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WEATHER WAR
William E. Cochrane
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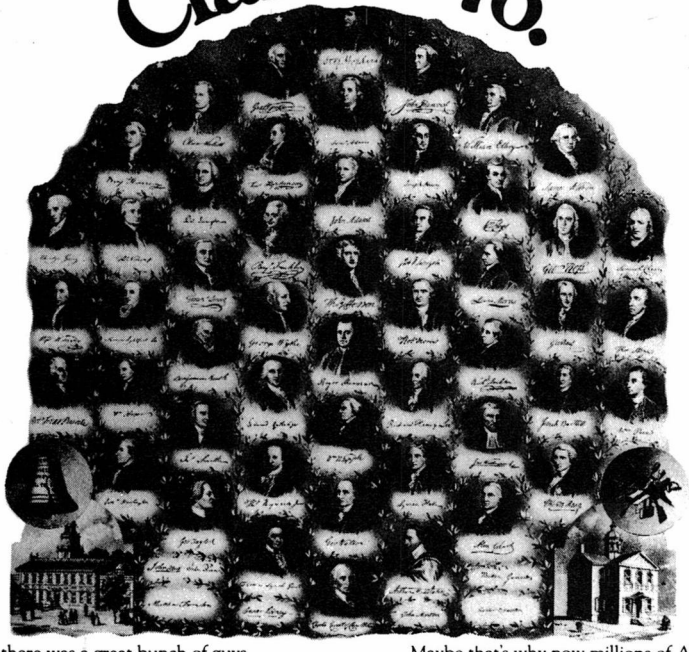

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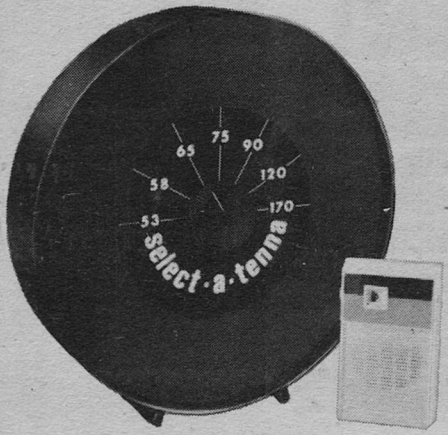

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editorial

not supersonic enough

The debates over supersonic transport aircraft have been a special agony to science fiction enthusiasts.

Most of us are fans of science and technology. Most of us are fascinated by big, shiny-new, graceful hunks of flying machines. Yet we have become painfully aware that technology can sometimes do more harm than good, especially when the technology is not accompanied by thorough consideration of the environment in which it is to work.

When the Congress shot down the American SST project, most science fictioneers felt both relief and pain. Relief that a project which could have had seriously damaging effects on the environment had been stopped. Pain that it had been stopped too soon, by emotional arguments that bordered on hysteria.

Now the argument flares anew, because the French-British Concorde has begun commercial service, and the American government has given its permission to allow the Concorde to land in the US.

There's an old-fashioned thrill in watching the Concorde in flight. It's a beautiful piece of machinery, sleek and lean and gleaming against the sky. But it's also a prime example of that old Second Law of Thermodynamics, which tells us that we must pay a price for any thrill we get.

Close your eyes as a Concorde flies by and you hear a very noisy airplane. It's much noisier than subsonic jets on landings and takeoffs. It generates a sonic boom when it's flying supersonically, of course, and as a result it has been prohibited from flying over inhabited territory at speeds of Mach 1 or greater. Thus, the Concorde is an SST only over the open ocean. Over land, it is a subsonic jet, and an aerodynamically inefficient one, at that.

Because its cruising altitude is much higher than that of subsonic jets, the Concorde dumps pollution emissions high in the stratosphere,

where they tend to remain aloft for very long times, unmixed by the turbulent airflow of the lower domains of the atmosphere.

Ecologically-strident critics have claimed that commercial fleets of Concordes could build up a permanent cloud cover over large parts of the Earth. This could eventually change our planet's albedo and global climate. They also fear that Concorde exhaust emissions could react photochemically in the upper atmosphere to thin the ozone layer that shields most of the sun's ultraviolet radiation from the Earth's surface. This could lead to thousands of deaths per year from UV-triggered skin cancers.

While scientists argue over these claims, and frustrated engineers fume, politicians make decisions. Our Department of Transportation has given temporary permission for the Concorde to land at two US airports: JFK in New York, and Dulles in the Washington area. Neither is within noise-pollution distance of Capitol Hill. And local officials have prevented Concorde operations at JFK after enormous pressure was exerted by angry New York area residents.

All the arguments about the Concorde seem to have overlooked one important fact: it's a lousy commercial airplane. It costs far more to operate than existing subsonic jets. It's too small for profitable operations. It gulps fuel at an atrocious rate when flying subsonically, and much of its actual flight time must be spent in this inefficient subsonic regime—at takeoff, approach and landing.

But the big part of the Concorde's woes is that the plane is just plain too *slow*.

It was designed about ten years ago, when the decision to build a Mach 2 SST seemed daring. But this was actually a conservative and shortsighted decision. A plane that shaves an hour or two off flights between the US and Europe simply isn't worth the extra fare, to most customers. But though the decision to build a Mach 2 SST was questionable, the British and French political machinery pushed doggedly ahead, making the Concorde a political symbol of joint Anglo-French cooperation, determination, and technological *élan* (that's *dash*, if you're British).

Despite growing doubts that the Concorde could be an economically viable aircraft, the project went ahead, year after dragging year, until now the British and French are all dressed up—SST-wise—but may have nowhere to go. Certainly if all American markets are closed to the Concorde, the plane will be a commercial flop. The suspicion is strong, however, that the Concorde would be an economic albatross even with an open American market.

In England and France, the major justification being given now for building more Concordes is not the

plane's performance or promise: it is the political necessity of keeping thousands of British and French workers employed on the project!

Does this mean that we don't need SST's, and subsonic jumbojets will fill all the needs of commercial aviation for the foreseeable future? No. There is a viable economic niche for an SST—but not for the Concorde.

Forget the Atlantic. Tourists and businessmen hop across it at less than sonic speeds in large numbers every day. But consider the Pacific Ocean, that vast and glittering sea studded with precious jewels of business and tourist opportunities. If you want to buy Japanese products, or sell American wares in Indonesia, or go to a science fiction convention in Melbourne, or ski all summer in New Zealand's Southern Alps, or bask on the black sand beaches of Tahiti, you must be prepared for flights of twelve, fourteen, twenty hours or more—subsonically.

But suppose you had a commercial transport plane capable of cruising at Mach 3 or better. The marketplaces of Japan and China would be as close to you as those of central Europe are today. The untrammeled ski slopes of New Zealand and the Andes could take on American visitors just as the Alps receive them now. Australia would be as close as Denmark is, presently.

If a Mach 3+ SST can be developed, the Pacific can become as small an ocean as the Atlantic is today. This will be particularly true if the ticket prices for the Mach 3+ SST are comparable to today's subsonic jet fares.

Such a plane can be developed, and it would be a useful piece of technology. Moreover, with the knowledge we have today, we could design a Mach 3+ SST that will be efficient, quiet, and ecologically unobjectionable, as well. This would be a "second generation" SST, based on the problem areas that the Concorde has exposed and the development of new technological solutions to those problems.

There is a precedent to all this. Back in the Fifties, the first commercial subsonic jet to go into operation was Great Britain's Comet. There were loud groans of despair from the American aircraft industry when the British got their jet into the air first. But the Comet was not an economically attractive plane. (Its earliest models also tended to burst apart in midair.) American aircraft manufacturers—most notably Boeing—entered the field late, but with planes that swept all the world's marketplaces.

The Mach 3+ SST would most likely use engines that burn liquid hydrogen, or a hydrogen-derived fuel other than the existing "dirty" petroleum-based fuels. William J.D. Escher, of Escher Technology Associates and the H_2indenburg Society

(see the September 1973 Analog), has made the following points in a report he authored on the "Prospects for Liquid Hydrogen Fueled Commercial Aircraft:"

1. Hydrogen contains about 2.8 times the energy per unit mass as conventional hydrocarbon fuels.

2. Tests of jet engines converted to hydrogen fuel were made in the mid-1950's and gave good results.

3. The space program has reduced the engineering problems of producing, transporting and handling liquid hydrogen to the level of routine technology.

4. The bulkiness of hydrogen (three to four times that of conventional fuels) and its requirement of cryogenic temperatures (21°K, -423°F) pose the main problems in its development as a fuel for commercial aircraft; however, both aircraft manufacturers and NASA have produced design studies that appear able to deal with those problems.

5. Hydrogen-fueled aircraft would have much lower gross takeoff weights than conventionally-fueled planes.

6. Hydrogen-fueled engines will be ecologically cleaner: there should be no CO, hydrocarbon or particulate emissions, and the NO-type emissions could be substantially reduced from those of hydrocarbon-burning engines.

7. Sonic booms and takeoff-and-landing noise may be reduced significantly because of the lower gross weight of a hydrogen-fueled plane. (Airport noise could also be reduced by improved engine design.)

8. No one has done in-depth comparisons of the economics of hydrogen vs. hydrocarbon fuels. But as hydrogen becomes cheaper and hydrocarbons become more expensive, the costs for the two types of fuels should be about equal in the 1990's.

All this may be over-optimistic pie in the sky. We might never get a clean, efficient, economically-attractive Mach 3+ SST, not even by the 1990's. Certainly we won't get one by then if the necessary studies and tests aren't started now. And equally certainly, the Concorde is doomed as a commercial transportation system.

Is it inevitable that somebody, somewhere, develops a commercially-valuable SST? The gut feeling of most science fictioneers is yes, even though the existing economic and environmental problems look almost insuperable. And remember, there was nothing inevitable about other fascinating pieces of transportation technology such as the zeppelin or the long-dreamed tunnel under the English Channel. But if large fleets of SST's ever do criss-cross the Pacific, the chances are they'll be hydrogen-fueled, carry three hundred or more passengers, and be built in the USA.

THE EDITOR

weather war

Technology and weaponry may change, but the basic element of battle is still human tenacity.

by William E. Cochrane

The tornado struck ground on Sand Island across the lagoon, a spray cloud of white sand hiding its foot. Gunner Moore watched it weave sinuously for seconds, then head out to sea. It crossed the waveline of Ietonga's reef with an explosion of spray, then the swirling air-column began to darken and thicken as the outer vortex sucked up the wave tops. The column leaned over into a seven degree angle and continued on out away from the reef. The twisting tube was shrouded with water vapor now, the sea level lifting in a surface wave at its foot, a dirty-gray path of foam spreading in its wake.

Gunner Moore let the tornado, now a full-fledged water-spout, ride down the Pacific Weather Range out to the five kilometer markers, then he spoke into his headset. "That's enough, Marine. Kill it. Cut the vortex!"

"Green Team, aye," the response came on his monitor speaker. "Vortex cut . . . Now!"

Out at sea the waterspout swelled in the middle, lost form and dissolved into a dark smear of falling rain. The wind cell held together for moments longer and tore at the cloud base, shredding it and breaking it apart.

"Peoples, what are you playing at!" Moore said, his voice grating with disgust. "The touchdown target is fifty meters off the reef. You hit Sand Island dead center, again. Do you hate Sand Island, Peoples? Is that what's wrong?"

"No, Sarge."

"Do you love Sand Island, Peoples?"

"No, Sarge."

"You don't? You do too. You love it so much you can't keep away from Sand Island. Can you?"

"No, Sarge."

" 'No, Sarge.' You mean you intend to do it again? You aren't. Are you? You're going to hit that target next time, aren't you?"

"Yes, Sarge."

"Well you better, Marine. You men are making me very ang . . . gry!

"Peoples, I've had enough of your team today. Wrap it up and bring the weapons carrier back into the shed." Moore's voice eased out of the DI snarl. "That's all for today." He marked the time on his grade sheet.

