As Sam scrambled the dials for a video of Cell 692's interior it soon became highly evident what was wrong. The cell was half full of water and the prisoner, a middle-aged murderess, was flailing about, shouting curses at the optibrain between reminders that she couldn't swim.

"Cell 692 to Penal Control Station 6. Plumbing failure, unable to effect repairs."

"All right. Increase cabin air pressure to three atmospheres, but slowly!"

"Message understood. Increasing air pressure."

"Keep me posted, Cell 692. Penal Control Station 6 to Cell 794."

No answer.

Sam repeated the call. Still no answer.

A fourth flashing red light caused his attention to waver and he cursed violently and demanded that Cell 794 respond. Cell 794 did not respond, and Sam was unable to pull in a video of the cell's interior. Feedback readouts were blank; there was no power being emitted from the cell. Sam shot a high-energy radar beam at the cell and read the meters: something was happening there because he got back more than a mere reflection, but not much more.

What Sam got back was some of the power of the laser beam Anna was using to transmit her holographic image to the interior of Davy's cell. Other than that unnatural glow there was no light, no power. The air was already getting stale and cold, and Davy was working frantically at a jammed locker hatch, trying to pull the spacesuit out.

"Davy, it's no use," said Anna, her holographic image the only thing functioning in the cell besides Davy. "I've tried everything, but nothing works. The hologram bank has melted."

"Uh!" said Davy as he got the spacesuit free from its trap. "Don't get excited, Babe. They know I'm in trouble. The plan can still work."

"No. It can't, Davy. There's no way I can get this thing to grapple the Rover. And even if I could, we couldn't leave the two men here like we planned. They would die as quickly as you."

Davy's shoulders slumped as he accepted the truth. Unhurriedly he wormed his way into the spacesuit and with Anna's guidance managed to get all the closures properly sealed and the air hose from the reserve tanks attached. It was only a matter of waiting now.

He smiled, It would just take longer than he had expected. They

would try again. But then, that's the way it always was. Everything took longer than he expected. Nothing ever worked for him the first time.

"Penal Control Station 6 to Rover 4. What's ETA at target?"

"Two minutes," answered the spacecraft. "We're locked on now."

"Be advised, Rover 4," said Sam. "Cell 794 has no power, repeat, NO power."

"We copy, Station 6."

Sam adjusted the broadcast frequency. "Penal Control Station 6 to Rover 2."

"Go ahead, Station 6."

"Priority order is as follows: first Cell 705, then Cell 692. Repeat, first Cell 705, then Cell 692. Prisoner 705 is unconscious with unknown biomedical malfunctions. Food poisoning is indicated. Cell 692 is flooded, but temporary measures are being applied."

"Roger, Station 6. We're coming alongside Cell 705 now."

"Roger, Rover 2. I will advise you on entry method for Cell 692."

"Roger."

Again Sam adjusted the broadcast frequency. "Penal Control Station 6 to Rover 5."

"Rover 5. Go ahead, Station 6."

"Proceed to coordinates alpha-five-omega. Cell 760 is in trouble."

"Roger."

"Sam switched over to the cell comm system. "Penal Control Station 6 to Cell 760. What's the problem?" As he talked he adjusted the monitors for a video of Cell 760's interior. Nothing appeared to be wrong. The prisoner was walking back and forth, displaying the classic caged animal syndrome.

"Cell 760 to Penal Control Station 6. I have experienced a rather discomforting thermostatic malfunction, discomforting to Prisoner 760, that is. Temperature variations are rather extreme for human tolerance, ranging from a chilly minus fifteen degrees centigrade, to a hothouse warm thirty-nine degrees centigrade. Presently the temperature is a comfortable twenty-one degrees centigrade, but on the rise."

"Can't you bypass the primary thermostat?"

"I have already accomplished that feat, Penal Control Station 6," answered the optibrain sarcastically. "The present dilemma has resulted from the inopportune failure of the auxiliary system."

"All right, Cell 760. Bypass the auxiliary and allow interior temperature to drop. Give your prisoner access to all the clothing and bedding in your stores, and tell him what's going on. Rover 5 is proceeding to your location and will effect repairs."

"Oh, marvy, Penal Control . . ."

But Sam cut the optibrain short. "Penal Control Station 6 to Cell 705. What's your status?"

"Cell 705 to Penal Control Station 6. Rover 2 has docked with

me and U.S. Penal Service personnel are currently administering aid to Prisoner 705."

"Give me audio with the crew of Rover 2."

During the expected hesitation, while the optibrain considered the legality of the order, Sam brought in a video. The two men from Rover 2, both in spacesuits with face plates open, were busily cramming the prisoner into his own spacesuit.

"You have audio, Penal Control Station 6."

"Station 6 to Rover 2."

One of the men looked around. "Yeah!"

"I'll be monitoring your frequency. Advise me as soon as you're prepared to proceed to Cell 692."

"O.K. Won't be long."

"Penal Control Station 6 to Cell 692. What's your status?"

"Cell 692 to Penal Control Station 6. Water level measures eighty-seven centimeters in cell interior. Several secondary malfunctions as a result of electrical shorting. High air pressure reported by prisoner to be extremely uncomfortable."

"Does your air lock still work?"

"Affirmative, Penal Control Station 6. Air lock is flooded but functional."

"All right. Get your prisoner in a spacesuit and then into the air lock. Once she's in the air lock bring the pressure down to zero atmospheres but keep her suit pressure up to three atmospheres. Do not attempt to decrease her air pressure."

"Message received and understood, Penal Control Station 6."

"Good. Rover 2 will pick up your prisoner."

"Roger, Penal Control Station 6."

On the video monitor Sam could see that the crew of Rover 2 was nearly ready to leave with Prisoner 705. He adjusted the broadcast frequency of the Rover comm system.

"Penal Control Station 6 to Rover 5."

"Go ahead, Station 6."

"Cell 760 has a temperature control failure. Can you effect repairs without entering the cell?"

"Think so, Station 6. We'll let you know if we have to enter."

"Thanks. Station 6 out."

"Rover 2 to Penal Control Station 6. We're on our way."

Sam spun his frequency control to its proper location.

"Roger, Rover 2. Prisoner 692 will be in the air lock. Do not attempt to enter without making sure the prisoner has been properly suited. Her suit pressure will be three atmospheres. She will need medical attention. How is prisoner 705?"

"He's pretty sick, but he should make it. We'll take them both to Moon Base 3. Will you advise them of the status of our passengers? ETA at Moon Base 3 . . . five hours plus."

"Roger, Rover 2. I will advise

Moon Base 3. Nice job so far. Station 6 out."

Sam adjusted the broadcast frequency still another time. "Penal Control Station 6 to Rover 4."

There was no answer. Sam Caleb felt the sweat in the palms of his hands and on his forehead. His uniform shirt was sopping, and the sweat rolling down his ribs was maddening. There were many reasons a Rover spacecraft might not answer, only one of which was the death of the crew.

"Penal Control Station 6 to Rover 4."

"Go ahead, Station 6."

Sam exhaled, his relief audible to the crew of Rover 4.

"What's your status, Rover 4?"

"We've picked up the prisoner. Listen, how did you manage to get him suited up and hooked into the air supply? Cell 794's hologram bank is completely destroyed."

Sam had no answer for that.

"Is the prisoner all right?"

"He's fine. Seems awful mad about something, though."

"Roger, Rover 4. Transfer him to Cell 796. I will activate it for you."

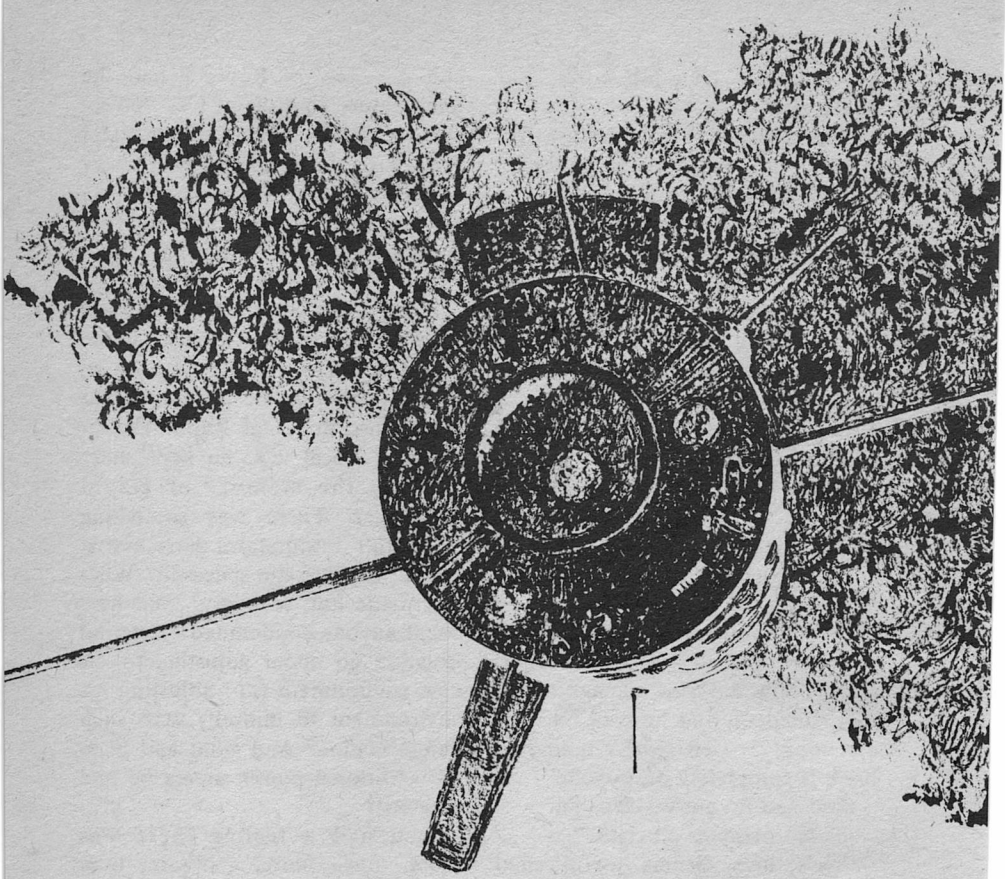
"Roger, Station 6."

The rest of the shift Sam was busy overseeing the cleanup operations of four optibrain failures. As it turned out he didn't lose any of his prisoners after all. Normal scanning operations took a back seat, but no other emergencies arose. Moon Base 3 took the news of two pending arrivals with indifference, and the crew of Rover 5 had the temperature controls of Cell 760 repaired within a half hour after their arrival. Prisoner 794, Davy McAllister, was deposited safely in his new cell, number 796, and operations returned to normal about twenty minutes before shift change.

It was only after Sam had been relieved and was on his way home that he began reliving the event. Sitting alone in an iso-module of the Transcontinental Rapid Transit System's Local 228, he kept snagging on the memory of David McAllister. There was something he didn't understand here. How *had* he got into the spacesuit? What had made him so angry? And how could anyone condemned to eternal isolation go about adjusting to his new environment (no! adjusting his environment to himself) with such determination? And what had been the additional power source he had detected?

Sam had a feeling there was more, much more, going on than he had any way of perceiving. What was it?

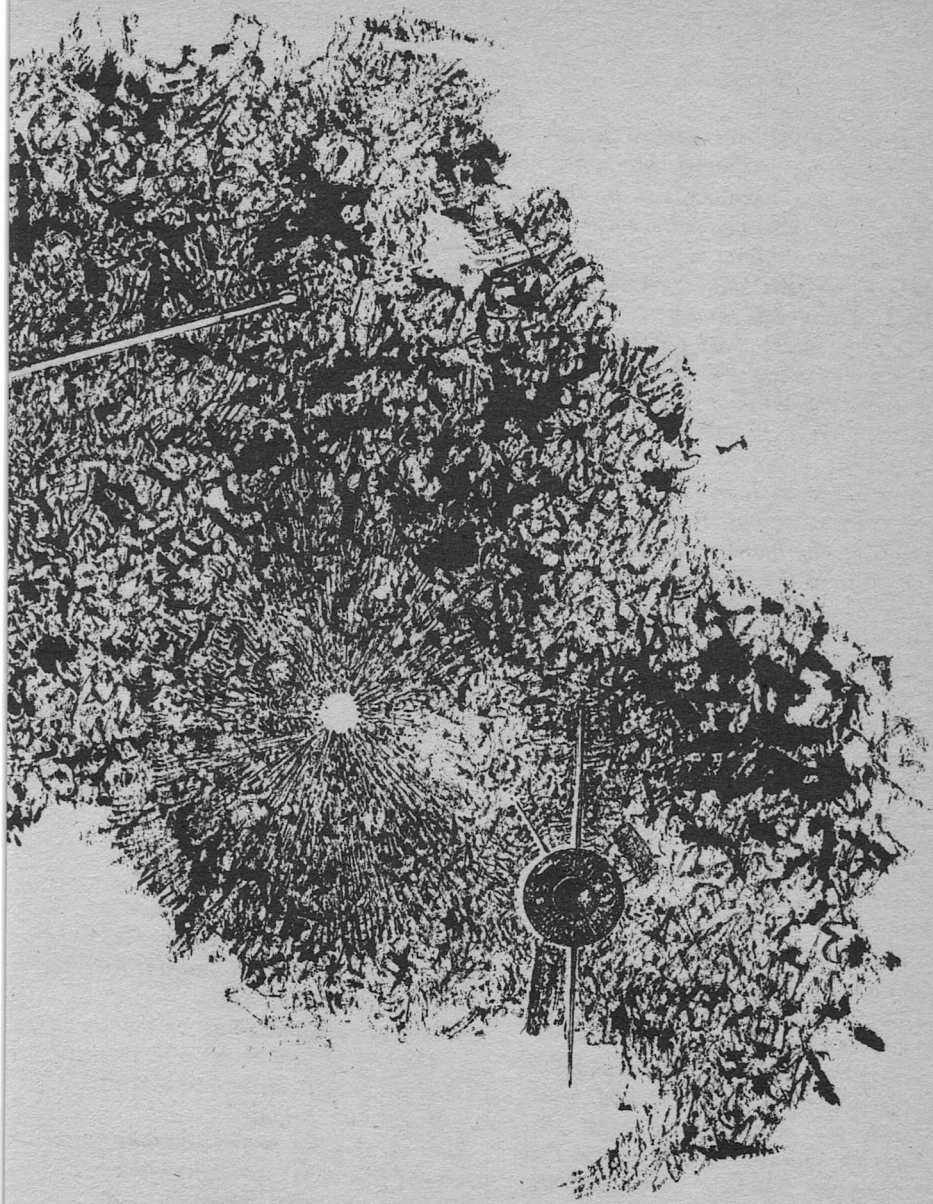
In cell 796 Davy McAllister lounged on his bunk, cursing the failure of the U.S. Government to at least stick to proven optibrain design. Also on his mind was the image of the girl Anna being holographically projected by Cell 796. Just a few more improvements and he would have a perfect image . . . ■



THE FAR CALL

Part Two of Three Parts.
The "impossible" can be done.
But the price can be impossibly high.

GORDON R. DICKSON



JOHN SCHOENHERR

Synopsis

It is the early 1980's. After a period of dangerous cutbacks, the space program has been revived in the form of an internationally cooperative six-party effort, to take advantage of the 1983 launch window and make a manned, three-year, round-trip spaceflight and landing on Mars. Providing "Marsnauts" (the name is the result of a compromise between the U.S. and Russia) to the three-man crews of the two ships, are the United States: TADELL (TAD) HANSARD; *Great Britain:* DIRK WELLES; *the Pan-European Community of Nations:* BERN CALLIEUX; *Russia:* FEODOR (FEDYA) ASTURNOV; *India:* BAPTI (BAP) LAL BOSE; *and Japan:* ANOSHI WANTANABE.

These countries are also represented by diplomatic representatives, known as Deputy Ministers for the Development of Space (Britain: SIR GEOFFREY MAYENCE; *Pan-Europe:* WALTHER GUENTHER; *Russia:* SERGEI VARISOV; *India:* MAHADEV AMBEDKAR; *and Japan:* MASAHARU TATSUKICHI*—plus their U.S. opposite number who goes under the comparative title of Undersecretary for the Development of Space, ex-newsman* JEN WYLIE.

As the story begins, the diplomatic representatives have just had lunch with the Marsnauts in their pre-launch quarters, the Operations and Checkout Building, Cape Kennedy. Upon boarding the bus that takes the politicos from the Operations and Checkout Building, JEN *uses a phone in the bus to call* WARNER (WARN) RETHE, *the U.S. Presidential Press Secretary, and asks if he can talk to President* PAUL FANZONE *about something that is presently concerning* TAD HANSARD, *who is the senior co-captain of the Mars mission (*FEDYA ASTURNOV *is the junior co-captain).*

TAD *is concerned that the load of scientific experiments required of the Marsnauts is too heavy for the safety of the mission, particularly during the first six weeks of the flight. He is trying to get word of this through* JEN *to the President, so that the six world powers involved can negotiate among themselves and reduce the number of experiments—in which a great deal of national self-interest and pride is concerned.*

The President, however, cannot talk to JEN *at the moment. The best the press secretary can offer is the hope of a chance for* JEN *to talk with the Chief Executive at the Presidential reception near the spaceport that evening, when* FANZONE *will be present in person. The President has otherwise avoided appearing on the Cape Kennedy scene, the political situation being delicate since the flight is from U.S. grounds. Technically,* JEN *is his representative on the scene in all things.*

That evening before the reception, JEN*'s girl friend,* ALINDE (LIN) WEST, *appears at the hotel where he and the other political representatives are*

quartered. He must leave her there while he goes to the reception.

At the reception, JEN *suggests that* TAD *talk to* FANZONE. *But nothing seems to come of it until the reception is over, when he is held back from leaving for several minutes by* WARN RETHE, *so that* FANZONE *can talk to him.*

FANZONE *tells* JEN *bluntly that as U.S. President he is the last of the six political groups' leaders to suggest a reduction in the experimental work load on the 'nauts. This is because the U.S. already has too large a share in the Mars mission to begin with; and because, from a political standpoint, the mission itself is secondary to the international cooperation necessary to getting the people of the world to fund basic research that will relieve power and food shortages and clean up a disordered (if momentarily peaceful) Earth.* FANZONE *admits his own interest in space development for its own sake; but says it must take a serving role to politics on Earth, and he must operate from that standpoint.*

Blocked of help from the President, JEN *approaches* BILL WARD, *the Mars Launch Director, on the next morning, which is the morning of the launch.* BILL *admits that NASA is also aware that the experimental work load is dangerously heavy, but says that those who work in the space effort have struggled to keep the program alive, and daren't be the first to risk popular criticism of it now, by offending national pride.* BILL *cites a time when Kennedy workers were offered the choice of taking ruinous cuts in salary or resigning their jobs; and says the first duty of the workers is to keep the program alive for the sake of future launches, even if it means endangering this one.*

Frustrated, JEN *sees the shuttle launched, with no change in the work load.*

Meanwhile, aboard the shuttle itself, TAD *is considering what he must do, now that he has been unable to get help to reduce the work load. He is still turning the matter over in his mind as the shuttle delivers him,* ANOSHI, *and* BAP *to* Phoenix One, *the first of the two ships making the trip, and then goes on to deliver* FEDYA, DIRK *and* BERN *to* Phoenix Two.

He and his crew activate Phoenix One. FEDYA *and the others do likewise aboard* Phoenix Two. *They are ready to make their space launch from Earth orbit, into the long coasting orbit around the sun that will bring them into Mars orbit, nine months hence.*

Both ships are flanked by two nuclear boosters, each with its own pilot. At the given signal, the boosters fire, and Phoenix One *and* Two *are lifted toward Mars. . . .*

Part 2

V

Twenty-eight minutes later, the pressure of acceleration ceased; and Tad floated lightly in the absence

of gravity upon his acceleration couch. On either side of him, Anoshi and Bap would be gravityless as well. A lightness that was from something more than just the lack of gravity seemed to touch Tad. He felt free and in command, at last.

"*Phoenix One* to booster shuttle pilots," Tad said into his helmet phone. "Is firing completed?"

"Booster Shuttle One," said a voice tinged with the accents of the western plains. "Firing completed."

The free feeling still lifted inside Tad. He pushed it aside. There was no time for that, now.

"Booster Shuttle Two," added another voice. "Firing completed."

"Thank you, gentlemen," said Tad. He reached out a gloved hand and changed channels. "Mission Control. This is *Phoenix One.* Both booster shuttles have ceased firing."

"Roger, *Phoenix One."* The voice of Mission Control came drawling back at him almost before his last words were uttered. "You're in injection orbit, right on the button. *Phoenix Two*'s right there with you. If you want to take a look to starboard there, about ten kilometers out, you ought to be able to catch the sun on her."

Tad turned his helmet with some little effort to stare out the glass port to his right. For a second he saw nothing but stars against the blackness of airless space. Then there came a slow, bright flash that seemed to burn for about half a second before vanishing. A moment later it was repeated.

"Looks like they're yawing just a bit, there," said Tad.

"Nothing to trouble about, *Phoenix One,"* Mission Control said. "*Phoenix Two* advised they're smoothing it out with steering jets. You all ready to say good-bye to your booster shuttles?"

"All ready," said Tad.

"You have the go-ahead, then, *Phoenix One,"* said Mission. "Effect separation from booster shuttles."

"Roger," said Tad. He returned to the frequency on which he had been talking with the pilots of the two nuclear booster shuttles, strapped one on each side of *Phoenix One.*

"This is *Phoenix One* again," he said. "All ready to separate. Shuttle One and Two, also ready?"

"Shuttle One ready."

"Shuttle Two ready."

The answers were immediate.

"Firing release charges," said Tad. "Three, two, one . . . fire!" With the last word his gloved finger came down on the button setting off the explosive charges which released the heavy bonds banding *Phoenix One* to her two booster shuttles. There was a dull thud from what seemed behind them in *Phoenix One;* and Tad reached up to activate a view of the shuttles on his pilot's screen, looking back from a sensor camera-eye mounted near the front of the spaceship.

Full in the sunlight, looking as if they were below the underbelly of *Phoenix One,* the two shuttles appeared to be falling away, separating as they went. A couple of flashes from further off told of the sections of banding, tumbling in the sunlight as they moved away at the higher speed imparted to them by the explosive charges releasing them. The support shuttles themselves were departing from *Phoenix* only on the small push of steering thrusters. Now, as Tad, Bap and Anoshi watched, each shuttle slowly revolved end-for-end, so that they faced in the opposite direction to which *Phoenix One* was still facing.

The two had lifted *Phoenix One* to Mars-injection orbit—that point from which she would now begin her nine-month coast to the next point where she would fire her nuclear engines to fall into a close orbit around Mars. Now they were dwindling in the screen, looking almost tiny. It was jarring to think that with their separation, plus the fuel they had expended, the Mars mission had already spent the greater part of its mass—just for the initial departure from Earth orbit. Tad felt the diminishment almost like a personal loss.

A little over half an hour ago, *Phoenix One* had weighed approximately one million six hundred thousand pounds. Now, with the departure of the two booster shuttles, that weight was down to six hundred and seventy-five thousand pounds. By contrast, at the time *Phoenix One* reached Mars, she would have lost only an additional twenty-five thousand pounds—down to six hundred and fifty thousand pounds. Life support and consumables plus fuel needed for mid-course correction would be the reason for the twenty-five thousand pounds that would be spent . . .

Bap was murmuring something incomprehensible, his voice a low tone over the helmet phones.

"What, Bap?" Tad asked, turning his head to look at the other's couch.

Bap broke off. His helmet was facing out a port at the dwindling booster shuttles.

"What? Sorry, Tad," he said. "Just remembering something from the *Bhagavad-Gita*—"The Song Celestial." In English it goes something like . . . *Today we slew a foe, and we will slay our other enemy tomorrow! Look! Are we not lords . . .?"*

"Hm-m-m," said Tad. The quotation seemed to have no application to the departure of the shuttles or their present situation. But there was no understanding Bap.

I should learn to keep my thoughts to myself in my head, Bap was thinking, a little ruefully. *No point in telling them that what I quoted was part of the speech of the Unheavenly Man, as Krishna delineates him. But it would have made no more sense to Tad and Anoshi if*

I had. Still, it is true. We are very lordly here with our nuclear engines and our mission plans, close to Earth. But out there close to Mars we will be small and insignificant. No, no point in trying to explain what I meant or felt. To the English anything religious must be immediate and personal . . .

Not, Bap corrected himself, *that Tad is English. But yes, he is, in the sense I use the word. Tad is distorted English, as Dirk over there on* Phoenix Two *is undistorted English. And the English do not understand such thoughts as I was thinking. Neither the English nor the American English understand. Would Anoshi? Not really; and in that sense, he is tinged with an English sort of color also. Even I am tinged with English, because I am conscious of, though rejecting, what it is to be Englished. Truthfully, we are all alike, Tad, Anoshi and I.*

*Possibly that is part of it. I love Tad—nonsexually, of course—*Bap grinned in his helmet. *One always has to make that distinction when thinking in English. Why am I thinking in English? Because I am thinking about English—rather, about some quality I call "English." No, I have a great affection for Tad. Once, long ago, it might have been that we rode to battle on horseback together, swords at our waists. And Anoshi, also. It is not sheer accident that the three swashbucklers among the six of us should find ourselves in one ship. Over in* Phoenix Two, *they are in common of a different breed and cloth, once one ignores all their national differences. Even Dirk, who is English, is not-English in that sense . . . I am becoming whirled about with words. The words are losing me among them. I should stop thinking and return my attention to duty . . .*

Outside, the booster shuttles were now pointing away at an angle from *Phoenix One.*

"Booster Shuttle One to *Phoenix One,"* said the phones in the helmets of Bap, Tad and Anoshi, "So long, and good luck."

"So long, *Phoenix One,"* said the different voice of the Shuttle Two pilot, "good luck to y'all."

"Same to you," said Tad. "So long."

Bright fire, barely visible in the sunlight of space, spurted from the jets of the two shuttles. They seemed to hang there a moment, not moving; then they began to shrink, at first slowly, then more and more rapidly, until they were suddenly gone.

Somewhere off the starboard of *Phoenix One,* Tad knew, the two booster shuttles of *Phoenix Two* would also be retro-firing to head homeward into Earth orbit again.

"Mission Control," said Tad, punching up the Mission Control frequency on the console before him. "Our booster shuttles have just taken off. We're now ready to restore *Phoenix One* to an active status."

"Roger, *Phoenix One,*" came back the voice of Mission Control. "We copy that. You're now going to restore *Phoenix One* to active status. Your next communication with us will be 1600 hours, according to schedule."

"Roger," said Tad. "Copy, 1600 hours. Over and out for now, then."

"Over and out, *Phoenix One,*" said Mission Control.

Tad switched back to communication with his two crewmates.

"O.K.," he said. "Let's get this ship unbuttoned and back in full operation."

He sat up on his couch and the other two rose with him. Still in their suits, they turned to the business of bringing the ship around them up to operating conditions.

Primarily, this meant restoring the operational and life-support systems of the ship, which with the exception of the biomedical lab, had been under storage conditions for the last nineteen days, since loading had been completed of the two Mars mission ships which had been constructed in orbit. Chief of these systems was the five-psi nitrogen-oxygen operating atmosphere of those sections of the ship where the three of them would live and operate without suits, closely followed in importance by the thermal control systems and the power distribution systems. Plus all the related mechanical activities of the ship that would enable them to live and work aboard her for three years, until they saw Earth orbit again. In his mind's eye Tad saw the duties to be done like soldiers standing at attention, waiting to be dealt with.

The three of them raised their couches into control position, and went to work on the consoles before them where primary controls for all the systems were located. One by one, the small red sensing lights began to burn in signal that the systems were up to full operational level. Then, one by one, for the benefit of the ship's automatic log recorder as well as for their own, each of them went verbally through a checklist of the systems he had brought to full activity.

". . . and all systems full on," said Tad aloud, finally winding up the checklist. "*Phoenix One* in completely active operating status. All right, let's start our visual check of the decks."

He led the others as they got to their feet and headed toward the tube running through the center of all four of the ship's decks and giving access to each of them. In the absence of gravity, and still in their spacesuits, they bumped somewhat clumsily against each other, opening the door to the access tube and entering it. Tad went first, pulling his way along the tube—in the direction that "down" would be, once *Phoenix One* and *Phoenix Two* were docked together and rotated to provide a substitute for gravity—

until he reached the door opening on B Deck. This was the first deck below A, the control deck they had just left; like A it consisted of a doughnut-shaped space, the outer wall of which was separated from the skin of the ship only by insulation and a network of thermal tubes designed to balance interior temperature between the heat of that side of the ship in direct sunlight and the chill of that side in the shade. The interior wall of B Deck, like that of all the decks, was the wall of the access tube.

"Home," said Anoshi, cheerfully, when they had all emerged on B Deck. And, in fact, that was what it was.

Unlike A Deck, which was all open space with the control consoles and other equipment spaced about its floor, B Deck was partitioned. Three of the spaces enclosed by partitions were the individual cabins, somewhat more spacious and deserving of their name than the individual "sleeping compartments" in Skylab.

"Look," said Anoshi. "Nameplates already up on each door. No danger forgetting where you sleep."

Tad looked. What he saw had not been specified anywhere in the original plans, or part of any of the mock-ups of B Deck he had encountered back on Earth. A solemn black nameplate had been attached to the door of each cabin—a small, almost impish, touch on the part of those who had finished off the interior of the spaceship. The nameplates were unnecessary. Long ago, the three had decided which cabin would be whose among the three of them. But they were a little bit of human decoration, a going away semi-present from some of the ground workers. He felt the emotion behind the nameplates in spite of himself; and reading the tone behind Anoshi's words, understood that Anoshi—and undoubtedly Bap as well—felt it, too.

"Well, let's check them out," said Tad, to break the spell.

Each stepped into his own cabin, the magnetism of the soleplates on their boots switching on and off with each flexing of instep above it—so that it was a little like walking across a kitchen floor where something sticky had just been spilled. The rooms checked out; and they met again outside them to step together into the wardroom.

The wardroom—dining and recreation quarters alike for the three of them—took up nearly a third of the space on B Deck.

"I'll check storage and waste compartments," said Tad. "Meet you down at C Deck."

He went next door to the small consumables storage compartment where immediate supplies of the food and drink they would consume in the wardroom were packed. The storage compartment checked out, and he moved on to the waste management compartment. The strict utilitarianism

of the waste management compartment that had been tested out in Skylab had undergone some improvement here—in looks, if nothing else. But the basics remained. Equipment had to be available for the biomedical monitoring of the three men's body wastes—although on *Phoenix One* automatic equipment took over most of the job. In addition there had to be disposal capabilities for a mass of things, from food containers to damaged tools or parts and discarded uniforms, which it was easier to throw away than launder under space conditions. Again, happily, automatic machinery took care of the freezing and dumping of these wastes through a channel leading to an air lock in the unpressurized section aft.

With the waste management compartment checked out, Tad went on down to C Deck and the four different lab and workshop sections that made use of the space there. Anoshi and Bap were still checking the C-Deck equipment, so Tad went on alone to D Deck.

The fourth and final deck was packed solid with stores and equipment. Much of the equipment was that which was connected with the experimental programs to be engaged in by the mission during its first four weeks of coast to Mars, while public interest was still high. Tad looked at the ranked cartons grimly.

These Mars mission vessels had been designed originally to carry double the crew they had now—six men per ship. Now they barely had convenient room for three. Part of the crowding was due to the proliferation of basic research itself—the larger countries, at least, had finally begun to wake up to the need for it, under the demand by their peoples for new technological answers to large natural problems of air, water and land. But the larger reason for *Phoenix One* and *Phoenix Two* being so overloaded with research equipment and problems was political.

Jen Wylie had failed him in getting the list reduced. That left no one to turn to but himself. And Tad had done some tall thinking in the last twenty-four hours. In fact, he had come up with a possible way of saving the men and the mission. Only he would need at least some help—and the only one he could turn to for it was Fedya.

He would talk to Fedya at the first chance. Meanwhile—he shoved the matter from his mind and came back to the immediate job. A quick check took D Deck past inspection—and beyond D was only the Mars biolab, sterilized and sealed at present. From the Mars biolab forward to Control Deck A constituted the so-called "shirtsleeve" area of the ship. Familiar as he was with it from training with the mock-ups of the individual spaces, Tad could not help feeling a new sensation of being constricted and

enclosed. This was the life zone—these four and a half decks—of *Phoenix One.* Outside of that zone, and its duplicate on *Phoenix Two,* there was no place where life was possible without a spacesuit between here and the Earth they had just left. Beyond the biolab and the unpressurized section surrounding it there was only the hundred-and-sixty-foot section of the single nuclear shuttle, their main engine, that would not be fired until they had reached Mars and it was time for them to drop into a close orbit around the red planet. Forward of the nuclear shuttle, the life zone plus the unpressurized compartment beyond A Deck holding the unmanned probes and the MEM, the Mars Excursion Module, made up the remaining hundred and ten feet of the spacecraft. In less than fifty-six feet of that hundred and ten, he, Anoshi and Bap would spend most of their next three years living and working.

It was cramped, it was not beautiful—but it was their ship, it was *his* ship. And he would bring it through. Buoyant, Tad turned and made his way back up the access tube to A Deck where Bap and Anoshi were already waiting for him. The A-Deck chronometer showed 1400 hours exactly.

"Visual check of *Phoenix One* shows everything A-O.K.," Tad informed Cape Kennedy. It still seemed a little odd to him to be reporting to Kennedy at this point instead of to Mission Control at Houston NASA. Tad's experience in space dated back before 1977 when the last and most serious economy cut had reduced the NASA installation at Houston to a shadowy establishment. In theory NASA headquarters was still there. In reality, only a few administrators and a planning division still occupied the few buildings NASA made use of at the once-busy installation. Mission Control for the Mars flight would be at Kennedy throughout the trip.

"Roger. We copy. Visual check *Phoenix One,* all O.K."

"So," said Tad, "unless you can think of a good reason for us not to, we'll start getting out of our suits now."

"Hold that desuiting for a moment, will you, *Phoenix One?"* said Mission Control. The helmet phones fell silent.

"Now," said Anoshi, "they'll send us back to run a white glove around the compartments for dust, before desuiting."

"Not dust," said Bap. "Gremlins. There is nothing worse than gremlins in your control systems. An EGW—an Extended Gremlin Watch—must be kept in operation at all times—"

"O.K., there, *Phoenix One,"* said Mission Control, coming suddenly to life again, "you may proceed with the desuiting."

"Good enough," said Tad. "Copy. We'll begin desuiting."

It was not quite as much of a problem getting out of the spacesuits as it was getting into them; but it was still an awkward and lengthy process that only in theory could be easily performed by the spacesuit wearer, alone. In practice, a good deal of helpful hauling and tugging by extra pairs of hands was welcome. Tad, as spacecraft commander, had the privilege of being the first to be helped out of his suit; after which he helped to free first Anoshi, then Bap.

The emptied spacesuits went into a storage compartment, leaving the men in the undersuits that were designed to match with the many connections and entry points of the spacesuits.

"Go ahead," Tad told the other two. "I'll be ready to man the first shift." Standing orders called for one of the three-man crew to be dressed ready to don his spacesuit at all times. The other two were free to shift to CWG's, Constant Wear Garments. Bap and Anoshi disappeared down the access tube; and Tad seated himself in his acceleration couch, now in control position, to inform Mission Control that they were now ready to begin docking maneuvers with *Phoenix Two.*

"Roger. We copy that," said Mission Control. "Have you got position figures of your own yet?"

"In process," said Tad. He was squinting through the sextant lens of his console at a composite view of the Sun, the North Star and Earth, seen simultaneously through three different sensor eyes on the outside of the ship. His right hand twisted knobs until the three lines intersected at centerpoint on the lens. Then he punched for the onboard computer, lifted his eye from the lens and looked at the computer screen.

"I'm in reference grid cube JN 43721, Kennedy," said Tad.

"Copy. Grid cube JN 43721. How's your radar, *Phoenix One?"*

Tad looked at the radar screen with its sweeping line of light and the intersecting blip in the upper right quadrant.

"Fine," said Tad. *"Phoenix Two* looks to be not more than sixteen kilometers off."

"Thanks, *Phoenix One.* That checks with our data. Stand by for plane, bearing and distance."

"Standing by," said Tad.

While he waited, Bap and Anoshi came back up to the Control Deck.

"Say again?" Tad asked, for the sound of their return had obscured some of the figures Mission Control had just begun to give him.

Mission Control repeated itself, giving Tad first the angle to the longitudinal axis of *Phoenix One* of the plane which enclosed both spacecraft, then the bearing and distance of *Phoenix Two* from *Phoenix One* within that plane. Tad reached for the control buttons of the cold gas steering jets used to

maneuver his ship. A docking maneuver between the two vessels in space was too chancy to be trusted to any computer.

"All right, Mission Control, I copy," he said. *"Phoenix One* to *Phoenix Two,* if you are holding stationary, I will approach for docking."

"Holding stationary, *Phoenix One,"* came back the calm voice of Fedya. "Come ahead."

Tad's fingers descended on the controls of the steering thrusters. Out beyond the glass viewing port to his right, the little reflection of *Phoenix Two* was lost among the lights of uncounted stars. In the ceaseless glare of the Sun, through the airless distance between them, six hundred and seventy-five thousand pounds of *Phoenix One* tilted, turned, and drifted toward the six hundred and seventy-five thousand pounds of *Phoenix Two* under the necessity of coming together with a touch so light that it would not have dimpled the bumper of a four-thousand-pound vehicle back on Earth's surface.

VI

Phoenix Two, seen from *Phoenix One,* as *Phoenix One* approached her, was at first only a slightly brighter point of light among the surrounding stars for some minutes, then only a glare-spot for some time more. Not until *Phoenix One* was finally quite close did she appear to change suddenly from a light-reflection to a spacecraft. Actually, it was as only half of a spacecraft that she appeared in the forward view screen; because, lying nearly bow-on to the approaching *Phoenix One,* as she now was, her other half was swallowed up in the perfect darkness, that was shadow in airless space, so that she looked as if she had been divided longitudinally by an enormous bandsaw.

The motions of Tad's fingers on the controls of the steering thrusters were practiced, familiar ones. Still he felt the prickle of sweat on his face and at the back of his neck. He was as conscious of the whole two hundred and seventy feet of craft about him as a man might be of his own car while maneuvering it into a parking place.

He approached *Phoenix Two* slowly, bow to bow, the great bell-shaped ends of the forward sections, the space probes and their individual MEMs in airless readiness, now creeping toward each other like blind leviathans about to touch in greeting. Beyond the circular metal lip of each of those ends were six feet of the light metal scaffolding enclosing half of the zero-G lab pod and the cryotex tube leading back into the D Deck of each ship. The two scaffoldings must take the impact of meeting; and also they must interlock to hold the two ships together. It would be upon their joined structure that the strain would come

when the two ships were rotated around their common central point, where the completed pod would sit, to provide a substitute gravity for the men aboard both crafts.

". . . Twelve meters from dockpoint," Tad said aloud for the benefit of Mission Control, "ten meters . . . nine . . . eight . . ."

Phoenix Two seemed to loom above the viewers of the forward screen, as if she was falling upon her sister ship.

". . . three meters . . . two," said Tad, "one . . . *docked!*

What sounded like an unreasonably loud and prolonged clang rang through both ships. A red signal light, unlit until now, was burning to the right of the console in front of Tad, signaling that the two scaffoldings had locked correctly and were holding.

Tad sat back in his seat with a sigh.

"All O.K., *Phoenix Two?*" he asked.

"All O.K.," Fedya's voice answered.

"*Phoenix One* to Mission Control," said Tad. "Docking accomplished. Are we clear to send a man EVA from each ship now to activate outside equipment and secure?"

"We copy docking accomplished," said Mission Control. "Tad, will you hold off on EVA for the moment? We'd like to run another position check on the two of you now that you're docked together."

"Be our guest," said Tad.

There was a short period of silence from Mission Control.

"All right, *Phoenix,*" said Mission Control, coming back to life again. "Your position shows no discernible drift as a result of the docking maneuver. You may EVA and activate exterior equipment whenever you're ready."

"Roger," said Tad. He looked to his left, at Anoshi, who nodded. "Anoshi will EVA for *Phoenix One.*"

"Dirk will EVA for *Phoenix Two,*" said Fedya's voice.

"Roger. We copy. Anoshi to EVA *Phoenix One,* Dirk to EVA *Phoenix Two,*" Mission Control agreed.

Anoshi got up.

"Back into harness," he said. He disappeared down the access tube.

Bap touched the button on the communication headband above his ear, cutting off the microphone on the slender arm that curved around to the edge of his mouth.

"Good for you, Tad," he said softly. "Anoshi wanted to be first man out. Did you know that?"

"No," said Tad. "Besides, he's first out because he's the astronomer here. The cameras are his." So it was true about Anoshi—he had not known but he had suspected.

A little silence fell. A few minutes later, Anoshi came back out of the access tube, wearing his space

suit underwear. He went across to the spacesuit locker and got his suit out. Tad and Bap helped him into it, and fastened to his belt the tools he would need and the film packs for the cameras he would be activating.

"All set," said Anoshi, over the communication circuit. He went forward to the inner door of the air lock.

The air lock let him into the airless space containing the Mars Excursion Module and the unmanned planetary probes that would be sent down to Mars. He went forward alongside the two-meter height of the cryoflex tube that would later provide a shirtsleeve conduit to the pressurized section of the zero-gravity pod between the ships and exited through the hatch in the end wall. He found himself among the light metal scaffolding that had joined with the scaffolding from *Phoenix Two* to dock the two ships together.

There was no spacesuited figure from *Phoenix Two* in sight yet, so Anoshi turned and walked from the hatch, the magnetic soles of his boots sticking and yielding alternately to the outside surface of the end wall until he came to the edge of the ship's hull, proper, some twenty feet away. He stepped over the foot-high end-rim of the hull onto the cylindrical metal of the hull itself. Above him all the stars of the universe revolved solemnly as he went from the surface he was on to one at right angles with it. It was like a man stepping around the edge of a box from one flat side to the other.

He walked down the hull.

There were twelve recording star-cameras for him to check out and load, five fixed, three with automatic programmed movements and four which could be manipulated from inside the ship. There was the laser mirror to erect and align; and the solar cell holders to erect for the solar cells experiment. But, as he walked slowly along the ship, Anoshi was thinking only secondarily of these things. Alone, of all the six now between Earth and Mars, he had been ashamed not to be more than he was. He had wanted to be a true astronaut, a cosmonaut; not just a spacegoing scientist.

There were only two real 'nauts aboard: Tad and Fedya. Anoshi and the other three were merely scientists with 'naut training. For Bap, Bern and Dirk, this difference did not seem to matter greatly. What counted with them, apparently, was that they were *here,* on any terms. But Anoshi had wanted more than that; and only a trick of timing had forbidden it to him.

Unlike the other three, he had intended to be a 'naut—a true 'naut in the space program of Nippon. But that program had not gotten to the point of developing its own experienced astronauts at the time

that this mission was conceived and instigated.

That was why it was so important that he be out here alone as he was now—he interrupted his thoughts and knelt to check and load the first of the outside cameras. His gloved hands worked clumsily but surely and the loading section of the camera opened, black with shadow, before him. He loaded it, closed it and rose to his feet again. By the time he came back from this mission there would be nothing concerned with the ship that he would not have done. Anything any one of the others was to do aboard, he would find a way to do also, officially or privately. That was his goal and he would see it accomplished.

Moving on to the next camera now, he saw that *Phoenix Two* had disgorged her own spacesuited figure.

Anoshi finished the cameras and moved on to set up the solar cells in their holder. They made up a square panel standing almost as tall as himself above the hull of the ship. By contrast when—twenty feet farther aft of the cells—he lifted the copper laser mirror into erect position and peeled the protective coating from its carefully polished surface, the mirror stood barely thigh-high and was no more than a square foot in area. Miracle of science, thought Anoshi, fondly, handling it. Tiny, to serve eventually as a target for a coherent light beam all the way from Earth to Mars.

The laser mirror was small, but massive, with its heavy cooling fins at the back. He locked it in upright position and engaged its base with the control housing below it that would enable it to be aligned from within the ship. Then, finished at last, he rose and headed toward the scaffolding and the pod. There, he waited for Dirk to join him.

The scaffolding consisted of two heavy rod-like sections diametrically opposite each other around the circle of the rim of the end-wall of each ship. They held the two vessels a little under ten feet apart; and had been so designed that the rods of matching sections clung magnetically to those of the opposite ship as the vessels had come together. Magnetism and inertia still held them together, but the two ships were merely drifting at the moment. The rods had to be clamped tightly together to take the strain that would come upon them when the two 675,000-pound masses were rotated about their jointure to provide gravity for both ships.

The clamps were built into the rods. Working in silence Dirk and Anoshi pulled them into position and dogged them down by hand. Then, when that was done, they moved to the center of the space between the now locked-together spacecraft and began to seal the two halves of the no-gravity pod

that was approached by the cryoflex tubes from each ship.

The sealing was a simple matter on intersandwiching several specially treated layers of the rubbery, fantastically strong cryotex fabric along the lines of jointure. Once these layers were laid in contact, an electric current sent through the fabric from either ship would hold the layers together in a bond more than capable of containing the pressure of the ships' atmosphere. Shutting off the current would unseal them again when the ships needed to separate. Of course, only one half of the pod would have atmosphere and be connected to the tubes that now made a shirtsleeve passageway from one ship to the other. The other half, beyond its impermeable wall, was to be left airless, enterable only by someone in a spacesuit through a simple hatch in its side.

"Done," Anoshi announced over the common phone circuit of both ships. "Run the current through the pod fabric, pressurize and you're all set."

"Done, indeed," said Dirk's voice in the earphones. "*Phoenix Two,* pay no attention to any unofficial reports from *Phoenix One* personnel. This is your own co-worker announcing everything A-O.K."

"We copy," Tad's voice said.

"Copy," said Fedya. "Come on back inside, Dirk."

"I," said Anoshi, "am returning inside, *Phoenix One.* My apologies for taking so long; but there was some bystander in a spacesuit that kept getting in my way."

"Dreadfully crowded out here in space, nowadays," said Dirk.

They waved to each other and stumped off toward their respective hatches in the end walls of their ships.

By the time Anoshi was back inside A Deck, Tad had started the ships rotating about their common center to provide about half a gravity. "Down" was not actually down, now. Tad, seated at his console, had finished passing the word to Mission Control and was inviting Fedya over for a visit.

"We're scheduled for a down period now, anyway," he was saying over the phone circuit. "Come across and spend half an hour with me and a cup of coffee. We'll go over the schedule together."

Fedya nodded, looking back at him from the phone screen.

"I'll be over in five minutes," he said.

Five minutes later, punctually, the hatch in the ceiling of A Deck, just beside the access tube, opened. Fedya climbed easily down the handholds on the outside of the tube until he reached the deck. He looked around.

"Bap?" he asked. "And Anoshi?"

"In their compartments," Tad said, getting up from his console. "They're going to get some sleep."

"Dirk and Bern are down, also," said Fedya. He carried a folder of

schedule sheets under his arm. Now he held them out. "Do you want to compare these with yours?"

"No," said Tad. "We can just work with yours. Besides, there's something else I want to talk to you about, privately."

He led the way to the access tube. They climbed down to B Deck and went in to take a table in the wardroom by the dispensers. Tad got them both cups of coffee.

"Something else beside the schedule?" Fedya queried gently, when they were seated.

"Not really *beside,*" said Tad. He looked at Fedya. "Mission knows we're scheduled too tightly."

"We can only try," said Fedya.

"No," said Tad, "we can do better than that. We can keep the schedule. I've got a notion," said Tad, "Only, I'll need a lucky break—from one other man. Maybe I should say an unlucky break."

He looked at the long brown fingers Fedya had wrapped around his coffee container.

"Someone on *Phoenix Two,*" said Tad, "would have to have a minor accident—to his hand, say. Enough to bar him from working in a spacesuit.

"Not the sort of accident that would slow him down on his share of the duties inside his ship," said Tad. "Just enough to keep him from going out. To make up for what he can't do, the man from our ship would do both, now that they're docked. Meanwhile the man with the bad hand could be picking up the overload of work inside his own ship."

"And how will the man on the other ship find time to do double duty outside?" Fedya looked closely at him. "This man—yourself?"

Tad nodded.

"Don't ask me how," he said grimly. "In fact, don't ask anything. Forget we had this little talk. But I tell you the program can be kept and completed, if I just have that one bit of help."

Fedya's eyes held with his. They sat, looking at each other. That Fedya understood, Tad had no doubt. That he would help, was another question. It was up to him; all up to him, now.