"Make it a speed drill. See if you can get in before the rain starts again."

"Green Team, aye. Shut down and return," Peoples said. He didn't sound the least intimidated by Moore's chewing-out. "But you're too late about the rain, Gunner. We're getting it full blast out here on the pad. Came down like a bucket the minute I cut the power generators."

"Backlash. Happens that way sometimes," Moore said. "Bring 'em in, Peoples. Debriefing before chow. As soon as you get here. Command out."

The heavy rain started drumming on the shed roof. When the tornado system broke up there was always an increase in local front activity; blowing stratus layers; thunderheads forming and breaking up rapidly; and rain. The rain would be heavy for half an hour and then tail off as the storm cell that Peoples had twisted up passed across the island.

Moore switched off the command transceiver, closed the covers and climbed out of his jeep. He could have worked the training drill from the weather shed, but his communications jeep was part of the Mobile Weapons System and he ran all the firing problems from the transceiver panel. That way he could work the three teams in and out of the firing pads while the weather team recycled the simulation tapes in Weather I's computers. The training problems were each worked with different weather simulations so that the teams got maximum practice with different types of atmosphere and cloud conditions. Beside the time saving, Moore could see all of the lagoon and the weapons firing pads from this end of the shed much better than he could from Weather I—even when it was raining.

Moore palmed his helmet visor down, pulled the antenna out of his backpack and tucked the clipboard and firing scenario under his rain cape. He had two hundred yards of open duckboard to cross to the weather shed. His rain gear diverted the rain drops, but it didn't keep things from getting wet. It had been raining for most of the four day exercise. You had to make rain to spin tornadoes. Weather weapons were damp duty. Nobody on the island had been really dry all week.

The weather shed, Weather I, was a little drier than the outside. Its recurved roof drained the water at the corners and it mounted a bigger rain gear so that the eaves didn't drip. The air was moist and damp under the roof, but the floor was dry and the vertical blowers of the wind breaks kept most of the gusts out. The shed had no walls. When you played around with tornadoes it wasn't a good safety practice to work inside walls where lethal air expansion could tear the building apart in seconds. Sheds were uncomfortably open to the weather, but infinitely safer.

The weather crew was busily shutting down the training transmitters and de-programming the weather computer when Moore came in. They had heard him call off the day's training and were packing up.

"Hi ya, Gunner."

"When you gonna stop the rain?"

"I haven't been dry for a week."

"Ask Corporal Willard," Moore said. "He's the boss weatherman on this team." He handed the clip-

board to one of the computermen. "Here's Green Team's timing breakdown. Will you run off their evaluation and score for the briefing?"

"Uh huh. We'll be back on-line in a minute. Willard wants to see you."

Moore had seen the four-man crowd around the plotting table. The projection system was off—the crew was removing film strips of the simulated weather maps from the training exercise—but Willard and his crew were measuring something laid flat on the screen. A chart or diagram that Willard was trying to orient to the outline of the Ietonga Atoll and the West Pacific grid around it.

Moore detoured by way of the coffee machine and came over to Willard with the china mug warming his hands—and his face—as he sipped the near boiling brew gratefully.

"What ya got, Will?" he said casually. Then he choked, coughing as his indrawn breath turned a sip of coffee into a scalding explosion of spray in his throat.

Willard was positioning a photoprint on the map grid and Moore recognized the photo instantly. The white, curled-cat symmetry of the cloud feathers and the circular bands in the center of the mass were completely identifiable. Moore didn't have to ask what Willard had. He knew.

Typhoon!

"You called off the drill right on the time hack of a weather satellite," Willard said. "I had the receivers all hot and set up for your problem, so I just triggered the satellite and took off its films. It was too good a chance to miss. I thought I'd get a picture of People's tornado. Not this . . . "

Moore was swallowing his coffee in gulps now, trying to blast the fatigue out of his head. He'd been looking at the picture, knowing he couldn't see the atoll in the film, but trying to guess how close the typhoon was.

"Have you scaled it?" he asked, finally.

"Satellite Baker William 513," Willard said, sliding a plastic scale across the plotting table. Moore flipped it over until he got the edge with the weather satellite's scale-factor marked on it, and measured the cloud spiral on the photoprint.

"480 kilometers," he said. "Sh-ea! Willard, half the airliners crossing the Pacific can *see* this thing from thirty thousand . . . How the hell'd it get so close?"

Belatedly he realized that Willard had taped the picture over the map of the island and its atoll painted on the plotting board. "A typhoon doesn't sneak up on people. It sure as hell shouldn't sneak up on a *weather* team."

"Come on, Gunner! This isn't a weather prediction station for chrissakes! It's a weapons firing range. This equipment wasn't even pow-

ered until we got here.

"We were on the LST for one day coming out here," Willard was counting on his fingers. "You ran one set-up to Phase One right off the beachhead. That put us under rain clouds and had everybody here in Weather I scrambling to get the computer programmed and three sets of training tapes patched in.

"Three and four: We launched three tornadoes; Red, Blue and, just now, Green Team. Gunner, we've been rained on and fighting weapons-winds for better-'n-a-week. Weather I's been feeding artificial weather to your weapons. Nobody even asked about anybody else's weather. Up to now nobody gave a damn. Hell, Gunner, we've been completely out of touch for five days. I got eight-to-five says that rain out there ain't all ours. It isn't going to blow away, and the wind will start hitting us steady and rising . . ." he put a finger on the typhoon plot ". . . from that."

"Well, let's get back in touch," Moore said, ignoring all the rest. "This sand spit can't take a typhoon. I've got Marines to get off this island. Find out where *that* is coming from so that Lieutenant Stowarski can navigate the LST out of here."

"Gunner, I haven't got any comm transmitters that can reach Honolulu," Willard said. "All we got is our weapons system transceivers. They pick up the satellites when they orbit overhead, but the next one's five hours off. We don't even have antennas for CW transmission."

"Well, the LST does. I'll go down and get them on the air. See if I can find out anything.

"St. Claire!" Moore raised his voice.

"Yo!" The Red Team weaponsman was behind the computer bank changing tapes.

"Corporal, get everything closed down in here," Moore said. "Pack the computer units and all the tapes.

"Le'see. The cooks are about ready with chow. Rush 'em a little and feed everybody, then kick the cooks down to the ship. Pack the rations and waterjohns. Leave the rest."

"We're pulling out?" St. Claire hadn't heard about the typhoon.

"Damn right! Willard'll show you why.

"Willard, when the wind starts to build, that typhoon will roll the sea right over this island. The only safe place would be to climb Charley Mountain, and Lieutenant Stowarski can get the LST out to sea faster. We don't want to waste any time out here on this sand spit.

"Wake up Blue Team and get all the weapons carriers moving. I want everybody on the ship in an hour—hour and a half."

"Take the jeep out back," St. Claire said. "And the driver. I'll use your comm jeep."

"Gunner?" Willard called. "You

want me to try to get some real-time weather?" He waved his hand around. "Before we tear down?"

"Too risky, Will. You might run out of time. The LST's got to move before the sea gets too big to let her run the reef. You wouldn't learn much anyway. Typhoons are big—That's . . . what'd I say? . . . five hundred kilometers across? Our weather here's a drop in the bucket.

"You got another picture I can take?"

Willard handed him a second print. Moore looked at it again.

"Forget the local weather. This picture's real-time enough for me. Bug out!" Moore gathered the driver and went back out into the rain.

The ship—LST 1311, *Newport County*—was still on the beach and the ramp was still down. Moore's driver tooted his horn and ran right up into the vehicle well and all the way aft. Moore could see two sailors huddled up on the gun-tub bridge and the deck was vibrating under his feet. Stowarski ranked Lt. J.G., but he had been commanding Auxiliary Shipping in the West Pacific for a long time. *Newport County* was his third LST and he was a good Captain. He had a topside anchor-watch out and was holding the ship on the beach with his engines. *Captain* Stowarski's instincts were warning him about the storm, too, and he was ready to pull out into the lagoon if the surf got too rough.

Moore ducked into the hatchway and went up the ladder to the LST's wardroom. Stowarski met him there with a cup of coffee. It took only one look at the weather picture for Stowarski to start things moving.

"Nichols, wake up everybody. We'll make for open sea as soon as Moore's people are on board. Put a man in the bow to count heads and tell the anchor-watch to phone me the wind speed every half hour." He handed the picture to Nichols. "Take a look, Chief, so you can pass the word about why we have to hurry. That can't catch us in this atoll."

Nichols looked at the photo, whistled and said, "No, Sir." Like his Skipper, Chief Nichols had been in the Pacific long enough to have seen typhoon pictures before. And the real thing, too. "I'll hurry 'em, Sir.

"You bringing off your vehicles, Moore?" he asked. It made a difference on how he rigged the ship for sea.

"Weapons carriers and weather trailers, Chief. Just the mobile systems," Moore answered. "I'm leaving the baggage. Cooks and mud-Marines will start down to you in an hour."

"Good enough," Stowarski said. "I'd rather have some weight in the well. She doesn't roll so bad.

"Sparks, you next. Get to work.

Get us some weather reports on this thing. Our base at Terengakai first, then Guam if you can reach 'em."

The radioman, Sparks, nodded and went out behind the Chief.

"We'll be ready when you come aboard," Stowarski said, drawing his own coffee, and sitting down. "Don't stall it too long. This bucket is a bitch in heavy seas."

A sailor stepped into the hatch and handed across a chartboard. "Chief said you'd want this chart, Skipper."

"Thanks, Ellis," Stowarski said. "Now let's see where your typhoon is, Marine, and how we get out of here." He read the location numbers, ran them out on his chart and put a circle on the point. "Holy . . . Right on top of us! Wind direction?" He had a good idea, but Moore was the weather expert.

Moore swirled his finger counterclockwise over the map. "No data—just that photo. Should be like this. That's our present wind direction and speed in the corner."

"Well, that's good and bad. The lagoon's in the lee of the mountain, but I'll have a beam wind when I hit the sea.

"How big is that storm?" Something had occurred to him. "Pretty wide, huh?"

"Scales 480 kay-em," Moore said. "Yeah, it's big."

"Four hundred . . . then it's hitting Terengakai. And they've probably evacuated too. That coral rock is only fifty-five meters high, tops. I'd better head straight out for Ponape."

The phone rang. Stowarski leaned back and unhooked the handset. "Captain," he said, and listened. "Okay. Keep trying. You might get a break.

"Terengakai's not answering and Guam's breaking up. Steve gets some aircraft traffic, but nothing solid and they aren't answering him. Can't hear, I 'spect."

"I'm beginning to smell a stink." Moore voiced a worry that had been nagging him since he first saw the pictures of the typhoon.

"Hunh?"

"Typhoons don't sneak up on people," Moore said. "That . . ."

he pointed to the picture ". . . is a well-formed, mature storm system. Eleven thousand square kay-ems of bad weather. And we didn't know about it until now. Sir, that stinks."

"Well, you Marines have been messing up the weather around here for four days now. We weren't paying any attention. These training trips are soft duty. All I expected to do was stay out of the rain while you fired your weapons and . . ." Stowarski let his voice run down.

"Weather weapons," he said. He'd put two and two together. "But a typhoon, Moore? Who the hell'd use that for a weapon? How could they do it?"

"Damned if I know, Sir. But somebody knows how. This one started up too suddenly. Honolulu, Guam, Terengakai . . . Somebody should have put out weather advisories. Lots of them. Storms don't get lost."

"It's a big ocean. The whole Japanese Navy got lost out here once on purpose . . . and stayed lost a lot longer than five days."

"Yes Sir, but that was in a war. But a typhoon . . . You suppose we got a war on our hands, Sir?"

"Could be. China? Russia? Japan again?"

Stowarski got up and went through the hatch and across to the radio shack. Moore followed him.

"Sparks." Stowarski put a hand on the radioman's shoulder.

"Huh? Still nothing, Skipper."