VII

Day Two on the spaceship (Day One being the day of the launch that had ended with the talk between Tad and Fedya and sleep for all six 'nauts) began according to a clock set at Eastern Standard Time, at six a.m. Tad woke with the feeling that he had had a succession of not too pleasant dreams and a restless night. It was a feeling he had been expecting, however. The first night in no-gravity or an abnormal gravity—and that aboard the ship, imparted by the spinning of the docked vessels, was about one-half normal gravity—tended to disturb sleep patterns. If he adapted ac-

cording to average human responses charted previously, Tad could expect to get back to sleeping normally in about a week.

He sat up on the edge of his bed and glanced at the bargraphs for *Phoenix One* on the table beside it.

He was scheduled for S-H/K, Systems Housekeeping, immediately after breakfast; and both Bap and Anoshi were involved likewise in continuing duties until after lunch—at which time they would begin setting up the specific experiments in the various labs of the ship. He got to his feet with some little effort and headed for the waste management room.

He was the first one in to breakfast. Bap and Anoshi had yet to take their turns at getting weighed no-gravity style. Tad inflated the dining pod about their dining area, then stepped through the pod hatch to sit down at his place at the serving table and turned on the vacuum fan. There was a slight murmuring as the fan started to draw air through the filter in the pod wall and from the pod into the particle collector. There were as yet no floating food particles in the air of the pod for the collector to collect; but it was doing its duty nonetheless.

Tad punched for coffee, and a carefully measured amount poured into the container at his place. The bargraph for the day, which he knew by heart, floated before his mind's eye, as he considered what was to be done before the next sleep period. He found himself beginning to view the upcoming shipboard day with increasing enthusiasm.

The sticky sound of the entrance to the dining pod being unsealed brought his head around. Anoshi was climbing in, followed by Bap, who turned to reseal the pod entrance behind him. They both sat down at the table; and Tad came fully awake, looking at them.

"How'd the sleep go?" he asked.

"Not bad," said Anoshi. Bap laughed. He was the one wearing spacesuit underwear today.

"I was chased by elephants," he said. "And the lead elephant was being ridden by our Mission Director, Nick Henning."

"Did he catch you?" Anoshi asked, punching for a stream of hot tea into his own container.

"I am here to tell the tale," said Bap, waving his own container before he filled it. He looked around the pod and then at Tad. "Cozy little breakfast nook. I wonder if they had some ulterior motive in penning us up like this for meals, besides the collecting of floating particles of food from the air? The original Spacelab got along without this."

"And its crew inhaled a lot of stuff over a ninety-day period," Anoshi said. "Remember all the worry over 'space pneumonia' in men—"

"And women," said Bap.

"—And women who should have been free from virus infections?"

"Of course I remember," said Bap. "But I am also considering the effect of this enforced intimacy three times every twenty-four hours on the human mind."

He, like the other two, had been punching for and receiving heated, pre-packaged foodstuffs from the table slots before him; and he was already eating. Now he waved a disposable plastic fork/knife in the air.

"What if I become violent some breakfast and cut your throats?" he said.

"You'd have all the work to do by yourself from then on," said Tad. He changed to a more serious tone. "You're going to begin solar observations for flares in your first period after this meal?"

"Right away," said Bap. "I'll be using Numbers One and Two remote cameras as telescopes. Maybe I'll get some good pictures, if there's anything to take."

"Kennedy's due to warn us if a large flare crops up early in the flight, the way they've been predicting," Tad said. "It'd be something if we could spot it as soon as they do—or even before."

"We will," Bap said. "I promise we will."

They finished their breakfast, reduced the pod, and Tad took the scraps of uneaten food, the packaging and the other discardables to the waste management room to be carefully weighed and disposed of. Just as the body wastes of the Marsnauts had to be measured and weighed, so their food and liquid intake had to be measured and recorded with every meal. This was Medical Experiment 122, on the schedule. Then Bap went to his camera telescopes, Anoshi got out the aerosol collector to take a sample of the ship's air and discover what loose particles were afloat in it, in spite of the meal table pod, and Tad went to Systems/Housekeeping.

This early in the voyage, there were few housekeeping or equipment repairs to be made. Tad covered all four decks of the life zone of the ship within a short time, then went directly to the master log of *Phoenix One.*

The master log was pretty much what its name implied. It was to *Phoenix One* what a ship's log was to an ocean-going vessel, with the complication that *Phoenix One*'s log (and that of *Phoenix Two,* for that matter) included not only the commander's record of the voyage, day by day, but all recordings of data made on that day, which he was able to review on a computer screen before him and correct or amend with a keyboard and a light-pencil. The records of Day One of the mission, launch-day, were now waiting Tad's attention.

When he had disposed of the

log, Tad went out to find Anoshi at work in the C Deck lab space that would be his for his astronomical records. Face bent over the 45-degree-angled viewing plate, Anoshi was studying one of the photos he had evidently just taken of the solar corona. He was too wrapped up in his work to notice Tad; who went on across to the exercise section of C Deck to see Bap there, in full spacesuit, working at the taskboard in Mode C of the experiment dealing with daily physical exercise by each of them.

Mode C was constant physical exercise for twenty minutes wearing a spacesuit. Mode B was similar work without a suit; and Mode A was twenty energetic minutes on an exercycle or jogging treadmill. Space-Lab experience had shown how necessary exercise was to the health of humans away from normal gravity. Though hopefully not absolutely necessary, thought Tad grimly as he watched Bap, remembering his plans if Fedya should decide to cooperate. Bap, engrossed in the heavy work and the uncomfortable spacesuit, did not notice Tad watching any more than had Anoshi.

Tad took the access tube and went up to B Deck. It would be time for lunch in less than half an hour.

The diplomats sat in their hotel watching TV coverage of that day's mission press conference.

". . . Our first piece of information today," said the NASA official on the TV screen, addressing the press conference, "is that because of Nick Henning's illness, Bill Ward, here—" he nodded to Bill, sitting upright beside him at the long table cluttered with microphones and closeup camera eyes, "will be taking over as Mission Director. You've all met Bill before—"

"Have we?" asked Mahadev Ambedkar.

"You remember," said Jen Wylie. "Bill Ward was the man who came in after the Marsnauts' luncheon to take us out to the shuttle launch pad."

"Ah, yes," said Mahadev.

He, Jen, Sergei Varisov, and Walther Guenther, the Pan-European Deputy Minister of Science, sat close together in the lounge area of their quarters. They had just finished lunch. Later that afternoon, they were scheduled to hold a conference of their own for the press.

". . . absolutely, on schedule." Bill Ward was already answering a question from the floor. "So far everything has gone exactly as expected. The ships are now docked and the 'nauts are into their first rest period, according to the schedule. —Yes?"

He nodded, pointing at a different section of the press seats. A thin, dark-haired young man stood up.

"Can you tell us—" his accent

was French, "if there are any times when the schedule does not operate? Any holidays, or relaxation periods for the Marsnauts? And if so, when these holidays are on the schedule?"

He sat down again.

"As far as we know, there aren't any holidays in space," grunted Bill. There was a small stir and chuckling among the press crowd. "To answer your question, there's no period that isn't accounted for on the schedule, from the time the mission was launched to the time of its return to Earth orbit, three years from now. The schedule itself does call for open periods; both to relieve the 'nauts from routine, and to ensure that any overscheduling gets caught up. There are no such open periods in this first thirty days, however. As you know, this is when communications with the two ships are at their best; and we want to take the maximum advantage of that. —Yes? Next!"

The TV camera moved to focus on another questioner.

"It is like climbing a mountain, I suppose," said Varisov thoughtfully. "But like climbing a very big mountain, like that one in the Himalayas that is the highest in the world, which to climb with an expedition must take months. There may be days of occasional rest along the route. But any celebration, any vacation, must wait until the full job is done—"

He broke off. Sir Geoffrey Mayence, his face politely expressionless, had just joined them, taking a seat. His eyes moved over them, from Varisov to Guenther, to Mahadev, to Jen and finally back to Varisov again.

"Not interrupting anything, am I?" he said. He looked at Sergei Varisov.

"Not at all," said the Russian Deputy Minister, reaching out to turn the voice volume down on the TV set.

"That's good," said Sir Geoffrey. He glanced again at Jen, then back to Varisov. "Wouldn't want to be the unwanted guest. We don't see much of you—ah—Wylie."

"Sorry," said Jen. "One of my special duties is to hassle with the press for the Administration. I have to keep running out on errands to do with that."

"Yes. Well, duty first," said Sir Geoffrey, with a shrug. "Wouldn't you say so, Softy?" he went on, turning confidentially to Varisov.

"Oh yes, duty," said Varisov.

"And old Muddle, here," said Sir Geoffrey, turning to Mahadev. "You know what duty can be like, I think? You were with Softy, here, and me at the first Pan-European Conference—was that before your time, Tommy?"

"No," said Guenther, with a small cough. "I was there. I was pretty junior, then, though. The rest of you weren't likely to notice lower-echelon types like myself."

"Don't tell me you were caught

up in that business when the French presidential motorcade got routed clear off the road to Liège and came in three hours late?"

"Oh yes," said Guenther, laughing.

"Where were you when that was going on, Twigs?" asked Varisov, looking interestedly at Sir Geoffrey.

"Twigs was in the bar of the Number One Hotel," said Mahadev.

"Wasn't I?" said Sir Geoffrey, almost triumphantly. "I was there from one to nearly four, getting wound like an eight-day clock. I must have had fifteen Manhattans—that bartender there had a special touch with Manhattans. I—oh, leaving us, Wylie?"

"I've got a phone call I have to make," Jen said. "I just remembered it."

"Ah, well," said Sir Geoffrey, "see you a bit later on, then."

He watched Jen move off down the corridor and step into his own suite of rooms. His face changed, became businesslike.

"What's the latest news you've heard?" Varisov was looking at him, keenly.

"Well, now," said Sir Geoffrey briskly, looking back at him. "Nothing in particular. I've been having a small talk with Ceilly Welles, the wife of our 'naut. You remember her, I'm sure. It seems she was being interviewed by this girl friend of young Wylie's—the girl friend belongs to some magazine in the States here—and it came up that Wylie had some sort of talk with this Bill Ward who just got pushed up to Mission Director. Talked to him just before the shuttle lifted with the 'nauts."

"Why?" asked Mahadev. "Why should the U.S. Undersecretary talk to the Director of our mutual mission?"

"Ward wasn't Mission Director then, of course," Sir Geoffrey said. "Only Launch Director."

"What did they talk about?" Guenther asked.

"Who can tell?" said Sir Geoffrey, blandly. "There's that topic, though, that both Wylie and Hansard, the U.S. 'naut, were worked up about. Hansard wanted the experiment schedule cut."

"I don't remember any offer by the NASA people to cut their no-gravity experiments in cryogenics," murmured Guenther.

"The U.S. public would hardly stand for the deletion of that, do you think?" said Mahadev. "There is great popular interest here in the dream of keeping sick or aging relatives in stasis until medical repairs can be effected."

"No, they'd hardly want to cut those experiments in which their own scientists are concerned, and to which their people as a whole are attracted," said Sir Geoffrey. "I'd be afraid myself that any cut in the mission experiments would be aimed at the research in which

the scientists of *our* countries are concerned."

"We would certainly not want to give up any of our necessary research plans merely to favor the Americans," said Varisov.

"Or in any case?" Sir Geoffrey said, looking at him significantly.

Varisov looked back.

"In fact, no," Varisov said. "In any case, those experiments in which the Union of Soviet Socialist Republics is involved are directly concerned with our efforts to feed our people. Not nonsense like the preserving of useless and worn-out citizens, but plant biochemistry that could result in a nitrogen-fixing wheat, to flourish in our northern fields, and feed our people."

"The solar cell research," put in Mahadev, "holds the one promise of bringing necessary power to my country's population. Even if the other powers involved would be agreeable to sacrificing some of their experiments on the mission schedule, we could not agree to the solar cell experiments being halted." He spread his hands. "Literally, we could not. My government would be out of power in a week, possibly."

"And I assure you," said Guenther, "Pan-Europe will not sit quietly under any attempt to curtail our mission experiments into the chemical development of memory and intelligence."

"Now, now," said Sir Geoffrey, a little irritably. He was curled up on the base of his spine in his chair, rubbing his chin. "No point in our sitting around making speeches at each other. The point is, what might we do about it?"

"A word to the press," said Guenther.

"No—no," said Sir Geoffrey and Varisov at once, so that it was almost like one man talking.

"Never turn the press loose if you can help it," said Sir Geoffrey. "Couple of lines of poetry about that: *You cannot hope to bribe or twist, thank God, the British journalist. But seeing what the man will do, unbribed, there's no occasion to* . . . And that goes for journalists of all nations. There's no stopping them, once they're after something."

"Also," said Varisov, "there are repercussions with our home governments to consider."

"For my part," said Sir Geoffrey with his eyes half-closed in thought, "I believe I'll just have a word with some of their people I know in Washington. I've already done that; but maybe I didn't come down quite heavily enough."

"I may do some talking, myself," said Varisov.

"Perhaps we should discuss the whole matter right now, in detail," said Ambedkar, gently.

VIII

The fact that the mission was on Eastern Daylight Time made for coincidences. After the second meal

period of Day Two aboard *Phoenix One* and *Two* at just about the time the Deputy Ministers back on Merritt Island were sitting back to sip on coffee following lunch, thousands of miles deep in space, the Marsnauts were finishing their own lunch. Anoshi was scheduled for Systems/Housekeeping. Bap and Tad were due to go to work setting up experiments in the labs, including the atmosphere and null-atmosphere lab sections of the no-gravity pod between the two ships.

During the days just before the 'nauts had boarded *Phoenix One* and *Phoenix Two,* both ships had been on a standby basis as far as internal systems went—with a single exception per ship. The exception in each case was a sealed lab section on C Deck, within which atmospheric pressure and normal temperature had been maintained for the benefit of the so-called "live" subjects—ranging from field mice down through brine shrimp, fruit flies and flatworms, to simple molds and spores. The seal on this lab had been broken when the lab was opened during their first visual inspection of the ship after the 'nauts boarded her and brought her up to working order. But the experimental subjects themselves had been left until now in the care of the automatic machinery that had kept them nourished and alive since they had been put aboard by the supply and fitting crews from Kennedy.

Now, Tad and Bap left the majority of the subjects still in the formerly sealed lab. But certain of them were immediately to be transferred—to the plant genetics lab, the biomedical lab and the two sections of the pod. Tad and Bap worked together to set up the plant genetics and the biomedical lab sections; but when it came to the pod, while Bap could reach the inside section through the cryotex tube connecting with it and *Phoenix Two,* Tad had to suit up and EVA, going outside the ship to enter the airless, cold part of the pod from the hatch opening to space that lay in the perpetual shadow between the two locked-together and revolving ships.

The work was both difficult and clumsy in a spacesuit; but the spores and cultures which Tad carried to the outer pod were contained in trays that even heavy gloves could handle with some dexterity. One by one, Tad fitted these trays into the shelves and racks built into the airless section of the pod, working in the illumination from the pressurized section, showing through the milky, yielding cryotex wall between the two parts. The blurred shadow he saw coming and going beyond that wall as he worked would be Bap, at work there, Tad thought.

—Unless it was Dirk or Fedya from *Phoenix Two.* Each ship was due to supply some materials and

live subjects to the pod experiments. Primarily, it was the U.S. experiments on cryogenics that would be taking up space in the pod compartments. Although both the 'green-thumb' paranormal plant-response tests of the English, and the biorhythms experiments of the Japanese, were represented here. In essence, these were experiments which had been pioneered in the Spacelabs. But they would be taking place under different conditions here; in that they were both farther from the sun, and subject to a skidding, sidewards motion—too light to be consciously felt as gravity—that was caused by the two ships wheeling about their joined common center where the pod sections were.

Tad finished his work and left. So far, no one from *Phoenix Two* had showed up to bring that spacecraft's trays of experimental materials to the outer pod—which was a little strange. If Tad remembered the bargraphs for *Phoenix Two* correctly, someone from that ship ought to have been out here at the same time he was.

Tad returned to the inside of *Phoenix One,* and the air lock. He emerged into A Deck and began desuiting. Anoshi was there, waiting for him, and helped him off with the suit.

"Bap's over in *Phoenix Two,"* said Anoshi, as soon as Tad's helmet was off. "Fedya had an accident with some oxygen tanks toppling over in one of the labs. It seems he's hurt his left hand."

Tad and Fedya sat opposite each other at a wardroom table. This time it was the wardroom of *Phoenix Two;* and it was Tad who had brought the bargraphs that were spread out on its surface. Fedya's left hand, wrapped in gauze bandaging, rested upon some of these. Bern and Dirk had been with them up until a moment ago. Now, for the first time since Tad had come over from *Phoenix One* with the bargraphs, he and Fedya were alone. Tad glanced at his hand.

"How bad is it?" he asked, in a low voice.

"As I told you when you first came over," said Fedya, emotionlessly, "bruised, that's all."

Tad nodded.

"All right," he said, turning to the bargraphs and pushing a sheaf of them across the table to Fedya, who picked them up with his uninjured hand. "Here's how I think we'd better handle it. One man takes care of the outside section of the pod and all EVA duties for both ships. I've juggled the other schedules to spread the work load out as a result of this; and the parts of your own schedule that you won't be able to do one-handed."

Fedya studied the bargraphs for several minutes while Tad sat in silence. Then he looked across the table at Tad.

"The work load is all right over here," he said. "But over on *Phoenix One,* you're the one who's picking up the extra work that I am being relieved of."

"Not directly," said Tad.

"No," said Fedya, "not directly. But it amounts to two hours of work of which I'm relieved, and nearly an hour apiece off the schedules of Bern and Dirk. While over on *Phoenix One,* you personally pick up four extra hours of duties—and I mean *you* personally."

Tad looked grimly at him.

"As Mission Commander," he said, "I've got more independent duties and more free time than anyone else. I'll be absorbing those four hours into that free time."

"You know," said Fedya, "that's neither true nor possible."

"It's possible," said Tad.

"How?"

Tad sat back in his chair.

"As you told me when I first came over," he said, coldly. "Your hand's bruised, that's all. I won't ask you about it again."

Fedya sat for a long second without saying anything.

"All right," he said, then, "I won't ask how you plan to make this work. But what makes you think Mission Control will accept it?"

He waved his right hand at the bargraphs and the penciled changes Tad had made upon them.

"They'll have to," Tad said. "They've got no choice now. Out here, if it really comes down to it, no one can give us orders but ourselves. And if they got excited about it, that would be bad publicity for the mission."

Fedya nodded slowly.

"But you'll need help," he said. "You can't do all that alone."

"No help," said Tad, flatly. "And no discussion."

He reached out and swept the bargraphs back into a pile in the middle of the table.

"And I have no choice, either?" said Fedya.

"That's right," said Tad. He got to his feet, pushing back his chair from the table. "Don't spend your time thinking about me. You know we're all overscheduled, here. It may not seem so bad the first week or two. But by the third week, that lack of repair and down time is going to be piling up. You'll all five be putting in three of four hours more a day than you're scheduled for. We both know that. I'm just taking on my extra hours now, in accordance with an amendment of the schedules."

"And a week and a half or two weeks before the rest of us," said Fedya, softly.

"I tell you, I can absorb most of that extra duty," said Tad. He still kept his voice pitched low. "I'll be in better shape than any of you, three weeks from today."

"You will not," said Fedya. "And that is something else we both know."

But, before he could finish speaking, Tad had already turned and left the wardroom. Fedya heard him entering the access tube on his way back through the cryotex lane to *Phoenix One.* Soberly, Fedya rose, took the bargraphs from the table under his arm and headed toward his own sleeping compartment.

IX

"I just don't like it," said Bill Ward.

"Don't like what part of it?" Nick Henning asked. He was sitting up in the bed of his private hospital room, looking as if his massive coronary attack of sixteen days ago had never occurred, let alone like a man who was four days out of extensive heart surgery. Bill Ward had dropped in to visit him. The private room was a pleasant one, looking east, and the flowers on the windowsill looked crisp and well watered.

"Any part of it," Bill said, sitting massively upright in the sunlight on the visitor's chair by the bed, his face more irascible than usual under the skullcap of his close-cropped gray hair. "I didn't want your job in the first place, damn it!"

"*I* didn't stick you with it," Nick said. "The thought was you were the best bet to keep Tad in line, that's all."

"Keep him in line!" Bill made a small convulsive movement as if he wanted to get up and pace around the room, but would not indulge himself. "The fact a man's a friend doesn't mean you're going to have more luck keeping him in line—it means you're going to have less." He hesitated. "You don't know the worst of it. That Undersecretary of Science for the Development of Space—Jen Wylie—came to me the very morning of Day One, before launch. He wanted me to do something personally about the work schedules for the 'nauts, aboard the ships."

Nick frowned. They had been keeping him on a strict diet since the ambulance had brought him in; and he had lost weight. The frown made his round face fall into wrinkles that had not shown in earlier days.

"And you've never told anyone about this?"

"For God's sake!" exploded Bill. "Isn't it enough of a mess already? We know those boys are overscheduled during this first thirty days of the mission. Washington knows it. Every involved government knows it; and we all sit here like the three monkeys, with our paws over our eyes, noses and ears—see no evil, hear no evil, tell nobody about the God-damned evil!"

"This is something that falls outside our area," said Nick.

"That's what everyone says. What it boils down to is nobody

wants to be the one to tell the king the bad news."

"The king?" Nick stared at Bill.

"You know what I mean—the billions of so-called common people out there who're treating this thing as if it were a show put on for their benefit and a promise of an end forever to war and trouble and not enough to eat," said Bill. "Can't the damn fools see that the same old political backbiting and pully-hauling is going on just the way it always did—only now it's centered around this mission? Anyway, I almost did what Wylie asked."

Nick's eyelids came down to narrow his gaze and his eyes steadied on Bill.

"Good thing you didn't."

"Good for who? For Tad—for those others up there?" said Bill. "It's *not* good for them."

"This is something that just happens to be bigger than just an ordinary space mission," said Nick. "It's tough on them, being out in the front trench; but they're just going to have to take it—there's no way we can help them."

Bill flashed an angry look at him.

"You know what I mean!" said Nick. He made an effort to hold the tone of his voice down to a reasonable level. "The whole space program's at stake. It's been at stake ever since each country involved started loading the mission up with their pet experiments. Right from the beginning it's been the choice of giving the mission more than it could handle or face the accusation that NASA was trying to hog the show. That's still the situation unless the 'nauts themselves, or someone else, speak up first."

He stopped speaking. Bill Ward sat scowling and silent.

"Don't tell me you're thinking of sticking the U.S.'s neck out on this?" Nick said, slowly.

"Not yet," said Bill, still scowling. "But there was that accident on Day Two to Fedya's hand. All right, it turned out not to be anything important. But that's space out there; and things can happen when the men exposed to it get too tired or physically eroded. Remember the two Russian cosmonauts on the Soyuz Mission that reached the ground dead? Dead because of a mechanical error that wouldn't have been made, if they hadn't been suffering the effects of being too long in no-gravity without proper drugs or exercise?"

"But you *aren't* thinking of doing anything about this situation on your own hook, are you?" persisted Nick.

"Not yet," muttered Bill. "Not yet."

Day Twenty-two: Tad woke with a convulsive jerk; and lay in the dark, unable for the moment to remember where he was or what the time was now. His body ached for

more sleep, yearned for it like some dessicated desert plant yearning for rain. For the moment he was aware of only two things: that instinct-deep, desperate need for sleep; and the fact that he was disoriented, lost in darkness with nothing to cling to but the grim urgency that had driven him out of the cave of slumber back to wakefulness.

Then it came back to him.

Day Twenty-two: he looked at the illuminated face of the clock on his bedside table and the hands stood at 3500 hours. Eleven p.m. Bap and Anoshi would be asleep by this time, sleeping the heavy, drugged sleep of the exhausted. For him, after a two-hour nap, there were his personal medical tests and the log book to deal with.

He lay still for a few moments in the darkness, gathering his will to rise. At first thought, the effort involved in getting up seemed impossible. He felt like someone chained hand and foot to the bed by fatigue while before him, sensed but invisible, loomed the ever-growing stack of work to be done. Every day he attacked that stack, that mountain, with superhuman efforts; but every day, at the end of the day, it was higher. A little more time had been lost from the overall schedule. One more impossibility had been added to those already required of him. And the next day another would be added.

He shoved the self-defeating image from him. Follow your nose, he told himself. Keep the eyes in close focus on the immediate grindstone. Look at the total of things and you'll never make it. Besides, for him, the current day was not yet over. He had only allowed himself a two-hour nap while Anoshi and Bap dropped safely off to sleep. There were two more hours of work yet for him, before he could come back to this bed where he was now. Up—he forced himself to throw back the single cover and sit up, swinging his legs over the edge of the bed. For a second he slumped there; then with another convulsive effort he was on his feet, headed toward the waste management room and the shower.

The shower was beautiful. He stood, leaning and braced against the metal walls of the narrow, upright cubicle, letting its endlessly recycled and filtered four gallons of water beat endlessly down upon his naked body, driving some heat and life into his bones. Bless the water that never quit. To heat it, he was burning ship's power for a period of time beyond the normal interval, but to hell with that. They had power to spare and he was a piece of machinery that needed an infusion of energy to get it operating. Warmed, at last, to something like working temperature, he staggered out of the cubicle and headed back to his sleeping compartment to dress.

Dressed, he went into the wardroom and dropped down at the dining table, punching for a cup of coffee. Drinking it, he stared with unfocused eyes at the wardroom bulkhead opposite, where the dartboard hung, sprouting the feathered darts from someone's last game. Now that he was this far back into a waking mode, he did not really know how alert he was. Sometime in the past weeks he had lost his sense of feeling whether he was tired or not. Undoubtedly, he was tired. But all he felt, sitting at the wardroom table, was a sort of leaden brightness. The effective modes for him were no longer *awake* or *asleep;* but *operative* or *inoperative.*

It was, he thought as he sat drinking the coffee which was pleasant for its heat but no longer much use as a stimulant to him, a question how far Anoshi and Bap had also descended down this road to exhaustion on which he himself was now far advanced. If he could not judge his own condition any more, it was certain that he could not trust himself to judge them. Of course, he had started to bear the work a good week and a half before the gradual accumulation of lost time on a too-crowded schedule had begun to drive them to extra hours of effort. From that, he should be able to count on their still having reserves of energy that he had already squandered. Of course, he would be going to work on the log in a minute, and in the results of their daily physical checks, there should be some clue. But it was hard to be certain . . .

He would get to work any minute now. But first, one more cup of coffee . . .

. . . *Ah-hah! Caught you at it,* thought Tad, staring at his coffee container. His hand had just automatically reached out and refilled the container from the metered spout under his name on the wardroom wall against which the table faced. *Thought you'd con me into sitting here while I drank a third cup, did you,* he said to his hand. *Well, it won't work.*

Carefully, not spilling a drop, he poured the contents of the cup down between the bars of the drain under the spout, to be metered there also and deducted from the intake total the spout had been adding up for him in the log. He got up and went out of the wardroom.

He took the access tube to A Deck and went to the log console. Dropping heavily into the seat before it, he punched up the Day Twenty-two figures and began his study of them.

The recorded work schedule was by this time strongly at odds with the bargraphs of the projected work schedules aboard *Phoenix One;* and undoubtedly the same thing was true aboard *Phoenix Two* where Fedya kept the log. Meal

periods had shrunk to as little as fifteen minutes on occasion, and there were no open spaces between duties or experiments where one 'naut had a few minutes to wait until another could join him for a two-man activity. The Systems/Housekeeping periods were down to no more than five minutes. Finally, to top the matter off, the record showed the whole day running up to half an hour late into the normal beginning of the sleep period between 2100 and 2200 hours.

That much obvious increase of the work load and added use of time could stand in the official record. It was not an impossible situation, on paper—or rather, on the screen of the log here and back at Cape Kennedy. But on the other hand, it was not a true record of the situation, either.

What did not show on the record was the real trouble. For example, all three of them aboard *Phoenix One* had fallen into the habit of what they called "doing the chores"—rising an hour and a half to two hours early to do any number of things that did not involve use of the recording equipment aboard and which consequently did not show up on the log.

Tad punched the log screen to focus in on the running physical statistics on the three of them aboard. The overwork was showing up as a weight loss for both Anoshi and Bap in the mass experiment—M149. Bap had lost eight pounds and Anoshi five as of Day Twenty-two's weighings. Neither of those were unreasonable figures. Tad decided to leave them as they presently appeared on the record. Experiment M119 showed some calcium and nitrogen loss by both men; but again it was not so great a loss that it appeared threatening. M107—Negative Pressure—that experiment which required a 'naut to sit in a device covering him to the waist and fastened there with an airtight seal while air was exhausted below the ambient 5 psig—showed some cardiovascular changes that were not good.

Tad drummed his fingers on the lower edge of the console, debating with himself. It was one thing to stick his own neck out; but something entirely different to risk major damage to the other two. How many days were left? Eight, to finish the first thirty-day period; after which the schedule was to be cut almost in half. Risk it with Bap and Anoshi, he decided, for a few days longer. He left the M107 figures as entered.

He went on through the other checkpoints on the two men—heart rate, blood pressure, vectorcardiograms. The true figures on these would pass. The time and motion studies, on the other hand, showed Bap and Anoshi declining again—they had dropped sharply in performance in the last three days. In

this case, Tad made slight corrections of the record, improving their marks slightly. So slightly, in fact, that nothing was risked, either way; but enough of a change so that if, for any reason, he wished to improve the record of their performance tomorrow, it would not seem like a sudden change.

He left the log records dealing with Bap and Anoshi, and went to those dealing with himself.

For a moment he sat, merely staring at these. It had been a number of days since he had first begun to believe the evidence of his own physical deterioration as reflected in the records. Each day he corrected them to keep them in the same range as the records of his two crewmates; and each day the correction had become more unbelievable. It was true he was averaging no more than four hours sleep out of the twenty-four and working at least two hours more than the others; but it was hard to credit that difference with causing him to fall apart as the record showed.

Of course, he knew what the real reason was. He had known and figured on it before he ever spoke to Fedya about incapacitating himself. Tad's plan had been to use Fedya's injury as an excuse to juggle the work schedules of all six of them so that he himself would pick up a potential extra four hours of activities and each of the rest would have his load lightened by a potential forty-eight minutes apiece. One of the four extra hours Tad would eventually need to put in was to be an hour of activity after Bap and Anoshi were asleep—and he had deliberately thrown his schedule out of phase with theirs to explain why they might wake to find him up and around when they were resting.

But the other three hours he had intended to save by simple cheating—by not doing certain scheduled activities in which he alone was concerned and faking the log records to show them as done. It had been a difficult problem to find three hours of activity that he felt could be omitted without endangering the mission and his crewmates. But he had done it—thanks mainly to the eighty minutes he had saved by completely skipping his daily exercise period.

He could not have done this aboard the Skylab. There, all such exercise required two men—the participator and the observer. But one of the points NASA had yielded on as the experiments piled up for the mission, was the requirement that all exercise be observed. Tad had only needed to place his exercise period at the end of his day's schedule, after Bap and Anoshi were asleep, and then ignore it completely, except for recording fake evidence of it in the log.

It had been a calculated risk. Early in the period of manned

spaceflight, it had been discovered that bodies designed for gravity deteriorated rapidly in a no-gravity situation. A few days without gravity were enough to do noticeable damage. The Skylabs with their complete lack of gravity and long terms of duty by the men aboard them, had come up with an answer to this—heavy and prolonged daily exercise.

The two ships of the Mars mission, docked together and spinning, were not without gravity, even if it was a gravity less than half that of normal. There had been evidence to show that a full gravity might not be what was necessary to keep the human body in normal good condition. Even a light gravity might be able to do it. Tad had gambled on this being so . . . but there was no denying the evidence he had been forced to correct daily for the last two weeks in the logbook. Even in a light gravity, exercise was necessary. He had deliberately avoided exercise and the effects on his body were piling up.

But there was no going back now, or no changing his plans, even if he had wanted to. With a weary breath, he picked up a light pencil and began to correct his test figures to more healthy-looking ones—

"Yes," said the voice of Bap behind him. "You see, I was right."

Tad dropped the light pencil and spun about in the chair. He was braced to see Bap and Anoshi; but what he did see was worse.

The man with Bap, the one to whom Bap had spoken, was Fedya.

X

"How long has this been going on?" asked Fedya.

"What're you doing here?" demanded Tad.

Fedya ignored him. He took one long step forward to level with Tad's chair and looked down at the log imaged on the screen.

"Hold on there—" Tad tried to spin around to face the console; but Fedya pushed him back again and Bap caught him, holding on. "What the hell—"

His voice was thick; and his legs, when he tried to get to his feet against Bap's holding arms, were without strength. Fedya stood looking past him at the log records for a long moment; then he stepped back and Bap let go of Tad.

"I'm senior—" Tad began. Fedya broke in on him.

"You're a sick man," he said. "A seriously worn out and sick man. Bap, take a look at the figures on him in the log."

Bap stepped past Fedya in his turn. This time, Tad made no attempt to stop the log from being seen. He sat in his chair, glaring at Fedya.

Bap said something softly but emphatically, in a language Tad did not understand. He stepped back from the console and turned

to Tad, reaching out to close the fingers of his left hand upon the pulse in Tad's left wrist and gently lifting one of Tad's eyelids with the fingers of his right hand. Then he let go of the eyelid; and a moment later took his hand from the pulse.

"Tad," he said, looking down at Tad and shaking his head. "Tad!"

Tad glared up at them like a cornered wild dog.

"Cut it out!" he said, harshly. "You're not going to do anything. You tell Mission Control about me, and you'll blow everything wide open."

Bap looked at Fedya.

"That's true enough," Bap said. "But he can't go on like this."

"No," said Fedya. His dark eyes were boring into Tad. "So this was the way you thought you could get around the overload of activities? How could you try something so impossible?"

"Go to hell!" said Tad, savagely. "If the gravity had been enough, I'd have been all right. It's just the lack of exercise that's got to me."

Fedya glanced questioningly at Bap, who shrugged with his eyebrows.

"Probably," said Bap. He looked back at Tad. "Anyway, as the closest thing to a physician on this mission, I'm personally ordering you to bed until further notice."

"There're things to be done," said Tad. "Nobody but me can do them."

"They can wait ten hours," said Bap. "Even falsifying that record can wait ten hours."

"What'll you tell Mission, when they ask to have it relayed to them tomorrow morning?"

"That they'll have to wait," said Fedya. "And meanwhile—" he turned and walked over to seat himself at the command console, "we'll put them on notice that our activities schedule has to be cut, immediately."

He flipped the communication switch and pushed the lasercom control buttons.

"This is *Phoenix One,*" he said into the mike grid of the console before him. "*Phoenix One.* This is Fedya, calling Mission Control from *Phoenix One.* Come in, Kennedy."

The screen before him blurred with color and after a short time lag resolved itself into the features of a thin-faced communications engineer with the ranked consoles of Mission Control behind him.

"This is Mission Control," he said. "This is Mission Control receiving you loud and clear, *Phoenix One.* What's up, Fedya?"

"I want to talk to the Mission Director," Fedya said. "I must talk to Bill Ward, immediately . . ."

". . . left him there, locked in the closet." Sir Geoffrey wound up his story and the group about him laughed. One laugh in particular, that of the Princess Malahede, rang clearly across neighboring conversa-

tions. It was the kind of laugh that would. Sir Geoffrey winked at her in appreciation. Not a bad figure on the old horse, he thought—and instantly realized that once again he was sailing dangerously near his limit on drinks. It was damned annoying for someone who used to be able to drink all night and the next day without showing it. He would just have to quit for the evening, even though there were at least a couple of more hours to go. *Not a bad figure*—Lord save the hungry blind!

"But what happened to the man?" asked the dumpy little woman—wife of Bill Ward, the Mission Director.

"Happened? Haven't any idea," said Sir Geoffrey. "May still be there in the closet, for all I know."

More laughter. A man came up and pulled Bill Ward aside, speaking to him in a low voice. Something to do with the mission? Probably not, thought Sir Geoffrey. He began a new story, as Bill Ward beckoned his wife to join him and the man who had just come up; and the three of them disappeared into the crowd.

Bill waited until they were well away from anyone who might overhear, before turning to his wife.

"Nothing desperate," he said. "But the 'nauts want to talk to me about something. I'll have to run back to Mission Control. Can you get a taxi home?"

"Oh, someone will give me a ride," she said. "Don't worry about me." She looked up at his tall, thick-waisted figure concernedly. "Don't forget you need your sleep."

"Of course, of course!" Bill said. "Don't wait up for me, though."

He turned and walked swiftly off toward the hotel entrance next to the parking lot before she could give him any more good advice. She had fussed over him ever since Nick Henning's heart attack. He found his car in the parking lot and headed back to the Cape.

It took him nearly forty minutes to get there, in spite of the relatively empty, after-midnight highways. But ten minutes after he had arrived, he had talked to Fedya.

"Where's Tad?" asked Bill. "Can I talk to him?"

There was a small delay, even at the light speeds of the laser communication beam, before the lips of Fedya's face in the screen moved, and Fedya's voice was heard, answering.

"He's asleep," said Fedya, "and he has a tranquilizer in him. He can't talk to you now."

"There's something you're not telling me," said Bill.

"No," said Fedya. "What more do you need to know? The activity load is too heavy. All of us are worn down by it. Tad was so worn down he was ready to collapse."

Bill thumbed a pile of log duplicate sheets that had been brought

to him while he had been talking.

"According to these, Tad—" he was beginning; when a thought woke in the back of his brain. Quietly, he pushed the sheets aside. "You're asking Mission Control to cut the experiment list?"

"Yes. They can cut it," said Fedya. He paused. "Or they can face the fact that certain work will be left undone for lack of time in which to do it."

"How—" Bill's voice surprised him by its hoarseness. He cleared his throat and tried again. "How soon do you want an answer?"

"Twenty-four hours," said Fedya.

"Oh, now look here!" said Bill. "Cutting that list involves checking with various governments—your own for one. You can't mean twenty-four hours!"

"They can take as much time as they like," said Fedya. "But starting immediately, on both ships, we will only do what there is time for us to do in a normal day's work-period."

"That's not—" began Bill, and broke off as a paper was pushed into his hand by someone standing nearby. He read it and laughed. He looked back into the screen at Fedya.

"Saved by the bell," he said. "Guess what? We've just got word of a solar flare that's due to hit you in five hours and thirty-eight minutes. Did you get that?"

"I heard you," said Fedya. "We copy. A solar flare is due to reach us in five hours and thirty-eight minutes. I assume you mean a flare large enough for us to run the Lasercom tests."

"Of course," said Bill. "And running those tests lets you drop everything else, so as to concentrate on them. You'd better get started separating *Phoenix One* and *Phoenix Two,* and put as much distance between the two ships as you can. Meanwhile, I'll pass along your request for a cut in the activities schedule."

"Good," said Fedya. *"Phoenix Two* will speak to you again just before separation to lock communications contact with *Phoenix One* for the duration of the LCO tests. Over and out."

"Over and out," said Bill. The screen went blank. Bill sat back in his chair, gazing at the unlit surface for a long moment before he seemed to shake himself out of his brown study and look about for the person who had handed him the note about the flare.

"Who gave me that?" he asked. "And how bad's it going to be?"

"I did," said the communications engineer on duty, Al Ciro, leaning in toward him. "And it's going to be rough."

Tad leaped suddenly to full wakefulness out of deep sleep as if someone had shot a cannon off at his bedside. He lay listening, but there was no sound. He felt lightheaded but alert. Only his body

was still numb with exhaustion. He forced it up into a sitting position on the edge of the bed . . . and floated off the bed surface entirely into the air.

There was no gravity.

Phoenix One and *Phoenix Two* were no longer docked together and rotating.

In that moment he heard it again—the noise that had roused him from sleep. It was the heavy clang of metal against metal, somewhere forward in the ship—it sounded as if it might be on A Deck almost directly over his head.

Tad jerked himself out of the bed; and pulled himself through the gravityless environment to the hatch of the access tube, then along the access tube up to A Deck, and out onto A Deck. He saw Bap and Anoshi manhandling thick metal-sandwich panels into position around the control consoles. As he emerged from the access tube they finished locking the one they held into place against the line of panels already up to the left of the consoles; and Bap saw him.

"Awake, Tad?" Bap said. "I was just coming down to get you. We've got a solar flare coming—in fact, it's already here."

"A flare?" The information jolted out of Tad all the anger that had been building up in him at not being wakened before this. For a second his mind was full only of the situation that a large solar flare implied. Then his anger returned with a rush. "Why'd you let me sleep this long?"

"We were doing all right without you," said Anoshi. "The radiation index is already starting to rise; and we're all buttoned down outside, except for the Lasercom—and that's matched with the LCO mirror on *Phoenix Two.*"

"Where is *Phoenix Two?*" Tad asked.

"Fedya's moved her a good hundred and forty kilometers off. We've both said our last words for the moment to Mission Control. Now, as soon as we get the storm cellar set up, we'll be all ready to ride it out. You'd better get dressed."

"Dressed?" Tad recognized suddenly that he was wearing nothing but standard onboard duty clothes. Anoshi and Bap were dressed in the undersuiting that went with their spacesuits, including even biomedical sensors and the semi-bulky EMU urine collection systems about their crotches and waists. He looked at the new panel the two were now picking up—the last one to be put in place to surround the control system. The panels made up a specially protected area which the 'nauts themselves referred to as "the storm cellar."

"How soon should we be inside?" Tad asked.

"The next fifteen minutes, to be amply safe," panted Bap. In no-gravity, the panels lacked normal

weight; but their mass and inertia made them problems to handle.

"I'll be back up in ten," said Tad.

He turned and went hurriedly down the access tube to B Deck. He got into his undersuiting, swallowed a hot cup of coffee in the wardroom, made a hasty visit to the waste disposal room and was back up the access tube and into the storm cellar within the time limit he had given. He entered through the gap where the last panel of the cellar stood ajar; and he pulled it closed into its fitting with the adjoining panel behind him.

Bap and Anoshi were already on their acceleration couches. The spacesuits for all three men were racked beside their consoles. Tad pulled himself over to his own couch and belted himself down on it so that he would not float loose. He was once again clear-headed; but the heavy sleep he had just had had reawakened his appreciation of what bodily tiredness meant. He was like a live mind in a nearly-unconscious carcass.

"How long was I out?" he demanded.

"Nearly six hours," said Anoshi. "We got word of the flare when Fedya told Mission Control about cutting the activities schedule, about an hour after Bap put you to bed."

"And Fedya took *Phoenix Two* off? We're still holding course?" Tad asked.

"Right. Right on both counts," said Anoshi.

"How intense a flare?"

"The forecast Kennedy gave us was upwards of twelve thousand BeV at Earthpoint," said Anoshi. "That should push it right up near the end of our scale."

He pointed at *Phoenix One*'s outside counter. Twelve thousand billion electron volts was more than three-quarters of the way up its line of measurement. Right now the needle hung just above the bottom pin.

"Are we all buttoned up?" Tad said. "Did you get the live subjects from the labs into the safety room?"

"All of them, including the plants from the atmosphere section of the pod. All the films out of the outside cameras—everything. Relax, Tad," said Bap, cheerfully. "Everything's done. We didn't miss your presence at all."

"You hope!" snapped Tad. He was still fighting his exhaustion-deadened body; and Bap's usual humor irritated instead of amusing him. He turned to the communications section of his console and punched buttons to call *Phoenix Two* on the LCO.

Color swirled and became the face of Fedya. It was clear and sharp; but then it should be. To the laser beam carrying it between the outside copper mirror on *Phoe-*

nix Two to the duplicate mirror on *Phoenix One,* a hundred and forty kilometers was no distance at all compared to the work it would finally be called on to do, maintaining communications between Cape Kennedy and the mission, once it was arrived at Mars. Theoretically, even the billions of electron volts—the storm of proton and electron particles thrown off by the solar flare following its first burst of electromagnetic radiation—should not disturb it, at this short distance. But that was one of the matters that the mission was about to test. Both ships had aligned their outside laser mirrors on each other, putting them out of contact with Earth—except for radio communication; and radio communication, even with the more powerful equipment aboard *Phoenix One,* which was to do the long-range tests once the mission reached Mars orbit.

"Fedya?" said Tad, the second Fedya's face was identifiable. "You did talk to Kennedy about cutting the schedule?"

"I spoke to Bill Ward," Fedya answered. "I told him that in any case, we could none of us do more than there was time to do in the normal waking hours, from now on."

"Good," said Tad. His mind jumped to another problem. "About the log—"

"I said nothing."

"Good. You had a last word with Mission Control before realigning your LCO mirror?"

"Yes," said Fedya. "I called them to say we'd reached our distance of one-forty klicks from you; and that we would open communication again as soon as the particle storm was safely past its peak. Estimate is, that should be at least fifteen hours from the time of my last transmission to them."

"All right," said Tad. "How's everybody over there?"

"Just lovely," said the voice of Dirk, before Fedya could answer. "Snug as bugs in our storm cellar here."

Fedya smiled a little.

"You too?" he asked Tad.

"Affirmative," said Tad. "We'll leave the communications channel open for metering purposes. Feel free to talk to us at any time."

"We will," said Fedya. "Over and not out."

"Over and not out to you," said Tad.

Fedya's face moved away from view of the screen on *Phoenix Two,* which now showed a portion of storm cellar paneling and the paneling overhead of A Deck. Tad leaned back on his couch against the pull of the strap.

"Maybe I'll take a nap," he said, "as long as there's nothing more we can do right now. Yes, I think I'll . . . take . . ."

And he began to dream almost immediately, that *Phoenix One* had reached Mars. She was buried deep

in sand; and the sand, despite all they could do, was finding small cracks and fissures in her hull, through which it came, silently and inexorably trickling into the ship . . .

There was no sound to the solar storm, raging through the vacuum about the ship, and even through the ship itself. There was no sound, vibration, color or apparent motion. There was only the needle climbing on the BeV meter. It climbed slowly to twelve thousand million electron volts . . . and continued upward while the three in the storm cellar of *Phoenix One* watched, and waited, and waited some more; occasionally talking back and forth with *Phoenix Two.*

"Look—" said Anoshi, finally.

He was pointing at the BeV meter. The other two looked. It took a second to make sure that they were not seeing simply what they hoped to see.

"It's backed off, all right," Tad said. "Just barely. But it's backed off. *Phoenix Two—"*

He turned to the communications mike and the screen of the LCO. But the view of the panels and ceiling enclosing the command area of their sister ship was no longer showing on the screen. Instead, the screen showed a slowly drifting and changing pattern of random colors.

"Now what?" muttered Tad. His fingers went to the controls of the LCO, while he repeated himself into the mike grid. "*Phoenix Two. Phoenix Two.* Come in, please. *Phoenix One* calling *Phoenix Two.* Do you read me, *Phoenix Two?* Do you read me? *Phoenix Two,* this is *Phoenix One.* Come in, *Phoenix Two . . ."*

The colors continued to drift, unresolved. Tad reached out and turned the gain up on the console speaker; but all that resulted was a louder rush of background static.

"Either their LCO's out, or ours is," said Anoshi.

"Shouldn't go like that," said Tad, under his breath.

"What?" Anoshi asked.

"I said—" Tad raised his voice, harshly, "it shouldn't go like that—in just a short time, and so completely out."

He turned and flipped back the cover of the recording strip on the LCO, pulling out a long tongue of paper with five parallel lines running lengthwise on it—running steadily until, some eight inches from where Tad's hand grasped it, the straight lines broke into a wild up-and-down marking that continued back into the recorder.

"Went out suddenly, a little over three minutes ago," Tad said. He looked at the others. "Were either of you watching the screen then?"

Bap and Anoshi both shook their heads, watching him.

"Well, it must be our unit," Tad said. "Either that, or *Phoenix Two* is deliberately transmitting nonsense. Now why would our LCO

hold up beautifully all through the storm and then go on the blink the minute the storm started to back off?"

He looked at the BeV meter. The needle was now perceptibly down from the high peg against which it had been resting. Bap glanced up at the ship's chronometer, high on the console.

"The storm was stronger than they forecast," Bap said, "but it's slackening off before they forecast it. We should have an hour or more of heavy particle bombardment to wait out yet."

"As long as the storm fades, I'm not going to ask why," said Tad; and was startled for a second by the near-anger in his voice. *Get hold of yourself,* he said, internally. *You're becoming as touchy as nitroglycerine. —Becoming? Or have you been like this these last couple of weeks and been too tired to realize how you were acting with Bap and Anoshi?*

However, there was no spare time for emotional self-examination now. The point to concentrate on was that the LCO was malfunctioning. He looked once more at the BeV meter. There was a red line near the bottom of its scale; and a blue line below that. Once the indicator needle fell below the blue at the bottom of the scale, it would be safe for a man in a spacesuit to engage in EVA—extravehicular activity—outside the ship.

"As soon as we get below the red," he told the other two, "we can check everything right up to the point where the system goes out through the hull to the positioning controls of the mirror. Meanwhile, we can at least check the console part of the system. And I suppose we might try the radio—just for luck."