"Hook in the BBX-13," Lt. Stowarski ordered.

"BBX. . . ?" Sparks was astounded, but threw the switches cutting in the Fleet Combat Receiver. "I haven't used this black box since I got outta specialist school."

A four number code group appeared on the ACTION window. Sparks rolled duplicate numbers on the TRANSMIT dial and held the key down.

"Whatta you know, the thing works," he muttered, and began to copy the code groups as they came in the window.

"Captain to the bridge!" A speaker crackled the call; repeated it once.

"Decode that and let me know," Stowarski said. "Then ask for a weather report."

"Weather. . . ? Aye, aye, Skipper."

Lt. Stowarski was gone, out the companionway and up onto the bridge deck. Moore followed him more slowly. The Lieutenant could move fast around his ship. Moore was just coming up onto the bridge deck when the ship's alarm gongs went off.

General Quarters? Moore went the rest of the way up the ladder with a jump. The LST's only weapon was a quad-mount fifty caliber and somebody would be coming up the ladder to man it.

"Submarine off the reef," Lt. Stowarski said when Moore came

up beside him. He picked up the microphone and said into the PA: "This is the Captain. Secure from General Quarters. The submarine outside the reef is one of ours."

"Bridge. Radio, here."

Stowarski hung up the PA mike and picked up the phone handset. "Bridge, aye."

"Captain, code group reads; 'ComWesPac to all ships. Condition Red. Proceed independent command. More follows. Identify on frequency Able Fox Delta. Message ends.' "

"Okay, okay. Change frequencies, send out our ID and find out what's happened. Bridge out."

He turned to find a sailor standing by the quad-mount. The guns were still pointed fore and aft with the rain covers on them.

"Mudfoot, the next time that gong goes off you get to those guns while it's still ringing or I'll kick your butt up around your ears."

"I was in the head, Cap'n."

"Mudfoot!"

"Aye, aye." Mudfoot scuttled down the ladder.

"Bridge. Radio here."

"Bridge, aye."

"Skipper, that sub's calling us on the Able Fox Delta frequency. She's the *Tarpon* out of Seattle: Captain Micheals commanding. Skipper, she's one of those Dilly subs. No torpedoes, just tanks full of trained dolphins."

"Sparks. What does Captain Micheals want?"

"Oh, yeah. He has orders to contact Tech Sergeant Moore, USMC, Sir. And could we send him out through the reef . . . Sergeant Moore. Captain Micheals doesn't want to bring the sub into the lagoon . . . and his men don't know the reef."

"Want to take a ride, Sergeant?" Stowarski looked at Moore. Moore nodded. "Tell *Tarpon* we have Sergeant Moore on board and we will comply. Then ask for their latest weather. Sign it, *Newport County.*

"Matty," Lt. Stowarski said, motioning over a man standing by the helmsman. "Put the Zodiac over the side and you and Norman run him out to the sub . . . and wait to bring him back too, I suppose.

"Damn, here comes more rain. What'd I say about this being a soft voyage?"

Lt. Stowarski's crew didn't hit General Quarters fast, but the chance to see the inside of a sub had Matty and Norman working at top speed to get the little Zodiac boat swung over the lee side and a cargo net rigged so they could get down the LST's side to board her. Matty provided a life jacket for Moore, but wouldn't let him wear the rain gear.

"With the rain and that chop, we're all gonna be skin wet," Matty said. "Norman's a damn good cox'un, but if the Zodiac flips going over the reef that power pack'll skin you so fast you'll bounce off the coral. Leave it here, Sarge. It

won't keep you dry. It might kill you."

Moore nodded, shrugged out of the harness, and put on the life jacket. It had been years since he had to climb down a cargo net, but his hands and feet hadn't forgotten their timing. Matty followed him down and handled the bow line.

"Safety line," Norman screamed in his ear, and clipped the rope belt around his waist. "Hang on to the side lines."

Moore nodded again, and the outboard roared to a scream as the Zodiac pulled away. Then he was fighting for every breath as the rain and wind-blown sea spray blasted at him off the Zodiac's twin hulls. The trip seemed to take hours, but probably was more like twenty minutes. The rain squall stopped briefly when they hit the open sea and the Zodiac took on wind spray only when it rode up over the top of the swells.

The wind and waves weren't too bad out here. The reef opening was in the lee of Charley Mountain and the Zodiac felt the wind only in turbulent gusts. A bigger boat would have had no problem, the Zodiac floated like a cork, but it was only six inches off the water and the men crouched in it were unprotected.

The air inside the submarine was a hot furnace blast after the stinging spray. Moore was half-carried into the sail hatch and down the ladders to the navigation deck. The sub crew expected half-drowned men and were roughly efficient. Matty and Norman weren't in much better shape but blankets and dry clothes were on hand, and lots of coffee.

Moore found himself in the Captain's wardroom, seated behind a green covered table with his third cup of coffee. The Captain—Commander Micheals—had a photo ID of Moore and, after checking it, said, "My orders were to bring you this, Sergeant." He passed along a red-edged envelope with a large "K" printed in the center. "And then to provide you any assistance my navigator can give you . . . before you go back ashore."

"We have to evacuate," Moore said. "The typhoon."

"You'll have to handle that with your LST. *Tarpon* has another job. I couldn't take passengers in any case. This isn't a regular sub. I have twelve dolphins in tanks up forward. We're a DLI.

"But read your orders, Sergeant. Then we can plan."

Moore unsealed the envelope. It held one computer sheet and three output photoprints. The photoprints showed the typhoon. He saw that at a glance.

The orders. Moore read them slowly. The orders were brief. The bulk of the computer sheet was weather data on the typhoon. *Typhoon X-ray*, it was named . . . course, speed, estimated wind velocities . . .

But the orders themselves . . .

1. USMC TRN DT 597. REASSIGNED USMC WEATHER COMBAT TEAM ALFA. T/SGT MOORE, W. TO ASSUME PROVISIONAL COMMAND ALL USMC WEATHER PERSONNEL PRESENTLY ON TRAINING SITE.

2. USS LST 1311 NEWPORT COUNTY DETACHED TO INDEP COMM MSTR AND ORDERED TO EVACUATE NAVAL AND NON-COMBATANT PERSONNEL.

3. USS TARPON, INDEP ACTION COMWESPAC, TO PROVIDE ASSISTANCE SUBJECT TO PREVIOUS ORDERS.

4. YOUR STATION BELIEVED UNDER DIRECT ATTACK BY WEATHER WEAPON TYPHOON X-RAY (ORIG. UNKNOWN).

5. WCT ALFA WILL ATTACK TYPHOON X-RAY WITH ALL WEAPONS OF YOUR COMMAND UNTIL RELIEVED.

BREAK. BREAK. BREAK.

WEATHER DATA FOLLOWS.

He passed the sheet over to the Captain and spread the pictures out on the table.

"Welcome to the club, Marine," Capt. Micheals said softly. "*Tarpon* is ordered into the center of Typhoon X-ray to observe and report surface conditions and attack and destroy any vessel found in the eye."

He passed the orders back to Moore. "I've been briefed on your weapons, Sergeant. Do you think you have a chance of knocking out this . . . Typhoon X-ray?"

"I don't know, Sir." Moore said. "It's never been tried. I've read about two tornadoes impacting . . ." He brought his hands together in a prayer position to show the collision. "They tend to absorb each other. But a typhoon . . .

"If it is artificial, I may overpower its generating systems when I launch tornadoes at it. I just don't know . . . ComWesPac thinks I can, so I guess I'll have to try.

"What's the word on it being a weather weapon, Sir?" Moore asked. "Seems damn impossible."

"That's what my orders said. Based on the time it took to form up and its power and speed, ComWesPac doesn't see how it can be a natural storm. The times are on those pictures and we've been plotting the weather data, as we get it, on our charts. Guam hasn't made a fly-through yet. They claim to have lost two aircraft. The thought is, either the typhoon is more violent than any ever recorded, or the weather-scan planes were shot down by something in the center."

Moore shook his head to clear the fuzz out of his thoughts. The pounding of the Zodiac ride was still with him, the cold shaking him, tightening his stomach muscles despite the heat in the sub and the coffee.

The whole scene had an aspect of madness. Two men sitting around a green table calmly talking

about sending a tornado out to break up a Pacific typhoon. A man-made tornado warring against a man-made typhoon—and all this calmness in a submarine with rain squalls and wind-tossed seas just outside. . . . An air of controlled madness.

"Typhoon," he said softly, putting his finger on each of the time hacks printed on the photos to aid his mind in totaling the figures. The typhoon *had* formed in the five days that WTD 597 had been out of touch on the firing range. "Who . . . or what, are we fighting, Sir?"

Captain Micheals opened a folder and added two more photo printouts to the table display. "We aren't fighting anyone, as far as I've been told. That's the Russian-Chinese border . . . infrared scan taken four days ago, about 0500 hours, local time."

The picture showed all of the China coast from above the Japanese Islands to the bulging buzzsaw blade of the Fukien Coast. This was a mosaic, taped from more than one satellite. Fifty degrees North latitude to twenty-five or twenty degrees North—some of that area was covered by satellites orbiting north of the submarine's present position. That meant the mosaic had been relayed.

What Captain Micheals was pointing at were saw-flower bursts of heat patterns on the northern Mongolian border and up above the Korean Peninsula. The mosaic had the precise, but distorted, black-and-white-negative quality of infrared film, but the land/sea patterns were clear, mountain snow packs were visible, and the river valleys were the two parallel, twisted lines peculiar to China's big rivers.

"Lake Baikal . . . Korea . . . Tiensin . . . Vladivostok," Captain Micheals said for identification. "This shows conventional heat source weapons being used all along here—rockets, shell fire, maybe burning vehicles. The book says, a tank or artillery battle. Considering the terrain up here," he shrugged, "both sides would have had to be moving guns and tanks in there for months."

"Air strike? Bombings?" Moore suggested.

"Maybe. Somebody's shooting at somebody.

"And here . . ." Micheals consulted a card in his hand and made three grease pencil marks on the photo, ". . . are missile launching bases—short range and MIRV intercontinental. No indication of firing or launch preparations anywhere around these sites."

"So. Brushfire fight with the Russians. Then Typhoon X-ray is Russian?"

"Or Chinese . . . set up to build world sympathy and to tie up a massive relief effort, or to simply keep our naval and air from observing their coast. Strategy's not

my line. I'll tell you more about that when I get one of my dolphins into the eye with a TV pack.

"The reason your combat team is ordered into action seems obvious, Sergeant: Because you're out here, right on the course of this Typhoon X-ray. You've got to give a shot at knocking out their weapon. If you can do it, we've got a defense against any typhoons thrown at the continental US."

"Hurricane," Moore said absently.

"What?"

"There are hurricanes in the Caribbean. Two of my weaponsmen are from that area. They know hurricanes."

"Yes, well whatever, the place to stop one is here and now with your weapons. I guess ComWesPac thinks you're too good an opportunity to miss. I'm just the second team, sent in to observe, report, and clean up the loose ends.

"And that brings up my second concern. What is the danger to *Tarpon* from your weapons? We'll be out there near the eye by the time you launch."

"You'll be submerged?" Moore asked. The Captain nodded. "Well then, no problem. Tornado damage is mostly in air and air-pressure effects." He paused a minute. "Hmmm . . . they do pick up a sea-foot and carry fish aloft. But *Tarpon's* too big for that, and you'll probably be deeper than the wave action in any case."

"Periscope and the dolphins," Micheals said, stating the two parts of *Tarpon* that would be at the surface. "We'll be scouting our own patrol. How can I tell when your weapons are coming at me?"

"Very rapid drop in pressure, is the usual way. That, and high, high winds. Not much good in the middle of a typhoon, though—nor through a periscope. It'd be pretty much of a chance if you saw one directly."

"I can get barometer and wind readings from the periscope head," Capt. Micheals said. "We're rigged for weather-observing while submerged."

"Well then, Sir, you might see the pressure drop on your in-

struments," Moore said. "It's very fast, like this . . ." He drew a freehand, dropping vee with its tailspike on a pad. "Pressure up this way, time along the axis. The vortex is moving at seventeen to twenty-six knots and if we can hold it tight inside the typhoon winds, the vortex should be about fifty meters across. So this drop will be fast; down and back up in one minute or so; pressure drop, 2.5 inches of mercury; about eight percent negative pressure."

"Good to know. If we can't get out of its way, at least this is an answer to *what was that?*

"Now, one more item, then you better get back while the weather holds. Come out to the plotting room. Navigation has plotted the track of Typhoon X-ray. You can see the speed and direction on our charts and I'll give you a scaleable overlay. Bring those photos along. They're yours. I've got a waterproof bag so you can get them back to the island."

Moore nodded, sheafed the photos together. He folded the order sheet to put it back in the "K" envelope and read the orders once more.

"Cop-yew-lay-shun! Who volunteered us?"

"'Attack with all weapons . . . until relieved.' What do they think we got out here, two fifty-caliber machine guns and one belt of ammo?"

"Come off it, Sarge. We're a training platoon. We ought to be evacuating on that LST."

"Knock it off! All of you!" Moore used his weather voice to break up the chatter, then went on in a lower tone, "Knock it off! You aren't boots. You've all been through weapons training and you've served six months with a First Weather Battalion station on the mainland. You're out here on the island to spin wind on a range where you can let the funnels strike ground and run a little without tearing up property. I'm supposed to exercise you in proficiency firing, not teach you your trade. So! Now you got a chance to use your tornadoes in combat. For real. What's so different? You're Marines and this is what you volunteered for.

"Now settle down and do what you know how to do. We ain't got much time. We've got to get off this beach. Ask St. Claire. He was born and raised in Puerto Rico and he can read hurricane signs like an Apache."

"That's right, Sergeant," St. Claire said. "About two hours after high tide the waves should come right across here. They won't even know that the reef and lagoon are anywhere around."

"Like I said; not much time." Moore pointed at the board. "Now pay attention to what Willard's got spread out on the table. This is the last time we'll get to see the whole picture spread out on anything big-

ger than your weather screens. Gather 'round."

The weather pictures from *Tarpon* weren't transparent, but they had been precisely marked with grid coordinates for the storm center and Willard was able to place the three pictures exactly on the board.

"That one's a weather-satellite transmission," he said. "These other two are from something else that WesPacDef has taking pictures. They have time hacks, but no ID. We don't much care about what took them, though. The pictures are clear."

"Yes, indeed, they are," Peoples said. The development of the storm was clearly visible in the three films, and the pictures were aligned with the projection still on the board. In fact, Willard had just ruled a line through the four centers—a hard, straight line.

He began to call figures and times to Pfc. White, Tompkins' weatherman, who had walked over to the small computer on the end of the table. In a moment White said, "That figures to thirty knots . . . and course 253."

"Headed right at us?" Tompkins asked.

"No, I don't think so," Willard answered. "Let me see a big chart." He unfolded a West Pacific chart and x'd in the storm's first position and the 253-degree course line, then ran the line out until it hit the islands of Southeast Asia—around Borneo. "It will pass eighty kilometers north of us if it stays straight," he said. "The normal pattern is for typhoons to swing up the China coast like this—north—and either go ashore, or up into the Japanese High, to break up."

"Assumin' it's a weapon . . ." Peoples said.

"Hell, it's got to be," St. Claire cut in. "Look at those times . . . twenty hours to spin up into a four hundred kilometer spiral system. That's got to be artificial. And no weather build up ahead of it. Sh-ea! Honolulu should have had five days of storm before this got started."

"I'm afraid he's right, Gunner," Willard said. "I've got no met data on this one. Nothing. No advisory sitcom out of Honolulu; no typhoon watch bulletins; no six hour aircraft fly-throughs. Nothing."

"Microseismograph plots?" White asked.

"Of course not," Willard said. "If Honolulu made any correlation it's lost by now. Any request for the plots would get pretty low priority, too, I expect." He pointed to the pictures. "Who needs them now?"

"Micro-says-who plot?" Peoples said.

"It's a new weather map trick we borrowed from the earthquake prediction people," White answered absently. "To locate and plot major storms by their wave disturbances. The system has worked well out in the Caribbean. There isn't a very

wide network out here yet, but there are enough stations to have picked up this brute—if it started naturally."

"That clinches it, huh?" St. Claire said. "That's a weather weapon, just like ours."

"But an artificial typhoon?" Willard said. He shook his head. "Do you have any idea of the power it would take to generate a typhoon? Hell! You're playing around with the planetary wind system. Anybody trying that trick would have to put a loop in the ITCZ—divert the trade winds. Damn it, Gunner. Nobody knows how to do that. Sh-ea!"

"Nobody except the mad genius who did it twenty hours ago," Peoples said. "Russians?"

"Or Chinese," Tompkins said, pointing to where the course line ended. "They might shove it right across the trade lanes. Block any naval and air activity on that coast of China. A pretty good defensive barrier if you look at it that way."

"No way. Attack!"

"What?"

"I just can't see anybody using a typhoon for anything but an attack, Gunner," Peoples said. "When those winds and waves hit the islands they'll tear the cities right off them. And the China coast . . . floods, crop loss . . . God—*people,* Gunner! It'll kill thousands."

"St. Claire? He's right, huh?" Tompkins asked.

"Well, I think this is a lot like our weapons," St. Claire said. He wasn't nearly so worked up as the others. "There'll be lots of material damage and it will tie up a massive rescue force. The personnel kill-ratio will be high, but not high compared to the destruction. A saturation HE bombing would give a higher body count. No, I think they're going for property damage—and maybe shipping disruption. The China crop damage is a good thought, though. We don't really know whether it's a Chinese or Russian weapon. If they throw it at the Chinese mainland, of course, then . . ."

"You're all missing a point, men," Gunner Moore's voice was low. "The typhoon will hit us first.

"I don't give a damn whose weaponry this storm belongs to, or what its final target is. That typhoon is going to hit us first. That's what ComWesPac put in the orders. Those pictures there make it certain.

"And there isn't a damn thing I can do about how it got started or who sent it. But we are sitting here, right in its path, and there's damn well something we can do about letting it go past. That's what Marines are made for." He peeled the typhoon's picture away from the island outline, so that he could point things out. "We're going up Charley Mountain as high as the roads will take us and a little further.

"Peoples. You're Green Team. Get out here on the northeast

point—up above the road. There's a firing flat we use sometimes. Tompkins; Blue Team. Same thing out on Channel Point. I'll be with Red Team, here on the center peak, at the top of the road. When you all get in position, dig in. Let the mud-Marines blow deep holes. You're going to be fighting typhoon winds beside the back effects of your own tornadoes. Dig in deep and double-check your anchors."

"Fight?"

"How?"

"You're gonna take those orders seriously?"

"What the hell can we do against a typhoon?"

"Do what you've been trained to do, Marine," Moore said. "Get the wind outta your ears.

"Here, here . . . and here." He stabbed a finger at three places on the outline of the island. "You'll be set up in a Company Base Line. Close enough so you'll be working off common weather cells, but far enough apart to spin separate funnels. You set up, spin wind and put three funnels at a time into the typhoon. Like this . . ." He dragged three of his fingers from the island out across the course line Willard had marked on the board.

"If we can hit the typhoon wind system with a three-spread, and keep on hitting it, we may break up the pressure system. If you can get a couple of funnels into the eye wall, their turbulence should tear the storm system apart."

There was a moment of silence. Tompkins, Peoples, and St. Claire were all thinking the operation through now. They were top weaponsmen and they were considering launching potentials and pressure capacitances. They were remembering the power and destructive energies of the tornado weapons, and figuring the odds.

"Gunner?" Peoples said. "You think we can kill a typhoon?"

"Damn if I know, Peoples. You three teams will be the first to try it.

"And that's gotta be my answer to any other questions, too. I don't know. We'll find the answers as we go along."

"First thing, we better get off this sand spit," St. Claire said. "Let's get on the stick!"

"Right," Moore agreed. "The mud-Marines have been loading rations and ammo on your carriers. Get aboard and move out!"

"Ammo? Who we gonna shoot?"

"Grow up, Marine!" Moore snapped. "Whatta you think they taught you to shoot for. Those M-16's racked in your carrier aren't ornaments. Neither are the mud-Marines. Most of the time the ammo stays on the LST, but our TO says we carry six hundred rounds. You've got it all aboard. It won't do us any good on a ship headed for Ponape."

"Six hundred rounds!" Tompkins said. "Well, maybe we can shoot fish."

"We'll bug out of here," Moore said. "That's what we *will* do. Mount up Marines! Let's spin wind! Go. Go. Go."

"Sh-ea, Gunner! Thought you said no more of that training drek."

"Peoples, get your butt in gear! You men are making me ang . . . gry!"

"There goes the LST," St. Claire yelled, jerking his weapons carrier to a stop and slewing its tracks to the right so he could see the lagoon. They were on the high road, halfway up the mountain, on a point off the downwind end of the island. The LST was visibly rolling as it quartered into the swells coming in the channel. Captain Stowarski had to get out to sea while he could still power across the wind and seas to clear the reef. The ship would be reasonably safe in the open roadstead.

Moore pulled in behind St. Claire and his team, also watching as the LST maneuvered through the channel. There was something incredibly lonely about being on an island with no ship off the beach. Moore had men with him—a combat team—but he felt left behind . . . alone. More alone than he'd felt in years. The island firing range was empty except for his men and the wind was making a continuous noise now, rattling the bush, tugging at his clothes and changing sounds as it blew by his ears, or into them. The wind sound was a constant irritant that let him feel the emptiness of the island and the great, overbearing pressure of the typhoon moving down on top of them.

He noticed that St. Claire was not watching the ship in the channel, but was looking out to sea, scanning the clouds and the water. Born and raised in the Caribbean hurricane belt, St. Claire could read the weather signs all too clearly. He didn't need radar backscatter or satellite photos to tell him the timing of the approaching storm. The other men in the team knew what a typhoon was from the tech-manuals, but St. Claire had a lifetime of yearly hurricane seasons. He was able to feel the coming of a storm in the damp, heavy air and hear it in the rising wind. Moore had been through one typhoon in the Philippines and thought he was feeling the same tensions. He undoubtedly was.

"St. Claire!" Moore shouted. The wind was gusty enough to make shouting necessary. "Get it in gear! Let's go, man. All the way! We got to dig this gear in before the rain starts!" He leaned on his horn to attract everybody's attention and made hand signals to Willard in the weather carrier.

St. Claire turned his head, caught the signal if not the words and turned back to kick the clutch and slam his tracks into gear. He yawed the weapons carrier back into the

center of the road and clattered uphill. Moore followed him. A glance in the mirror showed Willard swaying the weather carrier and its trailer into line. Moore changed up a gear and closed the interval behind St. Claire as the weapons carrier picked up speed.

Ten kilometers higher, St. Claire slowed into the final turnaround, angled ninety degrees to the road, fed power to his tracks and headed off the road. At this point a sloping meadow broke the rugged jungle of the mountain. This meadow had been used for training set-ups before and was deforested regularly. There were eight or ten such sites scattered around Charley Mountain. Moore and St. Claire had picked the three highest.

St. Claire churned the big weapons carrier out into the meadow, worked the tracks until he got the rig lined up with the compass bearing Moore wanted, then he shut off the drive motors.

The four mud-Marines he was carrying piled over the back of the carrier and down the ladders. Martinez was out too, opening the outer lockers and passing out the yellow bundles of the ditching charges, and the pole-mounted locator flags.

"Get cracking Martinez!" St. Claire ordered. "Put the big cross out there and run out six ditching lines. We're going to get a lot of rain. When you're set up, give Willard a hand with the weather hole. I want to fire them all at one time. Tell Willard to bring his detonator down here. Move!" St. Claire busied himself with the red box of radio detonators.