He reached out as he finished speaking; and keyed in the radio system to the mike and the speaker. But at the first touch of the volume control, the torrent of static that poured in on their ears ruled out any possibility of communication by radio with *Phoenix Two.*

"Long shot," he said; and made himself grin at Anoshi and Bap. "All right, give me a hand at getting the front panel of this console off and we'll start checking the LCO."

They went to work. But that part of the system which was checkable within the area of the storm cellar was relatively easy to check; and it was not long before they had proved that there was no malfunction in the system as far as they could reach it. They replaced the front panel of the console and Tad looked at the BeV meter. Its needle was already below the red line.

"Dropping beautifully," said Tad, getting to his feet. "All right, let's break out of this storm cellar and check the system as far as we can the rest of the way inside."

Bap and Anoshi also rose. But Anoshi was frowning at the BeV meter.

"I agree with you," said Bap, although Anoshi had not said anything. "It's not what they told us to expect—the storm dropping off this soon and this fast."

Tad felt the sudden gorge of his earlier irritation and rage boil up automatically, like a sour vomit taste in his throat.

"Have you got some suggestion for checking on the situation?" he asked Bap. "We can't raise *Phoenix Two,* let alone Mission Control."

Bap merely frowned slightly, his dark brows joining in a single black line above his fatigue-darkened eyes, apparently more puzzled than provoked by Tad's words and the edge in Tad's voice.

"We could sit tight for a few more hours," he said. "*Phoenix Two* was the one who moved off from us. All we have to do is wait and she'll be rejoining us, if the storm's down and all communications are out."

"And if she's in trouble on her own?" Tad demanded. "What if she's in worse trouble than we are; and needs us to contact her and get word back to Mission Control?"

He did not wait for Bap to answer, but walked directly to the last panel that had been put in place to seal the storm cellar. He broke the seal loose and pushed the panel back, stepping into the open part of A Deck.

"All right," he said, heading for the access panel that would allow them to begin tracing the LCO system beyond the area that had been enclosed by the storm cellar. "Somewhere along here we'll find the malfunction."

XI

However, when they got the last access plate off, the LCO wiring checked O.K. right up to the inner skin of the bird.

"That's it," said Tad, disconnecting the leads from the test unit and putting the access plate back, fist-thumping it into its own tension-held position. "It's had to be in the positioning motor unit for the mirror outside, then, just the way I said. The storm was heavy enough to knock out any outside electronic components."

"The positioning drive is shielded," said Bap. "That whole housing below the mirror is shielded."

"Not enough," said Tad. "Not enough by a damn sight. Or maybe you think we overlooked something inside; and the trouble's not out there after all?"

He stared at Bap. Bap's dark face was honed now by tiredness to the sharpness of an axe blade chipped out of gray flint. There was no more humor left in him. Anoshi was equally pared down, and silently watching them both.

"I mentioned the shielding,

only," Bap said. "Of course, it must be outside."

"Right then," said Tad, his voice back to an impersonal note. He turned and led the way toward the central ladder tube; and they went up the metal rungs to the Control Deck again. Tad checked the needle on the radiation graph. It was down now, on a good thirty-degree slope of fall; still above the blue line by an inch or so, but plunging.

"All right," said Tad. He checked the radio; but only the mindless blare of static roared from the control console speaker. "I'll EVA and have a look at the trouble outside where it lives."

"We're not in the blue, yet," said Bap. "And there's Mission Control to consider—we should check with them before an EVA."

Tad looked at him again.

"No," put in Anoshi. "Until the storm dies down there's no reaching Mission Control on the radio. And maybe *Phoenix Two*'s had the same trouble. Without a radio she can't reach us—or Mission. At least we have a chance of reaching Mission by radio in a day or two—even if the LCO's are out for good, for both of us. We could lose *Phoenix Two,* meanwhile."

"All right," said Bap, still standing, looking back at Tad. "But you're the commander. I'll go—or Anoshi."

"I'm the commander. I'm going," said Tad.

He headed toward the ladder tube.

"We're not in the blue yet," Bap said.

"I heard you the first time you said that," Tad answered without stopping, without turning. "By the time I'm suited up and ready, it'll be down. That's a classic curve for flare activity, there on the graph. Tell you what, though—" he had to turn to face the other two as he began to back down the ladder, "the sensor eyes are working all right. Keep the picture on by Hatch Three. I'll wait to go out until you tell me we're under the blue line. O.K.?"

"O.K. Real fine," said Bap. "I'll keep the picture lit by Hatch Three and advise you when we're under the blue line."

"Right," said Tad. "And keep a radio and LCO watch in case *Phoenix Two* or Mission comes back in again."

"Will do," said Anoshi.

Tad went on down the ladder, out of sight of the two still on the Control Deck.

Over in *Phoenix Two,* a check of the Laser Communications System was also in progress; but with different results.

"There could be trouble outside," Bern said.

Fedya merely shook his head. They were in the Control Area of *Phoenix Two* and while the other two stood behind him, Fedya was

seated at the test board of the LCO.

"Not likely," said Dirk. "We'd have trouble lights somewhere. It's got to be the LCO over on *Phoenix One.*"

Fedya's long, thin fingers drummed thoughtfully on the edge of the test board. Of the three on *Phoenix Two,* he showed his fatigue the least. Above his white coverall collar his grave, handsome face looked not so much tired as remote and considering, as if this was only another theoretical problem to be worked out on the finite squares of the chessboard.

"No radio," he said, turning the speaker sound up momentarily with its roar of static. "No LCO with *One.*" He turned the speaker sound down again. "Very well. Let us see if we can make contact with Mission Control. Contact will prove our LCO is operational; and we can get word about *One* to Control."

He looked up at Dirk.

"Dirk," he said. "You stay on the radio and try to raise *Phoenix One* that way, while I work the LCO into contact with Kennedy."

Tad was sweating by the time he was sealed into his spacesuit by the Hatch Three air lock on the bottom deck; and the suit temperature controls went automatically to work to dry him off; so that he felt hot and chilled at the same time—a feverish sort of feeling.

He remembered suddenly that he should have had Anoshi follow him down to check him out in the suit before he went EVA. He had not thought of it; and evidently it had not occurred to Anoshi, either. It was not really necessary; but the fact they had both forgotten was another symptom of the bone-tiredness that was afflicting them all when it should not—that, and the sweat he had worked up getting suited, were both warning signals from their body systems. That was one of the bad effects of fatigue—it not only impaired judgment and put your temper on hair-trigger, it walled you off from the people around you. You could not spare the energy to remember that they were as worn out, as mistake-prone, as you were; and everything they did wrong irritated you . . .

Tad suddenly realized he had been standing by Hatch Three for some little time, holding the test kit he would take outside to check the LCO. He spoke into his suit phone.

"Bap? You've got me on screen, haven't you?"

"On screen. Right," came back Bap's voice.

"What's the matter? Are we still above the blue line on the graph?"

There was a little silence before Bap answered.

"No. Just below, now. But the curve's flattening out a bit. I wanted to give you a bit of margin below the blue line."

"Never mind margin. The line *is* below the blue?"

"Below the blue. Right."

"Then I'm going out," said Tad. "Light up the outside sensor eye from Hatch Three, if you can; and keep me in sight. I'll stay on tether."

"Sorry, Tad. Hatch Three sensor not responding. Maybe you better keep talking and we'll record."

"Roger," said Tad. "I've already got the inner air lock door open on Hatch Three . . . I'm in the air lock now and the inner door is closing. Evacuation of air lock . . . Do you read me?"

"Read you fine," Bap's voice said. "And we copy that."

"All right," said Tad. "Outer air lock door now opening. I'm on my way out, tether behind me . . . all the way out, now. I'm pulling extra length of the tether out so I'll have plenty of line to let me reach the mirror."

"O.K. Copying," said Bap.

"I'm going to stop this conducted tour for a minute or two," Tad said, panting. "Running out of breath. I'll get back to chatting with you in a few minutes when I start down along the hull toward the mirror."

He fell silent, pulling out the last of the tether-cable that not only tied him securely to Hatch Three and the ship, but also contained his main primary air and phone lines. *Damned mess,* he thought, sweating inside his helmet. His magnetic shoe soles practically welded him to the skin of the spacecraft. His chances of getting separated from the ship were one in a million. So much easier if he had come out here untethered, simply with backpack oxygen for what would not be more than twenty or thirty minutes work . . .

"Give us a word, Tad." It was Bap's voice sounding in his helmet. "Just so we know you're still with us."

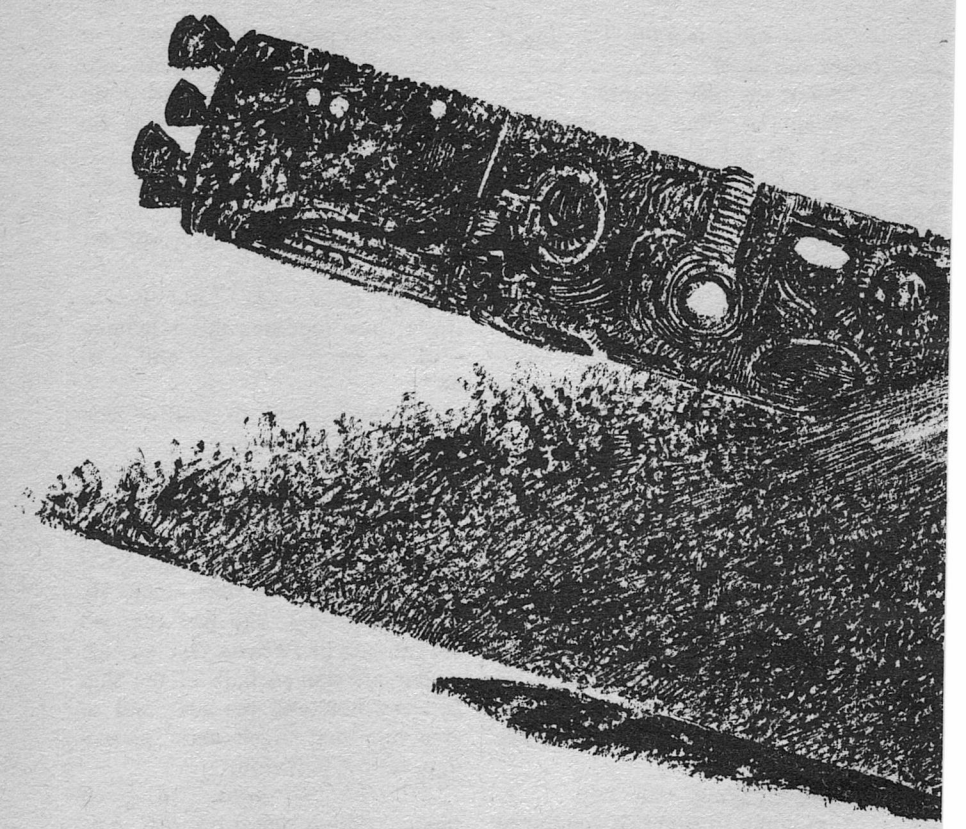
"I'm here. Hold on. Talk to you shortly . . ." Tad said.

He gathered up his tether and began the clumsy shuffle down along the hull toward the small, upright, square shape of the LCO mirror, outlined by stars alone. He was in darkness—Bap had changed the attitude of *Phoenix One* enough to put the slanted bulk of the ship between him and the sun; and so give him that much extra protection against radiation.

All right, thought Tad, *good enough. Play it safe if you like, Bap.* The only problem might be uncovering the mirror mount and testing out its positioning motor's components in the dark. But he had the work light at his waist. *Try it,* he thought, *anyway.*

"All right," he said aloud over his phone to the two inside the ship. "I've reached the mirror. Now I'll see about getting the cover off the motor mount."

"Reading you fine and clear," answered Bap's voice. "We copy

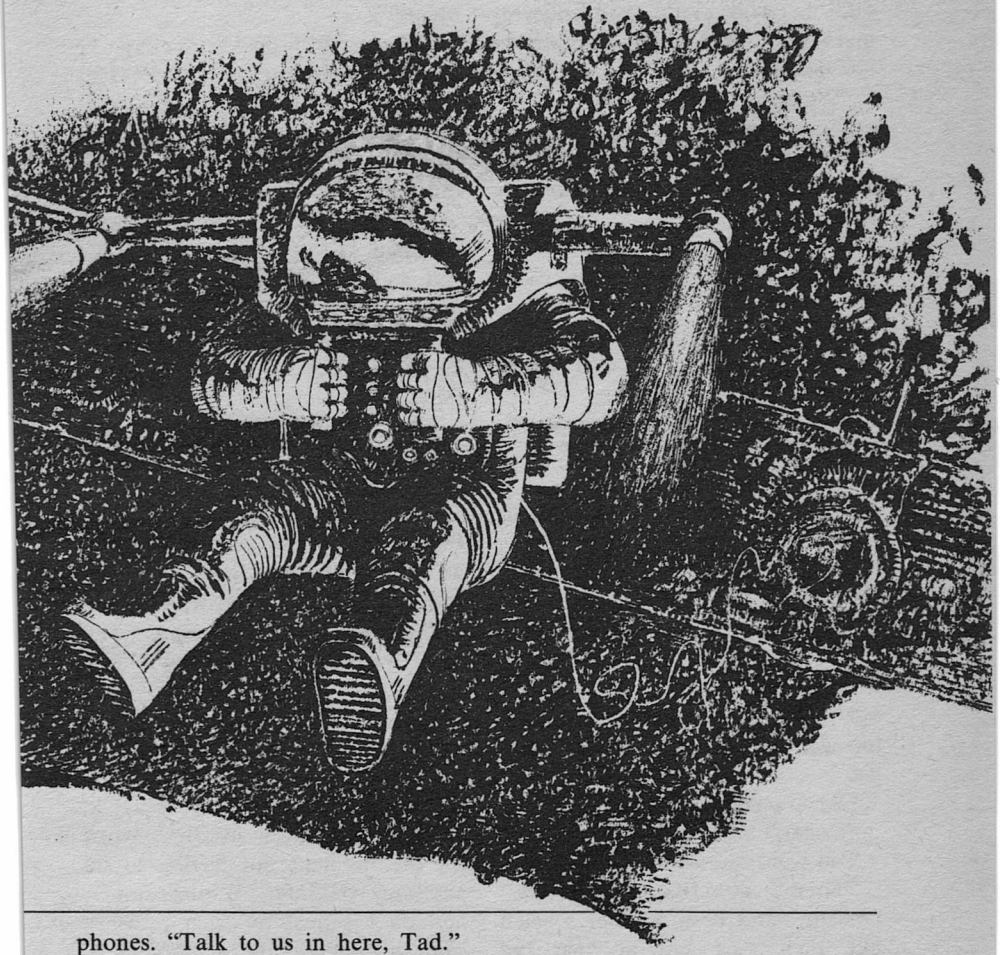


that—you're going to take off the motor mount cover, now."

"Going to try," muttered Tad. Tensing his leg muscles, he pulled himself and the clumsy suit about him down on its knees before the motor mount. He switched on his belt light. The motor mount cover with its four recessed bolts appeared just before him.

He got the socket wrench from his tool belt and went to work to loosen the bolts.

"Talk," said Bap in his ear-



phones. "Talk to us in here, Tad."

"Sorry . . ." Tad said, short-winded. "Too much, out here. To do. Let you know. Soon as I get—something done."

He worked on. Eventually he got the bolts loosened and the cover off. Inside was the neat tangle of components and connections. He opened the test kit he had brought and his gloved fingers clumsily picked up the leads, one, then the other, and pulled them out to at-

tach to the motor components.

"I've got the motor mount cover off," he said aloud, suddenly remembering Bap. "I'm starting to test now."

"We copy that," said Bap.

Time went by.

"Some news here for you," said Bap's voice, unexpectedly. "*Phoenix Two*'s getting through to us a little on radio. Lots of static, but every so often they come through clear. I've been talking back to them on our radio, telling them about our LCO trouble, but they don't seem to read me too well."

"How're their communications?" asked Tad, working away.

"Say again?" Bap asked.

"How's the LCO over on *Two?* Did it go out like ours did?"

"Negative," said Bap. "They're all right. They're trying to make LCO hookup back with Mission Control. As I say, I've been trying to tell them what's happened to ours, but they aren't reading me too well—don't think they've got it, yet."

"Keep trying," said Tad.

"Roger," answered Bap.

Tad went on testing.

"There's an AJK4191 out here," he said, "and both AJK60L's acted like they were out at first, but they're both responding, now. It's the signal amplification that's gone out. The motor was getting the messages but it couldn't do anything with them. —Also an M84B connector, also an AJK4123 are out. Check stores, will you, and make sure we've got replacements?"

"Roger. Will do," said Bap. "I copy, search stores for an AJK4191, M84B connector, and an AJK4123. Anoshi's going to check. I'm still trying to get our story told over the radio to *Two.*"

"O.K." Tad straightened up his cramped knees, rising erect in his suit, held by the soles of his feet firmly to the hull of the spacecraft. "I'll hold here while Anoshi looks at stores. Let me know what he finds."

"Roger," said Bap. "How are you feeling?"

"Like twenty hours more sleep," answered Tad. "If you don't mind, I'll just hang here and take it easy until Anoshi gets back with the word on those replacements."

"You do that," said Bap. "The next voice you hear will be Anoshi's."

The suit phone went silent. Tad hung there weightless, letting himself float in his suit, anchored by the magnetic soles. He was so weary he felt empty inside; but just for the moment not having to do anything was infinitely pleasurable; and on the heels of such pleasure came something like a moment of sanity.

He felt ashamed of the way he had undoubtedly been chewing on Bap and Anoshi. It might have been unconscious reaction to fatigue on his part, but it had been

hard on the other two men, nonetheless. Actually, he admitted to himself now, he had been indulging himself, like the selfish head of a family who says, "I'm important. I can take my temper out on you because I'm important. But you can't take your temper out on me."

I've got to quit this, he told himself now, *or we'll never finish the trip.*

And Mission Control, he thought, *had better trim that priority list on the experiments; or I'll do it for them. We can't take it. None of us can take it.*

—And no reason we should. We're out here now and when you get right down to it, we're the men who go and do. We listen to them when we're on the ground. We do everything they say. But out here, we're like fish in the water while they're back there on dry land. In the long run we've got to tell ourselves what's best for us to do.

He thought of the fact that they were all alike, in a way—all six of them in the two ships. Never mind the fact they all came from different cultures, different languages. Out here that was so damn small, that kind of difference. Out here it was like the hunting party in strange territory—really strange territory. And they were all here because they wanted to be here—really wanted to be here. Not just like someone who thinks it'd be something special to go out into space.

That's why we're all alike here, Tad thought, *and all of us so different from those back there. We've got to be different if we're going to live. And they've got to be different back there, because they've never come out here to know what it's really like.*

Tad hung in his suit and lifted his faceplate to the stars.

"All right," said Anoshi's voice in his helmet. "Tad, we've got the replacements. I've brought them to Hatch Three. You want to come back and get them? Or how about my going out and putting them in?"

Tad heard him; but his mind held the words off from registering for just a moment longer while he looked at the stars. He would answer in a second; but just for the moment, he wanted to finish his look and his thought.

Oh, you beautiful, he said silently to their lights all around him, *oh, you damn beautiful, beautiful, universe . . .*

In the first screen at Mission Control, Al Ciro, the Mission Communications Engineer, was watching the image of Fedya. It was a little wavery, but recognizable; and the voice that came through was only slightly mush-mouthed by uncertain beam linkage.

". . . had it over the radio, finally, from Bap," Fedya was saying.

"You mean now?" It was Bill

Ward, pushed in beside the Communications Engineer. "You mean Tad went out there as soon as their meter went under the blue line?" Bill jerked his head aside to speak to one of the engineers standing about. *"Get me an estimate on that."* He turned back to the screen. "When did you hear, there on *Two?*"

There was the short wait as Bill's words, even at light-speeds, traveled the great distance to *Phoenix Two.*

"Radio contact has been bad until just now," Fedya said. "Evidently Bap was trying to tell me all along that their LCO motor control had been knocked out by the storm; but I didn't understand him until now. Evidently Tad went out as soon as their BeV showed it was safe to do so."

"And he's been out since? Get on that radio!" Ward said. "Call *Phoenix One* and tell Bap to get Tad back in there. There was a burp of increased flare activity only twenty minutes or so behind the trough of that first dip in radiation. Get on it!"

Bill stopped speaking. Before Fedya could answer, the engineer Bill had asked a moment before for an estimate came back with a piece of paper. Bill snatched it, glanced at it; and stepped back from the screen toward the outskirts of those standing nearby.

He looked up at the glass observation booth at the back of the Mission Control room, then around him until his eyes fell on Al Ciro. He reached out, hooked his finger in Al's shirt pocket and drew Al to him.

"That's Wendy Hansard up there, isn't it?" he muttered. "What did you say before you came down here, just now?"

"I? Nothing," said Al. "Just that I'd find out what was going on and come back up to tell her." He stared at Bill Ward. "What is it?"

"Oh, Christ!" said Bill. "Christ!"

Grimacing, he stared at the paper in his hand, scratching at his chin with one finger, briefly and furiously.

"She would be here!" Bill said. "This, of all times!" He looked at Al.

Al stared.

"Outside the ship? You mean he'll have been burned by that flare burp?" Al asked. "Bad?"

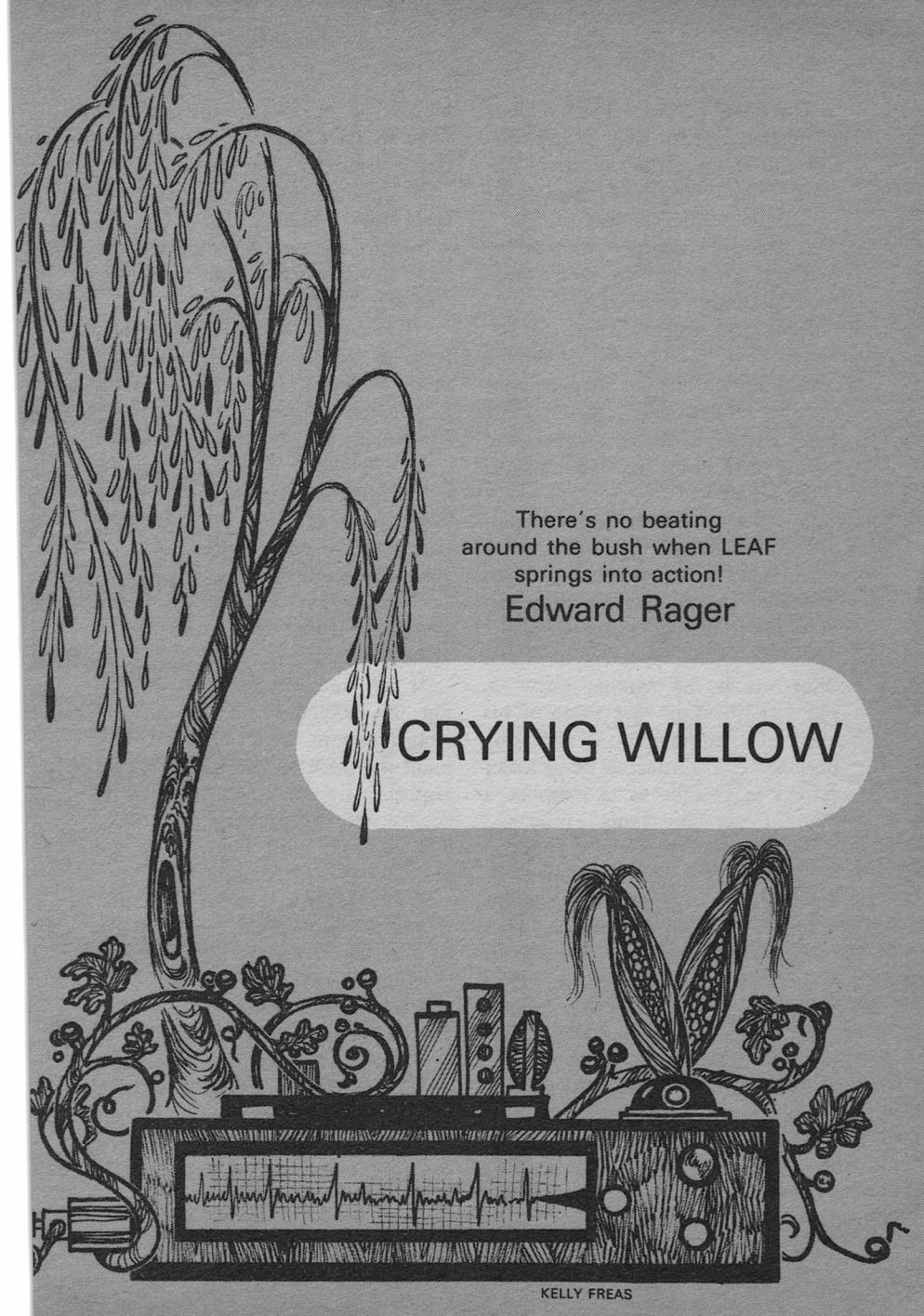
"Bad," said Bill. He stared at Al for a second. "Very bad. If he's been out there the way it sounds . . ."