Moore put his feet up on the jeep seat and stayed put. St. Claire's crew, Martinez and the mud-Marines, knew their drill. The job would get done. Moore's first job was to set up his comm net and check with the other teams, but the comm sets in the back of his jeep were off and would have to stay off while St. Claire was setting his explosive diggers. Stray radio signals were dangerous while the detonators were being put in the ditching charges.

The set-up didn't take long and Willard didn't need any help. He trotted down to the weapons carrier without any orders and put his detonator down beside St. Claire's. The wind, blowing hard across the meadow, made the yellow locator flags whip straight away from their poles and lent a sense of urgency to the work.

St. Claire took an eye count of the mud-Marines, and gave everybody a *down-flat!* signal with his arms. Moore rolled out of his jeep obediently, but kept his eyes on St. Claire until the last second. The red light on the detonator boxes winked on as St. Claire armed the switches.

"Fire in the hole!" St. Claire yelled, the wind distorting his words.

Moore put his head down on his folded arms.

The charges went off with a sharp, double, *Whump! Whump!*

The shock wave slapped at Moore, overriding the wind and forcing an intake of breath that brought the metallic taste and smell of nitrate. The wind came back, buffeting Moore's body from the other side, growling in his ears as it overcame the explosion and blew the dust and smoke furiously back up Charley Mountain.

St. Claire was already moving. He started the carrier's tracks creeping slow ahead and began swinging the plow blades down. Martinez walked slowly beside the weapons carrier and began opening up more equipment boxes. Willard scooted off toward his own equipment.

Moore got back into his jeep to watch St. Claire clear the rough earth on the edge of the blast crater and begin to work the hole. Three back-and-fill passes with the big carrier's dirt fans throwing the loose soil up into the wind, and St. Claire had the main hole big enough to completely contain the weapons carrier below the level of the ground.

The stabilizing jacks were coming down now, and Martinez and the mud-Marines were reeling out the wind-wires to brace and anchor the antenna sections that would be above ground level.

Crack! The wind whipped the sound of the explosive anchors, thinning them to rifle-crack volume. Martinez was forced to set the anchors one at a time. Thin as the cables were, the wind was strong enough to whip them. Each anchor took two or three mud-Marines to lay out the wire before Martinez could shoot the anchor. Moore counted the eight shots, then watched Martinez reel the wires taut, checking the leveling bubbles with quick dips of his head as he brought each reel up to tension.

"Okay, Gunner. We're ready for your jeep now." St. Claire came up alongside the jeep and yelled across the seat. "Drive on in!"

Moore nodded and started the engine. He worked his transmission into low gear and crawled the jeep down beside the carrier. St. Claire brought the comm cables across before Moore cut his engine. Moore's jeep had the comm transceivers on it, but they were interconnected to St. Claire's weapons console.

"I'll get my headset on in a minute and we can talk better," St. Claire said. Talking was easier below the ground level, the wind noise was less, but it would rise.

"Never mind. I'll get the Net open," Moore said. "I want to know if Tompkins and Peoples are in position." The last half of his words were lost as Martinez started one of the portable ditchers. The three, one-lunged diesel ditchers were unmuffled and ran at high

rpm. They were noisy, but they threw dirt. The drainage ditches had to be clear. It was going to rain soon. St. Claire was going to make it rain. And the typhoon would add to the downpour—in spades. Those drainage channels would have to be clean, running rivers or this weapons hole would turn into a lake. Opening those ditches and keeping them open was how the mud-Marines got the nickname they were so proud of.

"The Net!" Moore said, yelling again. St. Claire nodded, climbed up into the carrier and opened his console panels. He began to press switches and light up indicators. Moore saw the panel for the weather trailer light up, then two more Christmas-tree areas. The comm board on his own jeep lit up with operating lights as St. Claire slaved it into the carrier's console.

Moore swore and swung over into the back of his jeep. St. Claire had turned on the transceivers using the parallel switches on his panel. That was his way of telling Moore to get on the stick. Well, he was right. Coordinating the weapons and running communications was Moore's job when they were firing a platoon problem. St. Claire had his hands full getting the weapon mount erected and powered. Moore should have been manning the comm panel right away.

"Let's go, Marine," Moore muttered to himself, and took his headset out of its clips.

The jeep had four transceiver units racked alongside a bank of control switches. Each unit was outlined with a colored border. Moore switched the first three to AUTO/SEND and kicked in the call button on each in turn, to put out an automatic signal. The Red panel flashed an ACKNOWLEDGE light, as St. Claire opened his channel. The Blue panel showed the same signal a few moments later, but the Green panel stayed dark. Blue Team was Tompkins, and he was set up, or at least far enough along to power his transceiver. But Peoples, the Green Team, was still out of it. What the hell was holding the man!

The diesel diggers growled back to a maximum sound level and shut off, one by one. Martinez and his diggers had finished clearing the ditches and brought the little portables back to cool. He opened another kit box and started passing out rain gear.

His action reminded Moore of his own protective gear. He had changed his clothes three times in the last few hours and his original harness and power pack had gotten left aboard the *Newport County*. He took a spare set out of the seat locker and put it on absently with his attention still on People's dark transceiver. The rain gear was a wraparound poncho, waterproof and with a metallic mesh inner layer. He shrugged into the pack

harness, twisting to center the weight between his shoulders, then buckled the power pack belt around his waist. He reached up and pulled the vertical antenna up with a practiced jerk. For the moment he left his helmet off.

Peoples still hadn't checked in. Moore pushed the PRESS-TO-TEST buttons on the Green transceiver, got the right readings on the dial. The signal was going out. Next he recycled the Green board and sent the call out again. Nothing.

Either Peoples was stuck somewhere or the transceiver was out. There was the fourth unit, set for a battalion command link if this combat team ever went on the line with other teams. Moore didn't want to change the frequency on that set. He was holding that unit for the dolphin sub if they sent him any met data from the typhoon's center.

"Come on Peoples. At least call in and tell me you're stuck," he growled to himself. *"You're making me ang . . . gry."*

The Green acceptance light came on.

Moore looked over at St. Claire. He had the antenna array erected and was running rotation checks on the helices. He'd be occupied for a couple more minutes. Moore decided to open the Net with Peoples. He plugged his headset into the Green channel and said, "Peoples, where the hell have you been. What's the trouble?"

"No trouble, Gunner," People's voice came right back. He'd been sitting on the comm circuit waiting for Moore to chew at him. "This site you-all gave me is purely hard rock. We had to blow both holes twic't and I just finished shooting the drainage for the third time. Used all my charges. I just couldn't power up our radios 'til I got that done, so I guess I'm a little late."

"Yeah, you are. How are you fixed? When can you be ready to give me some weather rockets?"

"Oh, I'm dug in purty good now, but this ain't the best place in the world. This here's a lotta loose rock I don't much like. Howsomever, we got everythin' up and it seems to be working. The boys are still shooting our wire anchors, but they'll be done shortly. Give me five, and I'll be ready with the rockets."

"Uh huh. Okay. Switch your comm to Net and stay on the air."

"Green Team switchin' to Net and listening out."

"Red Command to Blue Team, switch to Net and check in."

"Blue Team. On the Net. Check and ready for operations." Tompkins was terse with his voice procedures.

"Red Command, Roger. Stand by, Blue Team. Red Team, switch to Net and check in."

"Red Team to Net. Check and ready for operations, Gunner." St. Claire's voice came in the headset.

Moore nodded to himself and

put the last switch on his panel to Net. Now the transceivers were operating as an open three-way intercom. The headsets were fitted with voice switching so all anybody had to do was talk to put his data on the Net.

"Red Team will act as command post and monitor the weather satellite frequencies. The rest of you keep off them unless ordered. I want clear pictures, and we're too close together for interference. Don't acknowledge orders unless I ask for it.

"Now," Moore tried for a more comfortable position on the jeep's seat. "Now, first I want two weather rockets. Let's find out what we've got up there. Shoot on your own time, all teams. Tape your data and repeat it over here to Red Command. Execute!"

Moore looked over at Martinez' station. He could see the top of his helmet and the upper lights of the computer panel. He saw the red light come on. The computer was ready to take the data from Willard's weather rockets. Moore swung his head in time to catch the puff of exhaust smoke from the first rocket and the flare streak as it lit the bottom of the overcast.

He didn't see the rocket go—they traveled too fast to follow when you were this close. But he did see the mud-Marines. They were fanned out in an open line to join up with Willard's men and headed to form a defensive perimeter on the beach side of the meadow. They were just kids, but they knew their job.

The second rocket flared off, even the smoke was blown away so fast it was barely visible.

"Rockets away! Data coming in," Willard's voice said.

"Blue Team away. Data coming in."

"Green Team. We're getting good signals, too, Gunner."

The top screen on Martinez' board was rolling with printed data as the computer began to process the readings from the sounding rockets. At the top of their trajectories the rockets would put out parafins and spiral back down through the storm, drifting with the horizontal winds and sending back more data. But for now, climbing through the storm layers with sensors on high-speed scan, the rockets would give a quick vertical profile of the air above the island. Martinez was already getting the smudgy fingerprint trace on his center screen as the computer turned the raw data into a picture of the cloud and wind layers, and the moisture belts and temperature changes in the weather over the weapons site. As soon as this vertical graphing had topped off, Martinez would play a pattern on his keyboard, storing the printouts for retrieval and shifting the data to his desk display. Then he would repeat the process with the taped data from Blue Team and again with Green

Team. When he was finished the computer would have presented him with a small, localized weather map of the storm cell over Ietonga. The two other teams had the same sort of a map from their own data, but Martinez would work with a composite map.

Moore decided to take a look at this first map. He unplugged his headset, climbed the side of the carrier, and dropped into Martinez' work cubby. The weather map was forming on the plate as the computer's writing circuits swept across the screen like a radar scope. The whole weather picture was condensed on the thirty-centimeter screen. The computer marked the data points and extrapolated isobars and pressure cells from its memory banks. All of the pressure curves were tightly closed arcs of circles on this small scale. The cloud layers over the island were well-organized and holding moisture.

Moore plugged into Martinez' comm unit. "Looks good," he said. "When will we get the weather satellite pass?"

Martinez pointed to a time, rolling backward to count the satellite's ETA. "Thirty-five minutes, Gunner. We cut it damn fine."

"Just so we cut it. Don't miss those pictures. You'll need them to aim us. What are you getting from Willard on his ground instruments?"

Martinez punched up a readout on the monitor showing the telemetered ground wind, pressure, temperature/humidity; readings from the weather carrier.

"It's going to rain," he said. "Lots of rain in those clouds. Rain before dark."

"Dark?" St. Claire said. "What's dark? Sunset's the only time we see the sun under this cloud cover."

"Sunset in half an hour, then, if it makes you happy," Martinez said.

"All right, Marines," Moore said. "Let's get your accumulators charged, as long as this typhoon is giving us all this free cloud." He unplugged and climbed back to his command jeep where he had the Net hookup.

"Red Command to all teams. Go to power-up phase. All teams, power up! Let's make rain, Marines!"

St. Claire punched his controls and advanced the rheostat to the sector marked RAIN. One helix began to spin faster. In a few seconds the rain started. Moore grabbed for his helmet. St. Claire was probing up through the cumulus clouds, changing the charged layers of the water droplets, driving them higher into the center of the cloud. He was forcing the convection currents and cooling the rising water vapor. The result was rain and a rapid change of static charge . . . rain, heavy, hard rain, driving at them on the wind. And power for St. Claire's accumulators. He was tap-

ping the energy of the rain clouds, draining the immature lightning he had generated with the release of the rain. St. Claire's weapon mount was using the pumping action of the storm cells, storing its energy and building the power potential for the weapon.

"Blue Team charging."

"Green Team charging. Gunner, we're getting a lotta rain over here."