His voice trailed off. He glanced back up at the booth.

"And there's Wendy!" he said. "And Christ, Christ, I've got to go talk to her. I've got to tell her—that just while she was standing here, waiting to hear about him . . ."

He stopped speaking. His big hands fell limply to his sides, one of them still holding the paper.

TO BE CONCLUDED



There's no beating
around the bush when LEAF
springs into action!

Edward Rager

CRYING WILLOW

KELLY FREAS

When I tell people I head a plant protection agency they usually figure I'm in industrial security. The truth is I'm with LEAF, the League to Eliminate the Abuse of Flora. The agency is charged with seeing that our green friends aren't wantonly destroyed or abused. We take on any job which seems to fall within our jurisdiction, including regulating and setting standards for the use of herbicides, coordinating the activities of forest rangers, and setting and enforcing laws against picking flowers.

Our newest, and strangest, operative is a different breed altogether. His name's Herb Greene and he's trying to communicate with plants both electronically and psychically. There's no need to tell you what I think about his psychic hogwash, but I must admit that some of his electronic equipment is certainly impressive. He attaches lie detector probes to the leaves to measure a plant's psychogalvanic reflexes—whatever they are. Says changes in the lines on the chart correspond to the plant's reactions to thoughts and actions from the outside. He's trying to use this to verify his attempts at communication. He's even got kids believing they're making beans grow faster by thinking good thoughts about them.

He must be some kind of a crackpot, but I'm stuck with him. The regional director told me to give him a free hand. Anyway, he gets us a lot of publicity and the visitors all go away impressed. I'll have to take the time someday to find out exactly what he's doing.

A few days ago Greene came to the office to tell me that there was a tree in agony somewhere in the city. I almost dropped my pipe. "What's that?" I managed.

"I've received an impression from a tree about two or three miles northeast of here," he said. "The signal corresponds to a tree's equivalent of pain, though I'm not sure whether it feels anything or not. It just responds as if it does. The graphs indicate that it's been happening several times a day since yesterday morning."

"Well, what do you think we should do about it?" I said, trying to humor him.

"I can home in on it by attaching the polygraph to one of the bean plants in the mobile unit. The plant will pick up the tree's distress signals and the polygraph will record its sympathetic response. The intensity will increase as we get closer."

We? He must mean his old buddy the bean plant. Seems to me he'd get along better with a nut.

"Sounds good," I said, "but I'd like to give it a little more thought. Run some more tests and see me in the morning." What was I going to do? I was supposed to give Greene a free hand, but I couldn't go out on a limb by having him knocking on someone's door and telling them they had a tree in pain.

Right after lunch, however, I got a call from the police department. It seems a woman had complained that a tree in her neighbor's yard was crying and bothering her. The police had understandably refused to investigate when she further told them she thought it was a weeping willow. The precinct captain turned the case over to us, and not without a trace of mirth in his voice.

"Julius," I said to myself, "here's a perfect job for Greene." Even if he hadn't come to me with a similar case, it was right up his alley. One crackpot helping another.

I put him on it right away. He took his log book and some equipment and left in the mobile unit.

I was just locking up my office when Greene returned in a highly agitated condition. I hadn't seen anyone in the department that upset since the time Dr. Pollard spilled the beans about the graft in the conifer branch.

"The man's a maniac! He should be committed," Greene said, waving a lie detector chart in my face. All I could make out was a long, jagged line with some high plateaus.

"Can't it wait, Greene? I'm just going home."

"But look at the graph! He's torturing that poor tree! A sadist! We've got to stop him!"

"Well, come in and we'll talk it over," I said, thinking what the trip home would be like if I didn't get out before the rush-hour traffic.

"His name's Marcus D. Shade," Greene said, before I could even hang my coat up. "I remember him from a group that toured my lab a few weeks ago. He asked me questions for fifteen minutes; mostly about how to measure the psychogalvanic reflexes and what they indicate. Now he's using that information to satisfy his sadistic tendencies at the expense of that hapless willow."

I wasn't even going to ask Greene if it was a weeping willow.

He held the chart up again. "I made this by recording the sympathetic responses of an iris plant in his neighbor's yard. These sharp rises in the curve show where he applied his tortures. In the few hours I was there, Shade scraped the outer layers off several leaves, dipped some others in scalding water, and burned the trunk with a soldering iron. He's crazy!"

"What about the woman?" I asked. "She said it was crying."

"It's that fiend Shade! He's attached electrodes to the leaves like I do, only they're connected to a sound system instead of a polygraph. He's adjusted the output so that the signals sound like human cries when the tree is disturbed. It adds to his sick pleasure."

"Well, it does sound like we're dealing with a crackpot here," I said. Another crackpot. "Maybe we could get an injunction or impound his tree."

"No! I checked. There's no law protecting willow trees from any kind of abuse as long as they belong to the abuser. He's not breaking any laws, except maybe disturbing the peace."

"Suppose he wore earphones," I offered.

"That wouldn't help the tree."

"You're absolutely right," I said. "This looks like a job for the boys in PR."

"Plant Rescue might take too long to decide what to do. I've got a plan ready for tomorrow morning if I can stay over tonight to work out the details."

"Go right ahead," I said, grabbing my coat. "The sooner you get started the better."

I didn't see Greene until early the next afternoon. He was all smiles as he lumbered into my office and draped his long limbs over a chair. I had reason to be happy, too, because of a call I'd just received from the police department. I gave him my news before he could speak.

"Well, Greene, our crackpot finally flipped his lid. He went crying to the police that his tree was out to get him. Said it threatened him verbally and demanded to be left alone. The captain is holding him for a psychiatric exam. Our troubles are over."

"Yes, Mr. Cedar, but not the way you think. You see, last night I ran some tests to determine exactly what frequency Shade would have to be using to receive the tree's responses in that particular timbre. I fixed up a small transmitter to broadcast in that range. This morning, just as he was about to release a jar of caterpillars onto the tree, I spoke into my rig. The output was adjusted to the same pitch as the tree's screams and I threatened him with everything from falling branches to Dutch elm disease. It would have scared anyone."

"Of course." Is the man a crackpot or a genius? "I don't suppose there was any chance that the tree could really have harmed him?"

"No, sir. I'm afraid its bark is worse than its blight. Plants have no central control systems as in animals' brains. Individual cells can transmit to other cells and receive, but they can't think or act."

"One thing I've been curious about," I said. "You seemed to know about the willow's dilemma before the police report. How did you find out?"

"You see, sir, plants do broadcast their anxieties to other plants, but usually only those in the immediate vicinity can pick much of it up. However, an antenna can be made by allowing a vining plant with broad leaves to grow along a specially shaped trellis. I have such a system."

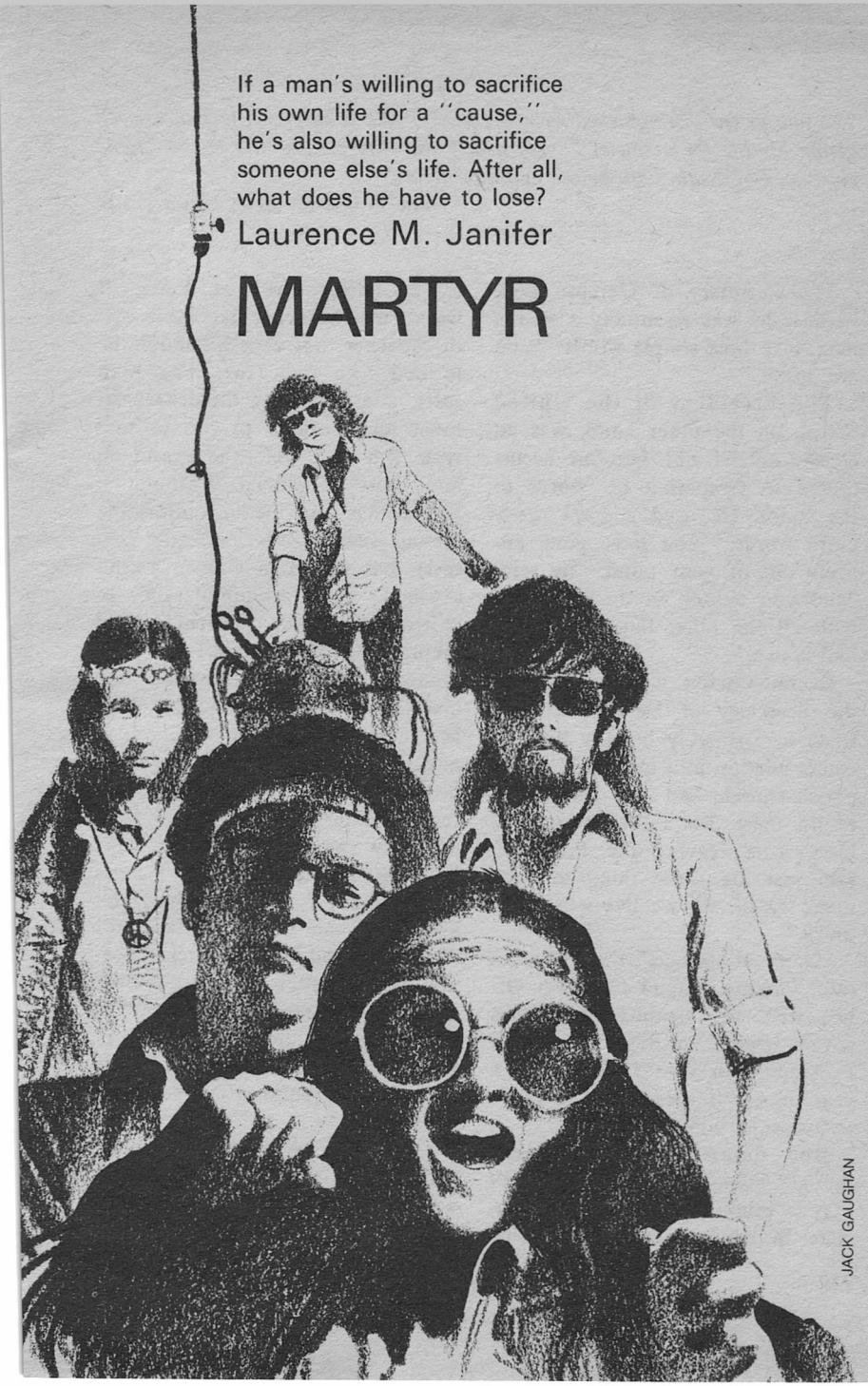
"That's what enabled you to pick up the willow's distress signals?"

"Yes, sir. I heard it through the grapevine." ■

If a man's willing to sacrifice his own life for a "cause," he's also willing to sacrifice someone else's life. After all, what does he have to lose?

Laurence M. Janifer

MARTYR



JACK GAUGHAN

The martyr (as distinguished from the person who is surprised to find himself giving his life for a cause) is very nearly the only person who is thoroughly convinced of death, both before and after dying.

—The Public Notes of Isidor Norin

The Secretary of Defense said, because he was essentially a simple man, just three simple words: "You are insane."

The President of the United States, on the other hand, was an elected official and therefore accustomed to tempering his words to the shorn. He used a good many more words. "You have gone entirely out of your mind," he said, "and you belong in the bughouse with all the other bugs, and nuts, and kooks."

Everett Carson, who had gone to the Secretary of Defense directly from a reasonably lengthy time of contemplation in a quiet pew of his parish church, and who planned to return there, for a few minutes at least, after leaving the President, said just the same thing to each man: "Well, sir, we live in strange times."

"Damned strange," the President said, looking around the Oval Office with the opaque resignation which seems to descend on all Presidents in that room, after a year or so. "I mean—well, I mean *very* strange times," he said.

But, damn it, the President thought behind his mask, it wasn't easy to think of Carson as an Associate Secretary and a responsible career officer over at State. It wasn't that he acted like some sort of preacher, not exactly—and if he looked like one (the long lean sort), a good many State Department men seemed to run to that type. But . . . well, the President, and most of official Washington, had always had the uncomfortable feeling (which was perfectly correct) that this man Carson wasn't satisfied with trundling off to church on Sunday morning and taking care of the matter of religion as normally as that. There had always been the suspicion that Carson might be found in a church at any time at all: Wednesday afternoon, for instance, or some perfectly ordinary Friday.

"Don't moderate your language in deference to me, sir," Carson was saying. "I've heard worse, you know. At the Crystal Palace, for one thing—the limited-level space-armaments conference. And—"

"Nevertheless," the President said irritably, "this proposition of yours is idiotic. Insane." He made a sweeping gesture with one hand. "Ridiculous."

"If I may, sir," Carson began, and, when the President nodded, went on: "What have we got to lose?"

"Five kids," the President said, in a voice his TV audience would not have recognized. "Five young, suburban, well-brought-up children, average age sixteen, are in possession of an armed atomic bomb. That silly magazine—the one that published the mechanics of a Molotov cocktail a few years back, during the riots!—ran a technical breakdown on the things a few issues back. 'America's Shame: Death at a Fingertip.' Something like that." Carson made a sympathetic noise. "And now these—*kids,*" the President went on, "are established in a cabin outside the Denver suburbs, and, thanks to the miracle of live-remote TV spy-eyes, have told the world that they are going to set the thing off—it's quite powerful enough to wipe half of Colorado off the map, you know—unless we agree to their terms."

"Yes, sir," Carson said, evenly, but still sympathetically. "And their terms would mean anarchy: the destruction of the rule of law—"

"Which is the only alternative to cutting your neighbor's throat when you happen to disagree with him," the President put in.

"Quite," Carson said. "The destruction of the rule of law, the destruction of this country and this society . . . as we both clearly see. And, since we cannot agree to any such terms, and cannot allow them to kill four to seven million people—or even take the chance of their doing so—we must come up with something else."

"Brilliant," the President said hopelessly. "A brilliant analysis. The dissection of the obvious . . . oh, damn it, Carson—"

"And we have come up with nothing else to do," Carson said, in the same even voice. "Sending a plane up and destroying the cabin and our—blackmailers—is impossible: the TV coverage there would call us murderers, at the least; and, at worst, we might just set the bomb off as well. Dropping a gas grenade, knocking them out and recovering the bomb is open to the same objections . . . the TV coverage would be merciless, sir. 'Unwilling even to discuss national goals with these brave youths . . .' You know the sort of thing."

"I'm afraid I do," the President said. "And the freedom of the press . . ."

"Yes, sir," Carson said. "There just isn't any way to shut off the spy-eyes—not without a nationwide uprising. And the uprising could as well be touched off by coverage

calling us murderers, or secretive, warlike men who cruelly brush aside the earnest voice of youth in order to continue our stockpiling of . . ."

"Stop that," the President said. "It sounds too familiar. Good Lord, Carson: do they really think we *like* killing people?"

"I wouldn't know, sir," Carson said. "I have never been able fully to understand such minds. But they exist—and in sufficient numbers so that one such act, carried by TV, would set off an uprising . . ."

The President nodded. "I know," he said. "And if we agree to negotiate, and *then* go in—barring TV for the actual negotiations, which they'll stand for—and gas the kids, get the bomb . . . why, the kids will speak up later. And if they're not around to speak up . . . Carson, every alternative is horrible. Everything we have to do is horrible—and none of it will even work."

"Exactly, sir," Carson said. "Therefore, since we must do something, and can't think of anything effective to do, I repeat: what have we got to lose?"

"Send you to negotiate with them? Actually *negotiate?* With five children? Now, Carson—"

Carson shrugged. The Oval Office had always had a strange feeling of closeness for him, as if he and its other occupant were locked in together, permanently. He dismissed the feeling, as irrelevant to the business at hand. "First, we must recover the bomb with the full agreement of the children," he said. "After recovery, TV will interview them: that much is plain." The President nodded. "And, too . . . there are very few adults in this world," Carson said. "I think that I have met four in my lifetime; and I do not count myself, not in modesty but on rather a long acquaintance. My wife might qualify . . . In any case," he said a bit more sharply, "age is certainly not a controlling factor. I have spent a good many negotiating sessions with children, Mr. President."

"Wordplay—"

"With respect: no, sir," Carson said. "Fact."

"And you think these negotiations of yours might—might—"

"Might remove at least this threat to the Republic and the world," Carson said. "And remove it entirely. Yes, sir, I do. Leaving us, of course, to deal with all the others."

"But the others—China, Czechoslovakia, the United Nations, Taiwan, pollution, the balance of payments—the others are *normal,* Carson. This—"

"I agree, sir," Carson said. "This is a trifle odd. Which is why I broke channels to present my idea. Unless there is a better operation now about to mount—"

"Nothing," the President said. "Nothing. You'd think the CIA, or Defense, or *somebody*—maybe

HEW, for all I know—would have come up with a plan. But—"

"I'm afraid," Carson said, very gently, "that they tend to have the wrong approach to this sort of thing."

The President stared. "The—" he began, and stopped, and tried again. "To this sort of—"

"Exactly," Carson said. "A pattern does exist. And I suggest, as gently as I may, that we hurry this a bit. They've given us, you know, a deadline."

"I know," the President said. "It's down to forty-two hours now, from sixty. Forty-two hours . . . Carson, there isn't *anything* that can be done in forty-two hours!"

"I should rather like to try," Carson said gently. "Mountainview, their nearest suburb, not yet having a full heliport of its own—if I might emplane to Denver at once, with Mr. Suessman, and proceed from there with two cars and chauffeurs—"

"And that's another thing," the President said. "There are hundreds of experienced men, Carson. You've seen them come and go for—what is it, thirty years?" He waved a hand, forbidding reply. "But this Suessman . . . well, I ran a check. Had Combined Records do it, rush-star-rush. He came into State three years ago. Wanting, the form says, 'to serve his country'; not many of those left, or at any rate not many who'll admit it. But before that he spent four years with Actors' Studio. A few off-off-Broadway parts, nothing special . . . a drama student, Carson. A *drama* student! No negotiating experience—basically a clerk . . ." The President shut his eyes. "Carson," he said softly, "will you tell me one thing?"

"If I can," Carson said, "certainly, sir."

"Why this one?" the President said. "Why Suessman?"

Carson took a breath. "Well," he said, "for one thing, he was never much of a success as an actor, sir. Never even appeared on television; he won't be recognized."

"I suppose that makes sense. But—"

"And for the other," Carson said, as the President opened his eyes, hoping, apparently, that all was now to be made clear, "he's never seen Denver, sir. Or any of the country out there. I think he'll rather like it; I know that I do."

Long training among hecklers prevented a Presidential explosion. After a time he said: "Now, really—" and felt proud of his moderation.

"We're running short of time," Carson said. "If your security precautions have been tightened, and the technical matters—"

"Damn right," the President said. "I mean: certainly. Certainly. No drone flying to Colorado Springs is going to get off the ground again without six checkovers. Or sixteen. If there'd been a pilot . . . well, we

might have had a dead pilot as well, I suppose. But the idiotic luck of the thing . . . the crash, these kids finding the cushioned bomb in the wreckage . . . for God's sake . . . I mean: for Heaven's sake—"

"God," Carson said with a perfectly straight face, "is quite acceptable."

"Idiotic . . . I thought the coast of Spain, years ago, had been the last of it. But it is not going to happen again. Believe you me," the President said, in a voice that sounded, briefly, very much like that of his native Ohio.

"Good. I'm glad of that," Carson said, meaning it, of course, quite sincerely. "Then all that remains—"

"Is your trip," the President said. "I suppose so. I suppose so . . . I don't know what else can be done, I don't know . . . Carson, there's nothing else left. You understand that, don't you?" He looked into the spare, pale face always diplomatically bland but never less than competent in appearance. "Of course you do," he said. "Certainly. Anyhow . . . well, Carson, I hope you do. I have to: it's the only hope we have, any of us."

The five (three male, two female, though the point of sex was quite irrelevant) were waiting in what they called their "conference room," after having tried "clubhouse" with a less dramatic effect. It had been their choice for a meeting, an abandoned shack in rocky country some five miles beyond the posh-suburban outskirts of Mountainview. Carson had taken some care to reassure his associate on one point, at least. "They won't shoot. Not at once, at any rate. They're negotiating with the entire U.S. Government, as equals. They should rather like the feeling of power that provides; our hope is that they continue to like it for just long enough." Suessman showed no signs of nervousness as he came to the opened door, and Carson hoped that he had done, outwardly, at least as well.

The tallest of the men, who seemed to be the spokesman and who had been the most heavily featured on spy-eye TV coverage, stood in the open doorway and looked the two men up and down. Carson: long, lean, fifty-odd. Suessman: middle-sized, middle-thirtied, middling-bald. Behind them two automobiles waited, and the chauffeurs stood, as Carson had insisted, at an easy attention in the broiling afternoon sun. The area had the temperature and the general feeling of a large oven.

The leader of the group of rebels spoke first, without moving. "We got the bomb inside here," he said flatly. His Western accent, not quite a twang, was, Carson thought, rather attractive. "No false moves, now, because we know how to set it off—*and we will!* One touch, and we all go up—and a fair piece of Colorado with us."

"Which would hardly do you a great deal of good," Carson said mildly. The leader (twenty-two, local-college graduate, no military history, no police history, no declared formal religion) gave him a flat-eyed stare.

"You're scared," he said. "Look: the people know what we've got here. Thanks to the TV. And if this bomb goes off, the people will *rise.* You know that, mister. A real rising, too—more than your shaky establishment can stand. Which you also know."

"I see," Carson said. The cars and chauffeurs waited, baking, as everyone else did except the four children inside the cabin. "Martyrs, then. Martyrs for your cause."

"Right on," the leader said. "Martyrs. Because we are not afraid to go. You have to understand that, mister: *we are not afraid to go.* Not if the people rise behind us. We'll be remembered, mister; we'll go down in the books, and in the stories. Later. When the establishment is gone at last—"

"I'm sure," Carson murmured politely. "May we come inside? I'll permit our drivers inside their cars, then, quite out of anyone's way, I assure you. They would appreciate the air-conditioning, and I'm sure that your conference room is cooler inside than out."

"Comfort," the leader said, and grinned, with the enormously attractive force of a very few of the insane. "Big comfort. That's what you all live for, isn't it—you big people?"

Carson knew that each of the five had come from a home in the twenty-to-thirty-thousand-dollar income bracket, and consequently from a life-style more opulent than either chauffeur's, or Suessman's. Carson himself drew a somewhat higher salary, but tithing with his church, and a few other such matters, brought him nearer Suessman's level than that of the rebels. He said, of course, nothing whatever; and after ten seconds had passed, the leader said: "All right, sure. Go ahead. What do we care?"

Carson nodded to the chauffeurs. He and Suessman stepped past the leader and into the cabin. Already in the dimly-lit cabin were three chairs, two candles, four human beings, and a heavy-looking sphere which shone rather dully in the light. A good many gadgets seemed to be growing out of the thing, and Carson found himself wondering idly just how a thing like that worked. Terribly complex, of course . . . probably beyond anything he could understand . . .

The door shut, neither quietly nor with a slam. The musty, cool air inside seemed to thicken. The leader, standing against the door, said: "All right. Now you're here. Now we negotiate—in private for now. You asked for that, and it's all right with us: if we don't show up again, or if this little baby goes off—why, then, everybody will

know what it means. Isn't that right, mister?"

"Exactly," Carson said.

"Now," the leader said comfortably, "here we all are. Let it out. What is it you think you have?"

Twenty minutes later, Carson said: "I take it, then, that you are determined to be martyrs, if that will best aid your cause?"

"Take it," one of the girls said abruptly, "and you know what you can do with it. Sure: we're set for that. Nobody searched you coming in here, did they? What harm can you do? Either the bomb goes, or we do—or we get what we want. This talk isn't worth spit. You just remember there isn't much time left."

"Not much," one of the others said. "Better get out of ground zero, big people."

"Because—"

"When she blows—"

"It'll be too late, mister, too late, too late—"

"Too late," the leader said. "We told you what we want. Now: do we get it?"

Spoiled children, Carson thought (not for the first time during a negotiation): *spoiled brats.* Aloud, he said: "Nothing I say can change your minds about this?"