"There'll be more," Moore said. "Typhoon's are wet. Didn't they tell you?"

"Wait until the sea starts to move," St. Claire said, "That'll make the rain look tame. Gunner, can you see my panel?" His voice came over the Net. The rain was roaring now, shrieking in as triggered thunderheads added their rain to the lashing downpour.

Moore looked up and across. "Barely," he said. The gap between the vehicles was filled with whirling spray. He was looking up, into the rain.

St. Claire pointed to an instrument group. "I'm getting surges. More than I can pull in. We're going to get some lightning strikes."

"Yeah man, we are," Peoples came in on the Net. "I just had one. Damn near peaked me out."

"Ground strike?" Moore asked. The way the weapons system antennas were beaming set up a massive neutral charge around the mounts and usually grounded lightning strikes outside the weapon perimeter. However, the surge currents from these strikes made control difficult and sometimes hashed up the computer.

"Some," Peoples answered. "Mostly high up. But the charging rate's higher than I've ever seen it on the range. Is that gonna harm us, Gunner?"

"Damn if I know! Nobody's ever launched in a typhoon before. Watch your red lines, everybody.

"Martinez, have you got time for another weather scan before the satellite comes in range?"

"I can handle Willard's data, but not a composite, Gunner."

"Okay. Willard, give me two more rockets. I want to find an altitude for our Dry Front. Red Command to Blue and Green Teams, send up a weather rocket on local scan. Hold the repeater tapes until we ask for them. Execute!"

"Rockets away! Data coming in."

Martinez didn't take long to form up the printout of one weather rocket. "You want to come over and look at it, Gunner?" he asked.

"I'd drown getting there. What you got?"

"The charge and temperature drop level off at thirty-five thousand. Looks like that's your operating altitude."

A lightning strike lit the jeep with a photo-flash glare. The thunderclap was instantaneous. Dazzle-blind and almost deaf, Moore

barely heard St. Claire call, "Ground strike!"

That was close, Moore thought, rubbing his eyes. The protective charge of the weapon mount had shunted the strike away. *Damn good safety device . . . if you're under it. . . . The mud-Marines . . .*

"Red Command, to all teams. Pull back your perimeter guards. All personnel in the carriers. We are taking lightning strikes. Get inside, Marines!" Then he went on, calling the squad assigned to St. Claire's carrier. They had a walkie-talkie on the Net frequency. "Red Team perimeter, pull back! Are you receiving?"

"Red perimeter, aye aye," came the answer. "On the way, Sergeant Moore."

"Cut two men by the jeep, will you. I'm moving the comm panel."

"Aye aye."

"St. Claire," Moore went back to the firing problem. "Are you charged for thirty-five thousand?"

"More than enough. I'm spinning," St. Claire said. "Top layer looks good."

"Then let's dry it out. Get to work. We need a high, Dry Front at thirty-five thousand. Dry it out!"

St. Claire changed his controls, pressing a new pattern on his keys and rolling new limit numbers onto the parameter potentiometers. This time he was using two beams, micrometrically angled to interact at the upper altitude. Here again he was charging water vapor, forcing

the droplets to move together, coalesce and form bigger drops. The micro-drops lost energy when they did this, cooled, gained mass as they flowed together and fell out of the air. The falling rain drained the moisture, but the heat energy stayed in the upper air. St. Claire's beams weren't tapping the energy this time. In fact, his stripping beams were adding to it, building heat. The tornado weapons needed a warm, dry-air mass working above the wet air, a dry mass to suck down inside the tornado vortex and keep it spinning.

"Red Weather to all teams," Willard's voice was calm on the Net. "Be advised: Wind speed on the ground is now sixty-five knots. We have a typhoon, Marines."

"Red Command, Roger. Can you give me another rocket, Willard?"

"Negative, Red Command!" Martinez cut in. "I've got a time hack on the satellite, Gunner. Hold five."

"Got that, Willard?"

"Holding."

The blowing rain slackened, swirled clear by the rising wind shearing over the weapons hole, or by a gap in the circular storm system moving across the island. Moore shook the water off his visor and could just see the picture forming on Martinez' upper screen raster. Only half the screen so far, but the tight-ball spiral of the typhoon was clearly coming onto the register.

The rain stopped abruptly although the wind still swirled sheets and droplets off the carrier with stinging force. A squall line had passed over the island. The rain was still falling, precipitation generated by St. Claire's helices, in the upper air, but the winds aloft were blowing it horizontally for a bit, carrying the rain clear of the mountainside.

"Give me two more rockets, Willard," St. Claire said. "Let's see how dry we are on top. The cloud base has started to circle on me."

"I just sent up a couple too, Red Team," Peoples said. "Let me know if you want the tapes."

Moore looked up at the bottom of the cloud layer. The dark, solid clouds were in heaving turmoil, like the surface of boiling oatmeal, but they were definitely beginning to show a tight circular movement. Not the five-hundred-kilometer-wide cloud he'd seen in the *Tarpon's* photos, but an angry five kay-em swirl.

"Looks good up there, Gunner," Peoples said. "You want to hold off any longer? Green Team, permission to strike?"

"Blue Team, check in," Moore said. He hadn't heard from Tompkins.

"Blue Team, hot and dry at thirty-five thousand. Permission to strike?"

Martinez held up a circled thumb and forefinger and said, "My readout's okay. And I got the

satellite photos taped in. It just passed over, north of us."

"Red Team, permission to strike?" St. Claire said, right on top of Martinez' report.

"Okay. Strike! Strike!" Moore gave the command. "All teams. *Strike your vortex!*"

"Gunner! Look at the beach!" Peoples said. "Down at the Shed!"

Moore pulled off his headset and scrambled across to the weapons carrier. The rain pounded at him, blinding his visor, but he grabbed a tight grip on the carrier's ladder and climbed up slowly. He went up until he was just under the rotation shield of the helix mount. This brought his head and eyes up above the rim of the weather hole. The wind tore at his head and helmet, pressed his visor hard against his cheek and forehead, but he could see down the mountain to the flat section of the island—to the training sheds they had left.

The sea had built up to the point where it was driving over the north reef in long, foaming breakers. The surf was driving up the beach as far as the Weather I shed and further. As Moore watched, a group of three waves swept clear across the island, one after the other, and foamed into the lagoon. The weather shed twisted, swayed and dropped one corner into the swirling white water. The next wave swept it away completely. The island at that point was only seven and a half meters above sea level. The seas were running five to six meters and rolling clear across the island. The training launch pads would be deep under the surf.

The center of the lagoon was fogged, and disappeared in the gray plume of falling rain—a curtain that swept across the rolling white water toward the mountain. There was a thickening at one side, a dark, near-vertical mass in the rain. It could have been a striking tornado vortex. But the rain was a solid curtain now, blanking the lagoon and even beginning to cover the breaking white water that marched across the lower island. Moore couldn't be sure of what he saw.

Then the rain was on top of them, the water shrieking at Moore and forcing him down the ladder. The visibility dropped to a few feet.

A gust of solid wind twisted Moore off balance as he grabbed for the handholds and he slid sideways on the wet metal, banging his right knee against the deck and digging the corner of his rain pack into his shoulder blade. The pain in his knee blacked out his vision for a second and his right arm wouldn't work. He waved his headphone jack around uncontrollably until Martinez took it away from him and plugged it into the computer comm jack.

"You okay, Gunner?"

"Uh huh," Moore palmed his visor up. "Nothing left down there

on the beach. The sea is covering the low part of the island."

"I'll never go swimming down there again," Peoples said.

"Blue Team to Red Command," Tompkins said. "I have a vortex. It's spinning. Can anybody see the funnel?"

"No sight. No sight!" Moore said. "Watch your instruments. We aren't going to see anything this time out."

"Red Team. Strike! Strike!" St. Claire called.

Moore looked out toward the center of the lagoon where Red Team's funnel should touch down. It was an automatic gesture. He couldn't see out of the carrier. What he did see was the mud-Marines coming back aboard the carrier. One of them held the walkie-talkie. "You ready to move the radios, Sarge?" he said, looking at Moore.

"Go ahead," Moore said. "Do it fast."

The Marine made a cross-the-throat signal, then, seconds later, reached down and lifted up one of the transceiver units. Moore took it from him and racked it in the comm panel area on the carrier's side. The other three units followed rapidly and Moore was connecting the power leads while the mud-Marines came on board. Two minutes flat, and Red Command was back in business inside St. Claire's weapons carrier.

Moore transferred his headset in time to get Tompkin's contact report.

"I have a radar contact," Tompkins said. "Blue Team is spinning."

"Harden it up, Tompkins," Moore ordered. "Let it build and harden it up."

"Radar contact! Red Team spinning," Martinez said. St. Claire didn't report on the Net. He was bunched over his console, working buttons and the rheostat handles.

"Green Team. Green Team. Check in!" Peoples was late again. He'd probably spent too much time watching the tide wash out the island.

"Green Team, no joy," Peoples came in at last. "I repeat; no strike. I am recycling. Gunner, we got a lotta wind over here."

"Snap it up!" Moore said. "We can't hold for you." Peoples was on the island's leading edge, a more exposed position than Red or Blue teams. He was fighting the typhoon's force directly, before the air currents were disturbed by the island's land mass.

"Red Command to Red and Blue Teams. Let's move! Martinez, give me a course." Moore was going to launch the two tornadoes he had spinning; bring Peoples out when he got the vortex recycled.

"Course North, fifteen, West to intercept . . ."

"That's enough for now," Moore said. Martinez could refine the navigation after the tornadoes were moving. "Course, fifteen degrees.

Lean 'em out, teams! Now!"

St. Claire's antennas, both helices, began to produce an audible howl as they spun into high mode—a high, humming buzz, almost like the noise of a tornado tube. The tornado itself couldn't be heard in this wild wind and rain, any more than it could be seen.

Suddenly Moore couldn't just sit in front of his transceivers, listening. This wasn't a training exercise where he was checking procedure against a scenerio, or marking a score sheet. This was a fight. His weapons against Typhoon X-ray. He had to see.

All the transceivers were set for Net; his headset cable was long enough. . . . Moore hooked his safety belt into Martinez' bar and braced himself so he could see the computer screens.

Martinez pointed at the radar screen. The image was an oddly regular blob with the distinctive split-S hook that indicated the grounded funnel. "I'm enhanced right down to the noise limit," he said. "This gear's built to look through our own storm fronts. Driving it through a typhoon is working everything up-front.

"You're drifting, St. Claire." This last was a correction for St. Claire's guidance. "Come left, ten degrees."

"Left, ten. How's that?"

Martinez punched a concentric reticle onto his screen. "She's still floating," he said. "Advance is thirty knots, but . . . hey, we're moving cross wind! That's it. Crank in another ten degrees left."

"Green Team, strike! Strike!"

"Course, North, fifteen, West—Peoples," Moore said. "tighten it up and lean it out!"

"Hey! What the hell! Look out!" Somebody's voice was a scream on the intercom. "Get it off!"

Peoples? Moore stiffened and involuntarily looked toward the northeast point of the island. All he saw was St. Claire's startled face. He couldn't see Peoples' position from here anyway, a shoulder of Charley Mountain was in the way.

"How's Tompkins?" he asked, twitching his head back to Martinez.

Martinez punched his scale switch. The radar picture shrank—and shrank again—as Martinez extended his search range.

"There's Tompkins," he said. "He's well away. There's Peoples." He pointed to the third tornado return. "Gunner, he's right on top of us. Hasn't started yet."

"Green Team to Red Command," Peoples' voice was controlled and tense. "I have a tight vortex, but I can't force it off the atoll. It's holding offshore, half-a-klick—no advance. We have sustained some rock damage here."

"Rock damage!" Moore said.

"Aye. The ground wind is very high, Gunner. Gusting to seventy knots. And this rock site is bare. The wind's moving boulders around out here."

"Forget the coppin' rocks! Move that tube!"