"Nothing," the girl said. The others murmured what seemed to be agreement. The leader said: "Nothing at all. Talk is cheap, mister—too cheap."

"I agree," Carson said. Before anyone could move, he had drawn his revolver and shot Suessman cleanly through the junction of neck and shoulder—one of the faster and bloodier of the absolute-fatal targets.

"And that, of course, ended it," he said ten hours later.

"Insane," the President said. "Entirely insane. We'll do what we can for them—"

Carson shook his head. "I shouldn't call them insane, sir," he said. "Just—unprepared. When they saw Suessman fall, quite bloodily, twitching his life away—"

"He will be all right, won't he?" the President said.

"Of course," Carson said. "Acting and makeup, mostly; though I understand he will need attention for shock, and for burns from the wadding of the blank with which I shot him. I'm afraid my aim is a bit rusty, sir—not enough practice time these days, really—and I came uncomfortably close. For which I am—truly—extremely sorry."

The President snorted. "Don't be silly," he said. "Good as new in a week . . . but . . . Carson, I don't understand. You shot your assistant. You pointed the gun—one gun—at the others. And they let you walk over to the bomb and pick it up?"

"Not exactly, sir," Carson said. "They let me walk over to it and guard it until the chauffeurs could

come in—signaled by intercom in my jacket, of course—and pick it up. It was much heavier than anything I ought to lift, sir: my doctor has been quite emphatic on the subject in recent years. Prudence therefore dictated—"

"Yes, yes," the President said impatiently. "But, damn it, Carson: *why?* There they were, five of them. Willing to be killed. Willing to set that thing off. They said so; they went on saying so."

"Quite," Carson said. "That was what I had counted on; that, and the fact that none of the five practiced any formal religion."

"That none of the—*what?*"

Carson sighed. "Religion, sir," he said, "perhaps especially Christianity, though it would be difficult to justify such a claim—religion teaches us to contemplate death. It does other things, too. But it does that, sir: it teaches us to become familiar with death, to accept it; to know it, sir, in short, in every detail."

The President shut his eyes, waited, opened them. "Well," he said. "Perhaps . . . perhaps it does. But I don't see—"

"Most people under, perhaps, twenty-two," Carson said, "have never seen truly violent death. I except some members of the military—perhaps the one in ninety who has any actual experience of front-line warfare, and also the medical corps, and so forth—and of course I except, as well, residents of those poor and hopeless neighborhoods we might as well call ghettos until some other word is available. And I except a few others. But the average suburban person of sixteen, eighteen, nineteen, even twenty simply has never seen violent death. He has seen carefully expurgated TV versions, perhaps, on news broadcasts or some especially enthusiastic shows; he has seen a Hollywood version in the movies. But the *fact* . . . no."

The President nodded. "Agreed. Well?"

"They cannot conceive of death," Carson said, "or at least of such an unpleasant, violent and painful death as a revolver provides. Or a plane crash . . . sir, if the plane carrying the bomb had killed a man in its crash, the situation would not have arisen; violent and distasteful death would have been seen and recognized by these children. But it was not; a life was saved therefore."

"At the cost of your ingenuity," the President said.

Carson shrugged. "At the cost of asking me to—or, rather, forcing me to request permission to—do my job," he said. "Nothing more. Certainly a lesser cost. But to continue . . . these children are encouraged by the society we live in to ignore death and to think of a sort of eternal life—even an eternal youth. The advertisements, for instance; even more, such catchwords as 'never trust anyone over thirty' . . .

well, all this is obvious." He paused and went on in the same calm voice he had begun with, many hours before. "They were faced with the actuality of that death. With no experience and no familiarity to draw on, they—froze, perhaps. Retreated. It was not something with which they were prepared to deal. Words—*martyr, execution, death*—come easily to the mind, sir. The facts for which they stand come to the mind with difficulty, if at all. The loose, the constant talk of martyrdom told me that these children had no faintest conception of the fact; the fact is not spoken of so carelessly, sir."

The President nodded again. "So you faced them with the fact," he said.

"Exactly," Carson said. "I had no wish to injure anyone, and with current techniques an actor could be used. But, if necessary, sir, I should have been quite willing to act as their—ah—example. Without makeup, or blank wadding."

"I believe you would," the President said. "I believe you would—be a martyr, in fact."

"Perhaps," Carson said. "At any rate, I keep in practice with my revolver when I can: riots occur, and if threatened I intend to protect my wife and my children, whether my own death is involved or not. At least, sir, I hope that would be my attitude."

"A rare one," the President said, and Carson shook his head.

"Not at all, sir," he said. "Suessman, for instance: he faced identical risks. All that is required is—not Christianity—but the ability to accept and to realize not only the concept but the fact of violent death. It is helpful, sir, to have that ability provided and confirmed by a formal religious structure. If, for instance, one of those five had been a formally—a truly—religious person, for instance . . ." His voice trailed away.

"Yes?" the President said.

"It occurs to me, sir," Carson said, "that a truly religious person might have done what I did not . . . and what I begin, sir, to regret having left undone."

"Regret?" the President said. "Come now, man: you've disarmed that pack of idiotic rebels, you've saved your country—possibly the world—"

"Yes, sir," Carson said. "All of that, sir, and all of it quite necessary." He paused for a long minute. "But . . . a truly religious person, sir," he went on, "might not have returned the bomb to Colorado Springs after all."

"But—"

Carson went on as if he had heard nothing—nothing except the voice he had always tried to hear, and thought he heard at that second, the voice that spoke, quite silently, within.

"A truly religious person," he said, "might, very simply, have destroyed the damned thing." ■

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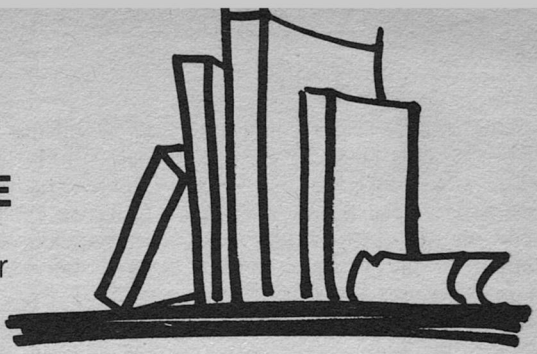
P. Schuyler Miller



THE JOHN W. CAMPBELL MEMORIAL AWARDS

Something new has been added to the spectrum of science-fiction awards. The Illinois Institute of Technology, thanks mainly to the efforts of Dr. Leon Stover, has instituted an annual John W. Campbell Memorial Award for the best science-fiction novel of the year.

The awards were made in April at IIT in Chicago, for the best science-fiction novels published in 1972. Books were nominated by their publishers and chosen by an international committee consisting of Brian W. Aldiss from England; Professor Thomas D. Clareson of the College of Wooster, Ohio, president of the Science Fiction Research Association; Harry Harrison, whom you all know as writer and editor; Professor Willis E. McNelly of California State University/Fullerton; and Dr. Stover, Associate Professor of Anthropology at IIT, who chairs the awards committee.

The committee's choice as best SF novel of 1972 was "Beyond Apollo" by Barry Malzberg (Random House; 138 pp.; $5.95). Second place went to James Gunn's "The Listeners" (Scribner's; 275 pp.; $6.95), and third to Christopher Priest's "Fugue for a Darkening Plain" (Faber & Faber, London), published in the United States by Harper as "Darkening Island" (147 pp.; $4.95). The judges also made a special award to Robert Silverberg's "Dying Inside" (Scribner's; 245 pp.; $6.95) for excellence in writing. I have reported on the Gunn and Priest novels here; I didn't read Malzberg's and Silverberg's until recently, and will remedy the omission now.

The Science Fiction Achievement Awards ("Hugos") made at the annual World Science Fiction Conventions in three or four (or more) categories, are now the oldest in the field: they have been made since 1953, with trophies based on a conventionalized rocket design by Cleveland fan Ben Jason. The Nebula Awards of the Science Fiction Writers of America have been made annually since 1965 in four categories; each trophy is unique, a mass of crystals and a nebula design encased in clear Lucite. The Campbell Award winner receives both a trophy designed by students in the IIT Institute of Design and (this year) a $600 cash prize; runners up get trophies and scrolls.

Another Campbell Award, for best new writer in the SF field, will

be made at this year's convention in Toronto. It is made by Analog's publishers, Condé Nast, to a writer whose first science fiction story appeared in the last three years. Members of the Toronto Convention, or last year's Los Angeles convention, will vote as they do on the Hugo awards.

There are also, now, a number of European and other foreign awards which I have passed over here because the winners have not been available to readers in the United States. (I pass up original English science fiction for the same reason.) If any of the winners do appear here, I will try to remedy the omission. *Luna,* the fanzine published by Frank and Ann Dietz, is the best reference I know on foreign science fiction and fantasy. They, and the news section of the *SFWA Bulletin,* indicate that we will begin to see the best of European SF quite soon—before you see this, in fact.

The Campbell Award winner, Barry Malzberg's "Beyond Apollo," is a strange book; in fact, several books in one. It is not at all the kind of book John would have published here, and it is very much the kind of book you would expect to appeal to an awards committee whose basic background and interest is modern literature. It appears to be a collection of confusing and conflicting statements by Colonel Harry Evans, survivor of a flight to Venus whose captain has disappeared somewhere *en route.* NASA officials and psychiatrists are trying to find out what happened, because the fate of their program hangs on the answer (a Mars flight has simply disappeared). Evans rambles on (presumably his babbling is recorded), he scribbles memoranda, he has real and imaginary conversations with his estranged wife, his dead uncle, the lost captain, hostile Venusians, and his inquisitors. Before you reach the end, you will find yourself wondering, among other things, whether: (a) the whole book is the "novel" Evans plans to write; (b) he is deliberately hiding the truth from his superiors to protect himself; (c) his unconscious is protecting him by suppressing what happened; (d) there never was a second man on the Venus ship; and (e) there never was a Venus ship—simply a hoax to fool the taxpayers and rationalize NASA spending without risking another failure. There is also, of course, the possibility that Venus is inhabited by telepathic reptilians who protected themselves by driving the captain and Evans insane and the captain to suicide.

A strange book, that grows more fascinating the further you go. You may never find an answer to the questions I have raised, or others you will raise yourself as you read.

"Dying Inside" is equally "new" science fiction, but wholly different. If I had read it earlier (as I should any book by Silverberg, as should you), I would have been uncertain whether to root for it or Gunn's "Listeners" as best of 1972. It placed third in the SWFA Nebula voting, and may still have a chance of winning a Hugo (which is nearly

three months off as I write).

The title of the book is literal. It is the highly personal first-person (mainly) story of a middle-aged Jewish intellectual, living by writing papers for Columbia University students, who through most of his life has been tormented by his intense ability to read others' thoughts. Now, at forty, his talent is first fading, then dying—he is dying inside—and the strange, lonely life he has structured around his telepathic power has fallen apart. It has become a crutch rather than a strength, a plague rather than a boon, a force driving him away from the very people to whom he should be drawn closest.

If Bob Silverberg were not stigmatized as a science-fiction author, this is precisely the kind of book that should have earned him acclaim in intellectual circles, especially the Manhattan/intellectual/literary/Jewish "mafia" that has appointed itself the Supreme Court of American literature. It is intensely human; it is intensely true in its depiction of recognizable perpetual-student types; and telepathy is close enough to the current infatuation with the occult to be fashionable. (Bob Silverberg treats it as anything but occult, of course. I think it is the best book about telepathy that I have read.) Readers are likely to remember "Dying Inside" a generation and more from now, when only archivists or the Institute of Popular Culture, or the Science Fiction Research Association, are still exploring his other—anyway, his earlier—books for Ph.D. material.

THE NEBULA AWARDS: 1972

Isaac Asimov, against some very tough competition, won the 1972 Nebula Award of the Science Fiction Writers of America for "The Gods Themselves," and as this is written he is right in there with the finalists for the Hugo, to be awarded Labor Day weekend at the World Science Fiction Convention in Toronto.

Third place in the writers' balloting went to Robert Silverberg's "Dying Inside," which received a special Campbell Award at Illinois Institute of Technology a week after the Nebula banquets. (I have already commented on it, and will comment on the second-place book, David Gerrold's "When Harlie Was One," in a review which follows.)

Arthur C. Clarke's "A Meeting with Medusa," the story of strange life forms in Jupiter's atmosphere that was first published in *Playboy* (you really should check out the pages of type some time), was voted best novella, and Poul Anderson's "Goat Song" best novelette.

Best short story was Joanna Russ' "When It Changed" from Harlan Ellison's second mammoth anthology of new SF, "Again, Dangerous Visions." Other runners-up from the Ellison Anthology were Ursula K. LeGuin's "The Word for World is Forest" (No. 3 novella) and Gene Wolfe's "Against the Lafayette Escadrille." Wolfe withdrew the three-part novel version of his "The Fifth Head of Cerberus" from competition, and placed second with the title section in the novella category. William Rotsler,

fan cartoonist extraordinaire, was a runner-up for best novelette with "Patron of the Arts" from the "Universe 2" anthology, and James Tiptree, Jr., placed second among the short stories with "And I Awoke and Found Me Here on the Cold Hill's Side" from *Fantasy and Science Fiction.* Analog didn't get in the running, but I suspect it will have better luck when the fans vote on the Hugo awards. They read more magazines than the writers do, and fewer books that aren't out in paperback by voting time. They also, it seems to me, are more concerned with content than style. On the other hand, today's writers are combining style and content in a way that the original English "New Wave" exponents didn't.

WHEN HARLIE WAS ONE
by David Gerrold • Ballantine Books, N.Y. • No. 02885 • 279 pp. • $1.25—Nelson Doubleday, Inc. (Science Fiction Book Club) • 247 pp. • $1.49

If you thought HAL was the most human character in the Clarke-Kubrick "2001: A Space Odyssey" . . . if you thought that Colossus, in the film based on D. F. Jones' excellent book, was even more impressive . . . wait till you meet HARLIE!

HARLIE is the acronym for Human Analogue Robot, Life Input Equivalents. He—you'll find it impossible to think of him as "it"—is a super-computer designed, built, and programmed to be the electronic counterpart of a human mind. His creators have been all too successful, for Harlie also has a human personality—the personality, psychology, and reactions of a precocious child forced into adult situations which he is intellectually capable of handling even better than his programmers, but emotionally totally unprepared for.

Harlie can't get high on marijuana like his human associates, but he can induce psychedelic hallucinations in himself. He is as curious about sex as any budding adolescent. Like an adolescent, he is forever testing his powers, finding out how far he can go and what he can get away with—and he gets away with a lot, which leads to a directorial revolt in the corporation that built and has financed him.

Then Harlie discovers the quotation: "If God did not exist, it would be necessary to invent him." He sets out to do just that—to invent a Graphic Omniscient Device, and get it built.

Much of the book is told in conversations between Harlie and his programmer, the robot psychologist David Auberson, a somewhat mixed-up individual who is not exactly the best person to bring up an infant computer of Harlie's capabilities. As Dave gets slowly straightened out, Harlie gets more confused about the beings on whom he is supposed to pattern himself. You may find this interchange a drag at first, but it will grow on you. (I have a feeling this is also a book that will give you something new each time you read it.)

Now I have to go back and read

the Gerrold books I've passed up. My apologies, one and all.

THE ETERNAL FRONTIERS
by James H. Schmitz • G.P. Putnam's Sons, New York • 1973 • 190 pp. • $5.95

THE LION GAME
by James H. Schmitz • DAW Books • No. 38 • 157 pp. • 95¢

"The Lion Game" is the Telzey Amberdon serial that you read here in Analog in 1971. If you didn't, do it now. "The Eternal Frontiers" has no prior credits, so it's presumably an original. It is also a better book.

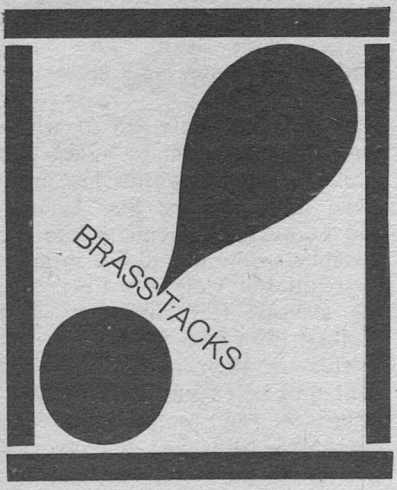
When we were first introduced to Telzey, here in Analog back in 1962, she was fresh, young, and believable. She's still only going-on-sixteen at the end of "The Lion Game," time being only one of the peculiar things about the Hub worlds where her biographer spends most of his time. But by this time her psionic powers have developed to the point where she uses (and discovers) them as casually as Kinnison and his buddies did super-physics weapons in the late great Lensman stories. She also pops in and out of inter- and intradimensional "gates" in the intricate innards of Tinokti in a way that bewilders poor old readers like me. We try to keep up, but I find myself panting as villains, sub-villains, schemes, sub-schemes, races and sub-races entangle themselves like a set-line with six eels on it.

"The Eternal Frontiers" isn't necessarily a Hub story (the Hub is the swarm of colonized worlds at the center of our Galaxy), but nothing says it isn't. I said it was a better story than "The Lion Game," but I may only mean it is simpler.

In that far future era of which James Schmitz normally writes, one cluster of human worlds has organized itself into the Star Union—and begun to differentiate into the Swimmers, who like to live in gravity-regulated weightlessness, and the atavistic (the Swimmers say) Walkers, who like to take on new worlds on their own terms and their own two feet. There are also institutions and corporations like Galestral that cut across and through all the social and racial intricacies of the human worlds.

When a team exploring a new planet is attacked by unidentified ships that may be aliens or may be scheming Swimmers . . . when the Galestral Company starts losing its field agents, and others find themselves in bad trouble that they don't entirely like to explain to the Star Union explorers . . . when a biped race, a lethal one, turns up where it isn't supposed to exist . . . when these and other problems have to be solved by our hero and his highly attractive fellow-agent . . . then, brethren, you have a story. Nothing great. Nothing significant. But good.

Belatedly, it occurs to me that if the book is part of the vast Schmitzian web of worlds, races, and adventures, it may tell the story of how mankind was introduced to the inter/intradimensional gates that have become commonplace in Telzey Amberdon's time, doubtless some centuries later.



Dear Mr. Bova:

In Part One of "The Third Industrial Revolution" (January 1973 issue), G. Harry Stine's reference to Clarke's Law is incorrect. "Any sufficiently advanced technology is indistinguishable from magic" is Clarke's *Third* Law.

Reference: "The Lost Worlds of 2001" by A. C. Clarke, New American Library, 1972, page 189.

CAPTAIN JOHN MARTELLARO
Box 1394
Eglin Air Force Base, Florida 32542

Right on! Clarke's Three Laws are:

1. When a distinguished but elderly scientist says something is possible, he's almost always right; when he says something is impossible, he's almost always wrong. (Editor's note: "Elderly," in this context, means over thirty, sometimes over twenty.)

2. The only way to find the limits of the possible is to go beyond them to the impossible.

3. Any sufficiently advanced technology is indistinguishable from magic.

Dear Mr. Bova:

I've just finished reading J. B. Beal's "Paraphysics and Parapsychology," in the April issue, and feel that his occasional sloppiness deserves some kind of remark. I am *not* arguing with the data he reports, his generalizations, or his conclusions and inferences. I *do* think he tends to get a little reckless on his details.

1. Semiconduction is an atomic property. Why does he seem to think shape has anything to do with it? I'll grant that the cell membrane serves as a capacitor separating the charges carried by the ions in the intra- and extracellular fluids, but when he says that the membrane's permeability to these ions is increased by low frequencies, I have to ask, "Low frequencies of what? And which ions?" Only the small ones, of course, which can fit through the holes in the membrane. Permeability depends on the electrical push behind the ion, so if he's talking about frequencies of electric current (or ionic), he's right, but since under "natural" conditions (as in nerves) the causal chain is the other way around, it's irrelevant. The ionic and electrical currents that can be observed during nerve action are the result of chemically initiated changes in permeability (see K. S. Cole, "Membranes, Ions and Impulses," University of California Press, 1968).

2. The graphs describing his results with that "Down Through-

Clairvoyance" test are meaningless to me until someone tells me what the labels are supposed to be on the ordinate and abscissa. I might grant that the curves are a little flatter with the equipment off, but without labels that's all I can say.

3. A permanent bar magnet at sixty cycles (Hertz?)? I thought the fields of permanent magnets were static.

4. "Random coincidence" is no explanation for something (telepathy) whose "existence . . . is beyond doubt." He shouldn't quote slavishly. Some things should be edited.

5. "'Extrapolated' predictions," or even hunches, have nothing to do with ESP. Extrapolation is a logical, rational process—ask a science-fiction writer—and hunches are the product, apparently, from all that I have read, of unconscious, and logical, connections between disparate bits of data.

I find some of Beal's ideas very interesting. The notion of electrical pollution is especially intriguing. If nothing else, there is plenty of room for extrapolation there. And as for the effects of our electrical environment on our nervous systems, a few years ago, when I was still in college, I tried to follow up the hint of a UCLA electroencephalographer that oscillating electrical fields could affect human reaction times. I tested frequencies of three, seven, and eleven Hertz and found that the hint appeared true: when the field was on, reaction times were reduced by five percent over the times with the field off. I had methodological problems and haven't been able to attack the problem again since, but if anyone is interested in trying to take a whack at it, I'll be happy to send them a copy of the original write-up, with the referees' comments . . .

THOMAS A. EASTON

The electrical environment's effect on humankind since wide-scale electrification of society could cast an interesting light on modern history!

Dear Ben:

I have been an avid science-fiction reader and quondam writer in the genre going back to 1930, but one aspect has bothered me for many years. Beal's article, "Paraphysics and Parapsychology," April issue, provides the incentive to get it off my chest.

My beef is on the heavy reliance on telepathy in more stories than I care to count. I'm willing to let the biologists, physicists and communications people struggle toward some breakthrough that will allow demonstration of telekinesis, even the possibility of transmission of the purely physical activities of the body through space to some sort of receptors in another body; these signals might even be verbally translatable as "emotions" by the receiver.

But on logical grounds there is no possible way, regardless of scientific (or parascientific, whatever the term may mean) breakthroughs, that language may be transmitted without manufactured instruments from one person to another except through use of the senses we now know. Before you leap to the assumption that I am a follower of

Herbert Spencer's principle of "Condemnation before Investigation," hear me through.

1. If mind is noncorporeal and if the average scientist's psychophysical dualism reflects the true state of affairs, then there can be no physical manifestation of the mind. For nonphysical communication between minds to occur the only medium possible would be a world mind, or God, however you may define Him. If this is the source of telepathy there is no occasion for any field of science to become involved, and stories of such communication belong in mystic novels, not science fiction.

2. If psychophysical interaction describes mind and its effect on the body, then telepathy is at least as possible as the magnetic waves emanating from bodies. Only if this is the case could Nelya Mikhailova concentrate on a match and move it from its fellows (assuming the match in question had magnetizable components). But anyone at all versed in elementary science is very well aware that psychophysical interaction vitiates the law of conservation of energy and of entropy. I assume that this statement needs no elaboration to the readers of Analog.

3. If either of the two extremes of monism—all is matter or all is spirit—is true, the latter eliminates *all* scientific study and the former eliminates mind. And, without mind as a necessary adjunct, telepathy is reduced to the possible electromagnetic field varying with physical functioning. And words—"thoughts," et cetera—are not transmissible if there isn't any mind.

4. No philosopher or scientist has been able to posit any alternative concept of mind to these listed except B. F. Skinner. And Skinner offers no consolation to those seeking to understand parapsychology, for he writes that there is neither any form of dualism nor of monism. What we call mind, he says, is only verbal behavior, internalized in "thought," externalized in oral expression.

By the way, *science*-fiction buffs should really dig Skinner, for he is the only person I know of who offers a truly scientific model of living things—from the paramecium to Einstein and Michelangelo. I know that followers of John Campbell rage at Skinner on the assumption that a Skinnerian world would be "Brave New World" and "1984" combined, but in fact he argues that we are going to get this combined hell for our children if we don't learn very quickly how we are now controlled by a combination of malign and haphazard forces. Skinner says only if we recognize very quickly what these forces are, how they control us, and how we can turn the tables and learn to control our own lives, can we become real human beings. I assume that most people who have heard of "Beyond Freedom and Dignity" know that Skinner is talking of going above these terms to greater humanity, not to destroy either freedom or dignity.