"I'm giving it all I got! *Hey, look out!*"

"Negative track, Peoples! Neg track!" That was Red Walters, Peoples' computerman, yelling now. "It's before the wind!"

"I got a reversal! It's coming back on us. Damn it!" Peoples' voice cut in. "Abort! Abort! Green Team to all teams: I am aborting. Now!"

"Stiffen up, St. Claire! Tompkins!" Moore called. Peoples' abort meant a massive wave of countercharge from the Green Team antennas. Moore had never run an abort with two other funnels spinning. He had no idea what would happen. The break-up signal could disrupt control of all the tornadoes.

St. Claire was cursing in a low tone.

"*Hey yaaah!*" Martinez yelled as all of his screens went white with the interference snow.

Moore pounded his knee with a fist, helpless to do anything else, until the radar and instruments could tell him whether Red and Blue Teams still had control of their tornadoes.

"Tracking!" Martinez said finally. "Our tube's still on course, Gunner. That's Tompkins."

"That's a relief." Moore saw the two blobs on the screen. "Green Team, check in. What's your status?"

"Green Team. It broke up. No funnel, no vortex. I still have heavy cloud base. Weather rockets away." Peoples' voice was still sounding unexcited, like he was only working a training problem.

"Ah . . . it looks like a big dent in my negative helix, Gunner," he went on. "One of them rocks must've bounced higher than I figured. It's taking check loads okay, but I don't think it'll spin true. As soon as Red gets the weather plot locked in, he and I'll try hanging counterweights on the balance plate. If we can get 'em up there. That's outta the hole and right in the ol' wind."

"Do your best. Call in before you recycle. You'd better hold up for the second wave." Moore said the only thing he could. One weapon out, but he had two on the way and those had to be driven hard into the typhoon. He couldn't help Peoples, so he went back to observing Martinez' screens.

The computerman was running an attenuation-scan program on his vertical radar. The return from the tornado would be coming back with a slightly different frequency than it went out. By tuning these frequency changes to a timed acceptor program, Martinez was getting a picture of the hardness of the tornado's whirling tube. From experience and by comparing to the computer's memory circuits, he was able to form an idea of the wind speed in the spinning tornado and the pressure drop at its cen-

ter—the hardness. Martinez was good at judging hardness figures, although the numbers he was working with were based on mathematical relationships in the computer's programming. There was no way to measure such speeds and pressures directly. In fact, out there on the sea, where the tornado funnels were spinning, there was no way to measure anything. The enemy might get something, if there were any ships in the typhoon's eye, and the submarine *Tarpon* might get some accidental tornado readings. But up in the air, nothing but the recording of imagination.

In the air above the sea, the tight tornado winds, 175 knots or faster, were slashing across the great circular winds of Typhoon X-ray. Typhoon winds that were, by themselves, spiraling inward toward the eye at seventy-five to eighty-five knots. This was the war; the meeting of tornado funnel and typhoon power.

Weather war—where the weapons met, at the surface of contact, there would be the titanic energy release of unstable, turbulent air: solid lightning strokes would discharge from air mass to air mass; screaming vertical winds would develop as the cloud masses and typhoon rain bands were driven upward by the release of heat. And rain . . . rain so tormented by wind and pressure changes that much of it would never reach the sea.

Moore's use of his weapons—the only tactic he could think of against a typhoon—was to slam the tornado's high-speed wind system against the spiral air masses of the typhoon.

For all its vast size and tremendous air-mass energy, the typhoon was an evenly balanced system of rising moist air masses. It was self-perpetuating and massively powerful as long as this wet air kept rising and moving outward to balance the inward spiral of the surface winds.

Moore's tornadoes—forced wind-systems—would be whirling at three hundred knots when they hit the typhoon center. The tornadoes were also fed by rising moist air, but with the difference of the dry, upper-air mass. Dry air that flowed downward into the funnel's low pressure vortex. The tornado and the typhoon fed on the same physics of the storm cells.

Moore hoped to smash the higher velocity winds of his tornadoes through to the typhoon's eye. He hoped they would distort the spiral air pattern, break up the eye's vortex wall and turn the typhoon's balanced forces into a dissipated tropical storm. He also hoped one or more of the tornadoes would stay together long enough to do some damage to the generating weapons—ships, or whatever—that were in the eye.

He hoped. That's all he could do. Nobody had ever fought a ty-

phoon before. He would use his tornadoes like assault troops. The Marine way. Slam at the enemy, and keep hitting, until the resistance folded up.

"Thirty-two klicks out, Gunner," Martinez said. "That's the limit of our control."

"Uh? Huh?" Moore brought his mind back to the business in the weapons carrier. "Yeah. They ought to be fat enough to hold their own." He had been watching the radar returns from the two-spread tornado pattern move away from the island and deeper into the center of Typhoon X-ray.

"Red Command to Red Team; Blue Team: Cut 'em loose. Disengage! Disengage!"

St. Claire straight-armed the red bar over his console and pulled his rheostat back hard.

"Stand by to recycle," Moore said. "Green Team, what is your status?"

"I'm with you on this one," Peoples said. "Ready to spin."

"Red Command to all teams. Spin 'em up!" Moore said. "Spin wind!" He could see that Martinez' weather panels were working. Willard and the other weather techs were firing their rockets, in sequence, without command. Their training, and the four days of range firing, was beginning to pay off. Red Team at least, was working *Gung Ho* . . . all Marine . . . very best kind.

"Green Team, strike! Strike!"

Hold it together, Peoples, Moore said to himself, as Tompkins, and then St. Claire, reported in.

Martinez gave them the course, corrected this time for the twenty degree windage he'd used on the first spread, and Moore said; "Lean 'em out!"

Peoples didn't have any trouble this time. Martinez' wide scan showed all three hooked-blobs crossing the range reticles with drill instructor precision.

Moore was watching the radar screen, but Martinez tapped the weather readout panel.

"Wind, Gunner," he said. "We're near our limits. Also it's dark out, if anybody cares. We missed the sunset."

Martinez' cubby and panels had their own internal work lights. With the rain and general low light levels, he'd been using full lighting for most of the shoot-sequence. Neither he nor Moore had noticed the darkness outside the carrier . . . or the rising wind. Moore had been in the typhoon wind and rain now for five hours. He was wet to the skin despite the rain gear. He had been slammed and buffeted by the wind gust, his ears no longer heard the screaming shriek of the air over the weapons hole. Part of his mind knew that the storm was rising, but his concentration had been on his own weapons. He'd almost forgotten the typhoon raging across the island. He certainly hadn't cared about the setting sun.

Martinez' wind figures were over eighty-seven knots. The typhoon center was now less than eighty klicks north of the island.

"We'll try one more spread," Moore decided. "All teams disengage and recycle. Make it as fast as you can, Marines."

"Red Team, recycling," St. Claire said. "Gunner, that wind's over my red line."

"Use boost power. You can't burn out anything."

"Can't hurt," Tompkins said. "I'm running practically water-cooled, anyhow. Spinning."

"What's a little wind," Peoples said. "All my flying rock blew away. Green Team, spinning."

"Oh, hell." St. Claire's helices started to whine overhead. "Red Team, spinning."

Martinez put a micrometric reticle on the tornado trace the second St. Claire called the strike. The wind speed—the typhoon's wind—was within eight knots of the vortex speed of the tornado when it first touched down. Some of the gusts were higher. High enough to blow the tornado out, or tear it out of St. Claire's control—force a reversal like Peoples' first funnel. Martinez watched the Red Team tornado very carefully.

"It's moving!" he reported. "Range increasing. It's going out. Going out. Very bes' kind."

"It'd better be," St. Claire said. "I'm bending my levers now, as it is."

The tornado was on its way. Moore could see the movement on the screen now. The radar pattern was marching out across the range lines at a steady speed. Martinez had shifted the course another ten degrees upwind, leading the advancing typhoon center as his computer tracked it.

"Here's a full sweep," he said, knowing that Moore would want to see the maximum range display. "Our second spread is almost off the screen. There—" he pointed.

"But they're still tracking?"

Martinez touched the radar traces with his light pencil and got the course and speed printouts displayed from the computer.

"Uh huh," he answered. "They've stabilized and are cutting across the typhoon wind pattern. Going straight in, Gunner."

"What's the time on our first spread?" Moore wanted to know. He was watching the second group of tornado funnels fade off the upper quadrant of the screen.

"Under a minute," Martinez said. "The sub should be able to see them pretty soon. If it can see anything out there.

"Hey, wait! Peoples . . ." He twitched the radar back to short scan. "*His funnel's still on the island!*"

"Red Command to Green Team," Moore snapped. "Peoples. What are you playing at?"

"Power's cycling," Peoples said. The strain in his voice was evident,

even through the headset. "I can't get push voltages. The funnel's holding, but I can't . . . Hell! There goes the coppin' circuit! Blow-out on control panel, Gunner. I got no power into the helix.

"Radar, Red?" He was asking his computerman. "Yeah. Gunner? We can track it, and I guess I can talk to you, huh?"

"Sh-ea, yes! Aye . . . firmative! Where's the tube?"

"It struck down on the reef," Red Walters' voice answered. "Then it pulled up again. Vertical scan shows an air funnel. It's drifting, coming ashore, Gunner!"

"Abort it! Abort!"

"Negative function," Peoples said. "I have a dead board."

"Strike! Strike!" Walters said. "On Charley. It's walking the mountain."

"Downwind," Martinez put in. "The typhoon wind's blowing it."

"Looks like," Walters said. "Yeah, downwind. Picking up speed. It's headed right at you, Gunner.

"I say again: Headed for Red Team site."

"Red Command, aye," Moore answered, then turned his head to look at the inside of the weapons carrier.

"Button up!" he yelled, flipping the headset mike up out of the way. He was hollering at the mud-Marines who weren't listening on the Net. "Stow those blankets and pump the lockers! Funnel coming!" He waved three hand signals too, his words were drowned in the wind noise.

The mud-Marines got the message, they had a drill for this, a training drill, but they worked it smoothly. The blankets and rations disappeared into the carrier's side hatches and high-speed pumps began to vibrate the floor. Storage compartments were evacuated to low pressure, so that the tornado couldn't suck them open—explode the air inside when the pressure drop went across the carrier.

"Martinez, how long before you can cut loose our funnel?"

"Ten klicks," Martinez said. "Too long."

"It's stable by now," St. Claire said. "You want me to try to tune to Peoples' funnel, Gunner?"

"Negative. No time. Peoples is only eight klicks away."

"The funnel's closer," Martinez said. "I've gone to snow all across my screens. Nothing!" He looked up into the rain, although there was nothing to see but the dark rain-sky. "It's right on top of us." Then he looked at his barometer chart. "There goes the pressure drop, Gunner. That'll lag in this wind."

Moore's mind was racing. He'd seen these reversals before, but there wasn't anything you could do about them except snuff out the tornado. There wasn't any defense. *Wait a . . . Defense . . . Last year at El Toro . . . Somebody wanted to*

sow abort generators like a mine field. . . . Tornado defense . . . A trick . . . It hadn't worked . . . or had it. . . ? Maybe . . .

"Cut it loose, St. Claire!" Gunner decided. "Count five, then fire an abort!"

"Cutting! Now!" St. Claire said. "One . . . Think my signal will break up Peoples' funnel? Two . . . Frequencies 'r' wrong. Three . . ."

"Bounce it up over us," Moore said tightly. The drop in pressure was becoming noticeable. He swallowed to clear his ears. "Breathe out! Remember your drill."

"Four . . ."

Moore made *breathe out* hand signs to the mud-Marines, but they were already pinching noses to equalize pressure and working on their skin diver breath-control exercises, as the pressure went down fast.

"Five . . . Abort! Abort!" St. Claire's voice was level and low.

Martinez reached up and kicked on his recorder tapes.

"Nobody's ever been this close to a funnel with instruments," he said. "Willard, are you on record?"