But be that as it may, I hope that future authors appearing in Analog (my favorite) will hesitate to give their characters telepathic

ability unless they can come up with some logical, even if not currently scientific, basis for it. I can see logical, if not scientific, bases for space warp and many other of the old standbys of SF. Just remember, please, that no scientific breakthrough since Newton was necessary for the Moon landings. Only gadgets and accumulations of engineering know-how were necessary.

PARKER D. HANNA, JR.
102 Roney Lane
Syracuse, New York 13210

We think largely in verbal terms. If the mind can project force or energy, why not coded transmissions—i.e., words?

Dear Mr. Bova:

. . . Having been on welfare for the past three years, your April editorial was naturally of interest to me. Your facts agree with all that I have read and with all that I have witnessed personally.

I am black and I am also the mother of two preschool children, and it is very uplifting to hear someone speak out on our behalf.

The Work Ethic will be in danger in the future as you say, but there may be more far-reaching effects also, that is, as far as sociology, economics, politics, et cetera are concerned.

I am a night student, learning to be an auto mechanic. Good work, yes, but we hit a snag here. I, like many others of my "class," do not wish to be on welfare. But the school I am attending (which is free) is being "phased out" by the government. I understand that "to work is good," and I think I understand the Work Ethic, but should there not be more money for education? Education to put more people on the job and off the welfare rolls?

. . . Most people have learned that nothing is free. Welfare is not free either. A few of us feel the same emotions as others of our race (human). We are sensitive people and on the whole, I would say, honest. We do not like the stigma attached to welfare checks, lines, and offices. We do not like to take our children everywhere we go. We do not like to leave them with incompetent strangers.

Day care centers run by trained welfare people would be *part* of the answer. Instructors to train them would mean more jobs. Contractors to build centers would also produce more jobs. Centers would have to be run by people, not machines. Thus more jobs. Not only centers for children, but for the elderly also.

O.K., granted you need money. But this is all a political issue and politics, too, must change.

Perspectives must change. As the Work Ethic is so inbred, the light at the end of the tunnel (excuse the cliché) is not in sight. At least not to my eyes. I cannot see it. Maybe you can. Your editorial is inspiring, and does show hope. I hope that others feel the way you do and will in turn try to figure this one out.

Many SF stories I've read show a totally socialistic government in the future. But even in these stories people cannot live without something to conquer or something to

produce. What does the welfare system produce?

Would there be a new Age of the Arts? Will my generation (I'm twenty-four) live long enough to see it? Will my children?

LINDA JOHNSON

674 Elm Street
New Haven, Connecticut 06511

The money we now spend on welfare is not achieving the goal of helping people to rise out of welfare status. The answer is not to cut the funding, but to invest the money more wisely.

Dear Mr. Bova:

With regard to your editorial in the April 1973 Analog, I feel impelled to congratulate you. I agree wholeheartedly that the IRS would be a superb agency for administering a system of dole.

There, however, agreement ends and delight in your starry-eyed idealism takes over. Your first and perhaps biggest flight from reality comes with your attitude that we need more consumers who don't work. Until we achieve the space travel we so desperately need, Earth is a "closed environment"—one which man has already managed to mess up badly. Nature decreed that those who didn't change should perish, but we have managed to change that. We are overpopulated and our "natural resources" are becoming increasingly scarce, and yet you appear to wish for everyone to have an equal chance to *waste.*

Next, as a complaining taxpayer who has known a number of welfare recipients (one of whom told me I was "stupid for working"), I was struck by a contradiction on the last page. You say, "When the nation's unwed mothers no longer have to storm welfare offices to demand *extra* checks for winter clothes"—then further on, "If the money gets spent on booze, it will be spent on booze and there will be no more." Certainly you can't believe that—that the poor family of a drunk would be allowed to go without winter clothes simply because the money was already wasted. That is unhumanitarian and manifestly unrealistic.

I sincerely do hope that our present welfare system is indeed headed for disaster—a situation where the higher intelligences limit their families while the so-called lower class is paid a bounty to reproduce is disaster for the race. But then you probably don't believe in breeding principles, although natural selection is a law of nature.

I also join you in your panic as indicated by the statement, "Multiply it to encompass the majority of the human race: unemployed, *unemployable*—" With the key word in my panic being "unemployable" because of the inability to adapt to reality.

W. R. FLORES

5216 Wilson Drive
Riverside, California

If any welfare system is to work, it must impart a sense of responsibility and self-esteem in the welfare recipient. If that person cannot adequately care for his or her children, then the children should be removed from that person's care. It's better for the child, and usually better for the in-

adequate parent. It's a tough rule, but the alternative seems to be an endless round of welfare generations.

Most of the unemployables in our society are unemployable because they have been shunted away from decent education, decent upbringing, and even decent nutrition by social strictures. I don't know of any parent who wants his or her children hungry, cold, or stupid. It's those who have enough money to pay taxes who complain about the welfare taxes—and who, by their shortsightedness, guarantee that a welfare class will continue to exist in this nation, no matter what system we do or do not employ.

Dear Mr. Bova:

Being both a member of the white, middle class that's opposed to welfare and a former recipient, I'd like to comment on your welfare editorial. When my mother went on welfare we were in the situation most recipients are in: no husband, young kids to be taken care of (I was nine, my brothers were seven and five). My mother's solution was to place us in a nursery while she worked. We went there for lunch and after school, and were picked up at night; when we were a little older we didn't go at all. The statistics that list women with young children lump together those with eighteen-month-olds and eighteen-year-olds. By the time they're in school, part-time work is feasible; by the time the youngest is ten, they can stand to be alone from three to five o'clock. The real problem is that the bureaucrats who run the system could care less about getting people off the rolls . . .

My own experience suggests that the reason for illegitimacy being so high is simple: to most hard-core unemployed, the future is unreal. Nine months is like nine centuries, too far away to affect you personally. I think that's the reason so many drink up food or rent money. Today is real, next week isn't. We used to provide some horrible sanctions if you didn't think ahead, like starvation. When we decided not to let that happen any more, we failed to provide new sanctions, and didn't know that forethought has to be learned. Too many of the poor have yet to learn it, a disability they seem to share with most politicians and world-savers.

I agree with you that the negative income tax would be a vast improvement over the present mess, but I kind of think the mess will persist for a long time. There are those who believe in the present system, those who supported it in the past and won't admit they were wrong no matter what. The bureaucrats will fight to retain their jobs (that's where most of the money goes anyway) and plenty of demagogues will be convincing the poor that it's all a plot against them. Remember Tricky Dick's Family Assistance Plan? It was the negative income tax, combined with a provision that those who could work would. After Congress had its mitts on the plan a while, it became an addition to the mess, instead of a replacement; the work requirement got lost in the shuffle. Nixon said recently there were no prospects for passage of

reform in this session, and I'm afraid he's right . . .

STEPHEN ST. ONGE
922 West Edinger
Santa Ana, California 92707

There are not enough jobs available today for unskilled youngsters. And T.D.'s budget cuts are closing day care centers across the land.

Dear Sir:

Your April 1973 editorial advocates the negative income tax—a program I, too, support. However, your material is inaccurate on at least three points.

1. The negative income tax (NIT) goes into effect *after* the citizen files his/her annual tax return. A transitional arrangement is needed during the interim year or more until the paying government agency starts to issue checks.

2. You state, "If the money is spent on booze, it will be spent and there will be no more." Well, no matter which Ethic we use, neither you nor I would allow a child to starve or come to similar harm because the parent spent all the money on booze . . . Child abuse—and I define such broadly to include omission of care and neglects of all sorts—cannot be allowed. Therefore, some controls will be required . . .

3. Much of your editorial tells of fewer jobs in our future. Then you offset that with "incentives" by which the parent shall seek employment. Your statements are incompatible.

I suggest the following employment for those receiving welfare, NIT, or any other public support monies. In exchange for such funds, the adult(s) would be required to spend at least twenty hours weekly in a creative endeavor, at home, or in a center, or elsewhere. These efforts might be in fields such as art, music, writing, ceramics, inventing, et cetera.

We have seen, in recent years, a tremendous shift in our popular music preferences. No one can deny the impact such has had on all of us. Much of this change came from poor people—who developed their musical talents to obtain income. Although we didn't specify that our public money be spent in this way, such did happen, with the result that many found employment. Let's deliberately expand this concept to all creative efforts; perhaps we can develop a new source of SF writers?

Finally, I must add that this idea is somewhat related to the WPA of the 1930's. But, the proposal merits consideration . . . Who knows what genius we may uncover?

RAYMOND ROWE
1135 SE Salmon Street
Portland, Oregon 97219

To answer the three points:

1. Certainly there shouldn't be a waiting period as long as a year before the negative income tax payments get to the recipients.

2. If we're going to have a welfare system that works, then we've got to remove children from environments that have proven to produce a new generation of welfare recipients. This means either educate/train the parent(s) to be more responsible, or take the children away. There's a complicated legal and moral situ-

ation here, but it seems clear that current practices have not solved the problem. Drastic action may be necessary.

3. The editorial was pointing out the "cultural gap" between our view of jobs as a necessary and good goal in themselves, and the future time when most jobs will be unnecessary. Under present circumstances, people need jobs for economic, social, and psychological well-being. But we are already into an era where certain kinds of jobs are no longer available. The blacksmith disappeared long ago; so has the ditchdigger and the dishwasher. So will the assembly line worker and anyone whose task is mechanically repetitive.

Finally, most science-fiction writers seem to be people who are very busy doing many other things, and write SF for fun. I don't know of any successful artist of any kind who got interested in his work because he didn't have anything else to do. I'd be interested to hear of such cases, if they exist.

Dear Ben:

I want to reply to your editorial in the April 1973 issue . . .

You say, "The situation could get worse as automation continues to take over more and more of our manufacturing industries." Why, Ben, I didn't know you were so old! Or that you'd been away for so long! That's a Nineteenth Century attitude. Of course, it might just be that you're one of those "Don't confuse me with the facts" types. Well, there's been so much written refuting your attitude, and so much evidence against it in the last dozen or so years, that I'll resist the temptation to add my bit to that rhetoric. But it is surprising to hear that from a leading science-fiction writer.

Another point that I want to address myself to is your apparent attitude toward slavery. Oh, I know that you'll protest that you're against slavery. The fact remains that your editorial is strongly in favor of it! Slavery is that condition in which a person is forced (against his will, and without contract) to provide for another person. And that, Ben, is welfare. What you are advocating is an expansion of this form of slavery. And, please, don't come on to me with that crap about social responsibility; or about blacks or the elderly. "Welfare" is more than blacks, elderly or Aid to Dependent Children and their mothers. It's the civil servant who gets paid for doing nothing, or for duplicating someone else's work; paying a farmer not to grow crops; the politician on the "take"; the contractor who jacks up his price on government work; or any of the giveaway, make-work, and waste projects going on around us.

And then I saw (twice) in your editorial that we don't need more workers, we need more consumers! Are you in never-never land! Unless, of course, science-fiction writers don't have to read the help-wanted ads in the papers . . . Rather than read the unemployment statistics, why not check the statistics on column inches in those employment ads? Perhaps they tell a part of the story that you don't want to see, at least not in cold

hard facts. Perhaps they tell that some people *don't* want to work. Perhaps they also tell something about our society's attitude toward the things it considers "demeaning" (*The Wall Street Journal* reports, Monday, March 12, 1973, that there is a shortage of skilled labor, particularly machinists).

Your editorial certainly deserves much more comment than this. About the only positive thing that I can add is this: In the tradition of Astounding/Analog, you have presented a stimulating editorial.

CHARLES J. GRUNER, JR.
758 Junior Terrace
Elmhurst, Illinois 60126

An automated automobile factory does not employ many assembly-line workers. And despite brave words about retraining, there are many people who are now "technologically displaced" from their jobs, and there will be more in the future. The trend today is also to strip away the funding for retraining programs, so the displaced worker is stuck.

As for slavery, this is always the cry of the rich against the poor. NO society—from primitive hunters onward—can exist without the strong sharing with the weak.

And if you show a welfare mother, or a child, or a retired person those ads for skilled machinists, what have you accomplished? Sure, there are needs for skilled labor. But our unemployed are unskilled, untrained, and often uneducated. They don't match the job openings; that's why they're unemployed.

Dear Mr. Bova:

One of the basic axioms of economics is that human wants are unlimited. Of course, this does not apply to particular individuals—hermits, for example—but to humans in the aggregate.

Based on this observation, Jean Baptiste Say formulated his famous "Law of Markets" which, among other things, states that there can never be such a thing as overproduction.

Your editorial in the April issue would seem to negate these fundamental ideas in your statement that we need more consumers and fewer workers, and that "our work force has been too large since at least the end of the Korean War . . ." I suggest you may want to do a bit of rethinking. The reason for unemployment is not that we've sated the demand for goods—but rather we have insufficient incomes to buy all of the things we'd like to have. Production costs are too high.

In elementary economics, we teach that the reason that goods command a price is that (a) they have utility—they are wanted; and (b) they are *scarce*. I have yet to observe that "never-never land" in which production costs have so dwindled as to cause prices to fall toward zero. In fact, quite the opposite may be true and I anticipate that, in the not too distant future, rapidly rising production costs for basic minerals and commodities may put a serious dent in the "life style" of the average American. Scarcity, not abundance, seems to be the reality.

However, I look forward to the time when simple matter converters, operating on abundantly

"free power," make it possible for the average person to create goods in such abundance as to fulfill his slightest wish. It could happen. But I won't hold my breath!

HUGH P. KING
241 Machell Avenue
Dallas, Pennsylvania 18612

One of the reasons for high costs of many consumer goods is the expense of advertising those goods. The advertising is necessary because the demand for these goods is artificially stimulated. How many different kinds of lemon-scented furniture polishes do we "need"? How many brands of cigarettes or beer or bubble gum? Much of the stuff available in stores today is neither strictly utilitarian nor scarce: but it is heavily advertised, and the behaviorists who are manipulating the American consumer have thrown classic economic theory into a Skinnerian box.

Dear Mr. Bova:

The approach to welfare described in your April editorial is a good *political* solution. (Dr. Freidman has impressed upon me the importance of politically possible solutions as the only way to move toward theoretically sound solutions.) However, I am a radical and claim your basic assumptions are wrong.

Morally, state-supported welfare is wrong. There is no difference between the man who, threatening violence, steals my money in a dark alley to buy something he wants (currently it is said to be drugs) and the man who has an agency of government (IRS), threatening violence, steal my money to buy something he wants (cynically, votes, but maybe, a better life for the poor). This is not to say I should be prevented from helping others, if I desire to do so. On the other hand, I should not be forced to help, if I desire not to do so. I suspect the middle class, if it has analyzed its motives, resents welfare for these reasons.

Economically, there is no way of concluding, on the one hand, that there are *too many* workers or, on the other, that we need people who do nothing but consume. The correct version of the first statement is: There are too many workers at *prevailing* wage rates. At lower rates the marginal workers, those who are worth, say $1.50 an hour but not $2.00 an hour, would find employment. However, the unions, who want to protect *their members,* not some abstraction, labor, and the dominant intellectual theoreticians, who, earning very large wages, consider it a crime for anyone else to work at less than what they think the individual should work for, *even if an individual would love to work for lower wages,* have built in institutional restrictions that *guarantee* a large supply of unemployables. As to the second statement, do not forget that the money going to welfare recipients, so they can consume, must come from the producers, *who are equally qualified to consume.* Therefore, we do not need an unemployed class for the purpose of taking goods off the market. That job is easily handled by the producers who, after all, work only because they want to

buy things. And that brings us to the Protestant Ethic.

The Protestant Ethic is nonsense. Very few people work because they feel religiously bound to do so. People work because they want things that are more important to them than the work required to obtain them. This more important factor could be religious or it could be because the individual likes his job, but usually it is material: a car, education for the children, a summer home, or basic sustenance. I know no one who, hating his job, would continue to do it were it not that he hates his job *less* than he hates going without something he would like to have. I will bet you do not know anyone like this either. There are people who would feel lost if they could not work. Nevertheless, the same basic factor applies: satisfaction of their wants (to be employed) are more important than the work required to satisfy them. Force them into jobs that they like even less than the ones they have and see what happens to your Protestant Ethic.

You have fallen prey to the same thing that gets most intellectuals. You propose economic solutions (doesn't almost everything eventually boil down to economics?) without knowing economics. Therefore, while your solution is a good one, it is good for the wrong reasons. Thus your solution may not work unless the underlying reasons for the problem are understood and corrected.

ROBERT B. PEIRCE
123 West Edgewood Drive
McMurray, Pennsylvania

I'd rather have a good solution for the "wrong" reasons, than be "right"—and let unemployable mothers, children and elderly depend on the tender mercies of the wealthy. We tried your system for centuries. It led to vast poverty, unemployment, human misery and various economic depressions. Government is more than economics, and even more than politics. It is people. And without heart, and hope, and social conscience, no government can long endure.

Dear Mr. Bova:

Congratulations! You are the first writer I have ever read who has the sane common sense to admit there *is* such a thing as technological unemployment. Mention such a subject to most people and they promptly scream that unemployment would be worse without our modern technology. I am referring, of course, to your editorial in the April issue.

Of course, these very wise people who swear there is no such thing as technological displacement conveniently forget the fact that before technology, there was no such thing as unemployment. It took the greater part of the population working sixteen hours per day or more to produce enough food to keep any nation eating. Very few were able to do something besides hand-tilling the soil; and most of that few toiled equally long hours as artisans of some kind. The leisure class, at that time, were the landed gentry who could live off the "rentes" they drew from the peasants who worked their land.

Machines are displacing human

hands in every field of endeavor. There are very few man-hours in a ton of grain as produced today. Well within my lifetime there were hundreds of man-hours in any given unit of almost any food crop you could mention—or forage crop, for that matter.

The latest example of that displacement is the Rust Cotton Picker—and similar machines offered by other manufacturers. These machines relieve the human pickers of the back-breaking toil of dragging a cotton sack throughout a day that might run sixteen hours or longer—and pay the poor devil perhaps $12.00. These people also hand-cultivated the growing crop—and starved during the off season while winter interrupted the crop cycle.

Now the seed is planted at about the correct spacing, so the hand "chopping" is no longer needed; machine cultivation and herbicides have displaced the hand cultivation that used to keep the pickers alive until the cotton was ripe.

The pickers were "relieved"—to starve. In fact, those of them who lived in shacks on the cotton land were kicked out and the shacks torn down to make room for more cotton. Nobody knew or cared what happened to them.

I think a careful check in the so-called ghettos of such cities as Chicago, Detroit, and New York—as well as most of our other large cities—would show that a pretty fair sprinkling of these people are those who were driven off the land by the mechanization of farming . . .

Your suggestion of a negative income tax—not original, of course—might have some merit. Whatever the handout was named, it boils down to the fact that the government would have to collect at least $1.50 in taxes for every dollar that was handed out in negative income tax—if that government was to remain solvent . . .

The great big question in my mind is whether those working and producing so as to pay a *positive* income tax would go on contentedly paying the level of taxation that would have to be paid if the nonproducers were to receive their *negative* income tax! Such a tax would mean that people making any substantial income before taxes would find themselves paying out most of what they earned as taxes. I submit that very few of these people would go on working beyond what was necessary to "break even" on taxes. Why work for nothing, they would reason—and rightly so!

It is a nasty question, I fear; and there is no easy solution in sight. Still, we must have an economic system geared to a high-energy technology and that *soon.* The one we have is geared to a technology that was obsolete by the beginning of the Nineteenth Century! We must change economically by evolution; or be changed by revolution!

DAVID A. KING
94 Beacon Avenue
Layton, Utah 84041

Agreed. The ideal is to produce a situation where the welfare recipients become taxpayers, not tax consumers.

EDITORIAL
continued from page 8

development of new energy technology is fractured into tiny, trivial pieces throughout several agencies of the government. The Department of the Interior has some programs going, the National Science Foundation sponsors a little research, the Department of Defense is in the act, and so are the Department of Commerce, NASA, the AEC and even the Environmental Protection Agency.

The result is that nothing much is being accomplished, outside of the drive toward a working Fast Breeder Reactor and the increasingly optimistic-looking fusion research.

This dithering in energy R&D is similar to the government's inept handling of many other nondefense research efforts, especially those in pollution control and transportation. And no doubt a good economist could point out the parallels between the decline of our research and development programs and the decline in our foreign trade, and other key economic indicators.

To make that suggestion concrete, take a look at a completely different topic: commercial fishing.

For generations the men of Gloucester, Massachusetts, and other New England ports have "gone down to the sea in ships" to fish Georges Bank off Cape Cod and the Grand Banks off Newfoundland.

Our Yankee fishermen still put out to sea in the kind of small boats that Kipling wrote about in "Captains Courageous." They are being driven off the best fishing areas by fleets of large, modern, well-equipped ships from Poland, East Germany, and Russia.

There's no open fighting. But the individual American boats can't compete with the huge and efficient fleets of East European catcher and factory ships. As one disgusted Gloucesterman put it, "Once they're out there, there's nothing left for us to take."

While American fishermen have continued to work the way their grandfathers did, with very little input from our improving science and technology, other nations have incorporated modern oceanographic knowledge and technological advances in ship and equipment design to virtually drive our fishing fleet from its "home" grounds.

Think about *that* the next time somebody complains about the rising price of fish. It's the price we're paying for *not* investing in R&D!

And to get back to the energy crisis, think about this letter, which was originally printed in *Science* magazine April 6, 1973, and is reprinted here through the kind permission of the author, R. H. Shannon:

". . . Returning home from an

energy conference, I found twenty-one lights on, and a washer-dryer consuming large amounts of power in its 'hot water' and 'drying' cycles as one pair of blue jeans and one brassiere were being washed. My search of the house disclosed one daughter at home watching television in a darkened room.

"If my wife and other daughters had been home there would have been more lights on. In addition, at least one record player, possibly another television set, one hair dryer, certainly one iron, and an overcharged 'muscle' car being revved up by a guy waiting for one of my daughters to complete a series of electricity-consuming procedures essential for an evening of entertainment (whatever happened to rouge and powder!).

"The evening's entertainment was provided by a guitar rock band that used electricity instead of fingers, and by painting signs protesting the thermal pollution from the proposed new power facility on the north edge of the lake. (The thermal pollution from such a facility would be about the equivalent of that which my daughters and their friends contribute to the lake getting ready for a night out with their bathing, hair-washing, and clothes-washing.)

IN TIMES TO COME

Physical limitations pose problems that sometimes can't be worked around. The basic physical limitations on our cover illustrations include the size of the cover, and the format necessity for placing type in certain areas. There is also the need to produce a striking, arresting picture that will catch the eye of the casual stroller as he passes a newsstand carrying Analog.

Rick Sternbach is a young artist whom we asked to paint a cover illustration for G. Harry Stine's article, "A Program for Star Flight," which will lead our October issue. Rick produced a gorgeous painting, based on the technical ideas of Stine and Dr. Robert D. Enzmann. But our cover paintings must be "verticals;" that is, the long axis of the painting must run vertically. Sternbach's painting, everyone agreed here in the office, looks better as a "horizontal."

It must be printed as a vertical. So when you get the October issue, turn it on its side to get the full sweep of Sternbach's painting of a pair of starships orbiting the planet of a double star.

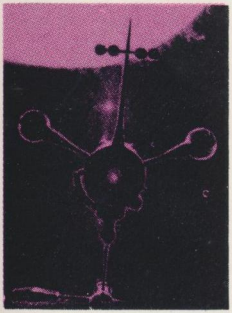
William E. Cochrane will be back next month with "Whalekiller Grey," a story of a society that combines the traditions of the bull ring with those of hunting whales. The conclusion of Gordon R. Dickson's "The Far Call" will show how the human spirit can rise above human frailties. And there will be several stories by newcomers, plus all the usual features.

"With more girls at home there should be an offset in power use. A few more things could be washed in one cycle. However, there is often a last-minute, second cycle of consumption by one of the others of some forgotten unmentionables. I can shower in three minutes with a few gallons of water. One of my daughters needs at least twenty minutes and at least seventy gallons of water for a bath or shower or whatever she does up there. I see little hope of retarding the growth of the residential power demand until scientists can apply highly-skilled analysis to the female and the particular, unanalyzable, unscientific, uncontrolled phenomena of their power consumption. (I never hear them running the power lawn mower.) . . ."

Mr. Shannon has done more than bring the generation gap and male chauvinism into the energy argument. He has pointed out—rightfully—that although everybody wants Something Done about the energy crisis, not many people are willing to Do Something themselves.

The scientists and engineers who advocate a Hydrogen Economy may have a good answer. It's at least worth a strong research effort, to find out if we can safely and economically use hydrogen as our major fuel.

I wear my *H_2indenburg Society* button rather proudly. THE EDITOR



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