"Tell your coppin' grandmother . . ." Willard said. "We'll get a whole chapter in the training manuals out of this." His voice broke up in a scramble of static. *Static? On these comm sets?*

"Gunner, look up!" St. Claire said.

Moore was already looking; jerking his head back to see. A blue-white lightning flash had thrown shadows on the comm panel.

Moore found himself looking straight up into the whirling wind-funnel of the tornado. He could see it plainly despite the dark. Small lightning flashes danced and forked around the inside swirl of the funnel. They arced thin threads and blue branches; snapping in the direction of the wind spin, flashing and snuffing out before they could truly be seen. But they left an afterimage on the retina and enough light to show the roiling wind-tube.

Breathing was difficult now. Moore had a great weight shoving at his chest from inside. The air in his lungs, still expanding as the pressure dropped, was used up, charged with carbon. He fought the desire to gasp and gulp in quantities of air. The air wasn't all that pure; spray wet and filled with mud and leaves torn off Charley Mountain, and the pressure hadn't hit bottom yet. A full breath could kill him. Moore fought the battering air.

Crack! Spaat! The ration wrappers swirled off the deck and left the carrier at rifle speeds. Moisture, rain pools, and rivulets on the metal vaporized and were sucked away in standing columns of fog. Even the wet rain capes and clothes were drying as the tornado's low pressure and wind violence tore at everything movable.

And the sound was audible. The tornado's buzzing roar drowned out

the typhoon's scream. The sound shook the weapons carrier, vibrated to the bones of the men inside, but it was a sound they knew. Wind spin . . . tornado snarl . . . familiar . . . not frightening. None of them had ever been this close to one of their tubes before. That was scary. Moore, St. Claire, and Willard knew the energy in those funnels—the destruction they were designed for. They were afraid of the funnel, but the noise . . . the noise was almost friendly.

Moore saw Martinez make a thumbs-up sign and point to the pressure plot. The tornado had passed by; was going on along the mountain.

Within seconds Martinez' radar screen lost its snow and began to form reliable shapes. Charley Mountain and the curvature of the island came back, but Martinez was shaking his head at the cloud patterns in the center of the reticule.

"Green Team to Blue: Looks like it's going on up Charley Mountain. Are you tracking?" Peoples was on the Net.

"Tracking," Tompkins came back. "The typhoon's got it. I can barely see a hook on my screen. Going off-island . . . downwind. Blow away.

"What's with Red Team? Can you raise them?"

"Carrier's still on the air," Peoples said. "They must've got shook up."

"Red Command to Green Team. How do you read?" Moore managed to say, looking around the weapons carrier to see if anybody had been hurt. Martinez had a cut from a plastic scale that Moore had seen him dodge. The mud-Marines were all right. There was one bloody nose and some of them were rubbing their ears. Moore's ears were buzzing too, and that wasn't all static in the comm net. A helmet was missing, but nobody had anything broken. Pretty damn lucky . . . considering.

St. Claire? What about . . . ?

"St. Claire?" Moore swallowed to clear his voice. "St. Claire? You okay?"

"Still with you, Sarge." St. Claire's voice sounded thick, but he answered. "The helices *look* okay. You want a test?"

Moore looked up. The twin antennas were still spinning. St. Claire's abort signals had been going out. They hadn't disrupted the tornado, but they had bounced the funnel over the carrier. One more for the book.

"Any chance of the funnel coming back on us, Martinez?" Moore asked. He'd pulled his safety belts so tight he could no longer see the screen from his comm panel, and he no longer wanted to unhook his harness. The tornado was gone, but the typhoon winds were back with increased power. The dry interior of the carrier was already flooded with the renewed rain flurries.

"No way!" Martinez said. "It's

gone behind Charley Mountain. I get no trace at all, now."

"Good enough. St. Claire, shut off and get down here, before you get blown away," Moore said to the weaponsman. "Be careful."

"Aye, aye."

The wind blasted and tore at the weapons carrier. Near solid gusts of turbulence from the air streaming across the mountain rolled into the weapons hole and slammed the carrier despite the protection of the high sides of the truck back. And the sound was continuous now, a constant roaring scream. Moore's ears could no longer separate out single gusts or detect lulls in the steady blowing rain. Occasionally he would taste salt spray, proof of the wind-tossed violence on the lagoon and reef.

"Red Command to all teams," Moore said. "Secure your weapons. Secure. Secure. We'll hold off 'til the wind goes down."

"Red secure," St. Claire said on top of the other two team call-ins, and a minute later he was swinging down into the sheltered instrument bay and hooking his belt to the safety bar.

"Wet and wild," he yelled over the storm, shivering heavily. One of the mud-Marines passed him a blanket-pack and two of the little brandy bottles out of the reopened ration locker. "Thanks. Does the Corps have a weapons team in the Sahara?"

"Third spread's offscreen, Gunner," Martinez said. His voice was on the comm net, loud in Moore's headset.

"What next, Gunner?" St. Claire asked. He'd plugged his headset into a comm jack. The wind noise made talking almost impossible.

"Not one thing, Marine," Moore said, beginning to shiver in his turn. After being dry, the second wetting was cold. The wind-driven rain washed heat from his body. "This is where we sweat it out." His teeth were chattering and the mud-Marine at the ration box passed two bottles and a dinner-pack around to him. "We gave it our best shot, and now we wait.

"Willard?" Moore pulled his microphone closer to his mouth. "What's our weather gonna be like for the rest of the night?"

"How the hell should I know?" Willard said. "Nobody's ever crossed a tornado with a typhoon." Then he answered the question. "Wet and windy, Gunner. If the typhoon stays together and keeps moving, the wind ought to back around about midnight. It will probably drop off fast about then. We're in the safe quadrant now; behind it by midnight. Might see the sun at dawn."

"He's about right, Gunner," St. Claire said. "A hurricane doesn't stay over an island long. Not like the way they pound at Texas and the Virginia coast."

"Very well." Moore nodded. "You hear that . . . Peoples?

Tompkins, do you hear?"

"Aye, aye."

"Gotcha, Gunner."

"Button up and keep warm. We'll take another look at midnight. Red Command, listening out."

Moore put the Green and Blue Team transceivers on LISTEN/STANDBY, but he kept the Red set active, on RECEIVE/INTERCOM, so that he, St. Claire, and Martinez could talk to each other comfortably.

"Those remind me," St. Claire said. "How are we going to call up a ship when the storm clears? Those thing are good for, what . . . fifty klicks?"

"We stay here until relieved," Moore said. He didn't mean it to sound so heavy. The brandy was beginning to warm him and the fatigue of the heavy work schedule, plus the strain of the storm, was beginning to make him feel lightheaded. "The Corps will send a ship in for us. They just gotta find replacements. Marines that'd like to serve on a waterlogged island.

"Don't sweat it. We've got a ship closer than fifty klicks, or as close as . . . I'm gonna call it ri' now." He was fumbling with the patch cords, trying to get the Number Four transceiver linked into the Net. His hands were slippery-wet and shaking a little, but he made the connections, turned Number Four on and began to call:

"WCT Alfa, calling Water Watch. WCT Alfa, calling . . ."

"The submarine," Martinez said. "*Tarpon*! Sure. She's waiting out there . . . under the storm."

"Better than that," Moore said. "Number Four's set on a battalion command frequency. I gave it to *Tarpon.* What with the storm, the short range, and this frequency, there's no need for *Tarpon* to code anything to us. I'm hoping for a strike report.

"WCT Alfa, calling Water Watch. Come in. Come in. Over."

He had to repeat the call three more times before the faint answer sounded in his headset.

"I hear you, Water Watch," he said, tuning the sensitivity to clear up the signal and raising the volume slowly. He didn't want to lose the submarine in the noise-hash.

"What you got, Gunner?"

"Peoples! Damn you! Stay off the coppin' air! Listen!

"Say again, Water Watch. Say again." Moore upped the gain a fraction.

". . . *by for . . . Captain.*" The incoming signal grew stronger. *"I say again; stand by for the Captain. We have a weather advisory for you. Over."*

"I hear you, now. WCT Alfa, standing by. Go ahead."

"This is the Captain . . ." The voice faded up and down, but Moore heard it all. *"This is a no-code transmission. We are in the center of a violent storm system . . . repeat; center. Wind Force 12. Seas*

five to six meters—confused. Severe cross-chop. Unable to report position due to cloud and wave action.

"We have just observed two other vessels in extreme distress. One observed to have been swamped by direct collision with a waterspout . . . as we watched. Damage extreme. Survivors unknown. Second vessel believed capsized, but not verified. Weather conditions prevent search for survivors . . . or identification.

"Waterspout conditions causing violent turbulence in the cloud wall near us and break up of wind conditions. Repeat; break up of wind. Area very turbulent. Rain and lightning. Am leaving the area. Do you understand? Over."

"WCT Alfa to Water Watch. I understand. Specific weather break up in your area, plus ship report. What is your condition? Any damage? Over."

"Negative. You can't sink us We're under . . . control. Minor crew injuries due to pitching and rolling." There was a pause. *"We were unable to recover two fishing buoys. They may ride out the storm. I am returning to your station until the storm calms. There is nothing more I can do out here.*

"Oh, the weather's fine out here, now. Just rough seas and thunderstorms. But I haven't any work to do until it clears, so I'll come back and buy you a drink. Over."

"WCT Alfa. I understand. Thanks. WCT Alfa, out."

"What was that?" Martinez said. "Fishing buoys? He said no code."

"Just Captain Micheals being cautious," Moore said. "A code message would have been suspicious, so he acted like a fishing trawler caught in the storm and just used double-talk. 'Fishing *boys*' were two of his scouting dolphins, I guess. Did you get the rest of the message?"

"Hell yes!" Peoples said on the Net. "We broke up the typhoon! Sounds like we sunk a ship, too! Ain't anybody gonna cheer?"

Moore cut Peoples' transceiver off with a slam of his hand.

"Hooray," he said in a low voice. "That's what we were trying to do. Peoples damn near wiped out our weapons carrier and he wants to cheer. Sh-ea!"

"Yeah," St. Claire said. "It doesn't mean the same thing when you can't see what the tornado damage was." He worked his way down to the mud-Marines, told them the news and got the same unenthusiastic nods. He came back carrying three more brandy bottles and dry blankets.

"They said, 'Good shooting!', but they're too wet to give a damn. Here's another brandy ration. *We* can celebrate. After all we did do what ComWesPac wanted. We killed a typhoon."

"Yeah. You'll feel more like a hero in the morning."

"Dry blankets?" Moore had just felt the inside of the blanket as he wrapped it around his arms

and shoulders. "How the hell!"

"They're pumping a vacuum over them in the storage locker and boiling out the water," St. Claire said. "Figured it all out while that funnel was passing over us. Product of a pure mind in a healthy body. They weren't even scared. Give 'em another couple of hours and they'll have the blankets heated."

"Mud-Marines," Martinez said, squirming into his blanket. His voice was a grateful sigh of admiration.

Moore drained the brandy ration and twisted himself into a comfortable slump against the comm panel. The wind screamed and roared across the top of the carrier and the rain, not so hard now, was still blowing in and falling steadily. The action was over. Now they just had to wait until morning. Then wait until the ship came to take them off Ietonga. Just wait . . . and sleep.

Martinez was already gone, his head leaning over against the computer board. St. Claire was looking up at the antenna mount; at the dark storm sweeping over them. His eyes and mind were far away. St. Claire, more than any of them, knew what their tornadoes had done. He was probably remembering past hurricanes, in the Caribbean, and thinking that now tornadoes could be used to stop them. Now, for the first time. . . .

Yeah, St. Claire. That's how it feels to do something first. Empty . . . drained. And it'll never be like this for anybody else. The next team will have all our data, all the facts and enough briefing and theory to scare them pissless. That's when you and I . . . yeah, and even Peoples . . . get to be heroes, 'Cause we did it without being scared. . . . And that's when you get to be an old man, St. Claire. When the kids remember that you did their job—first.

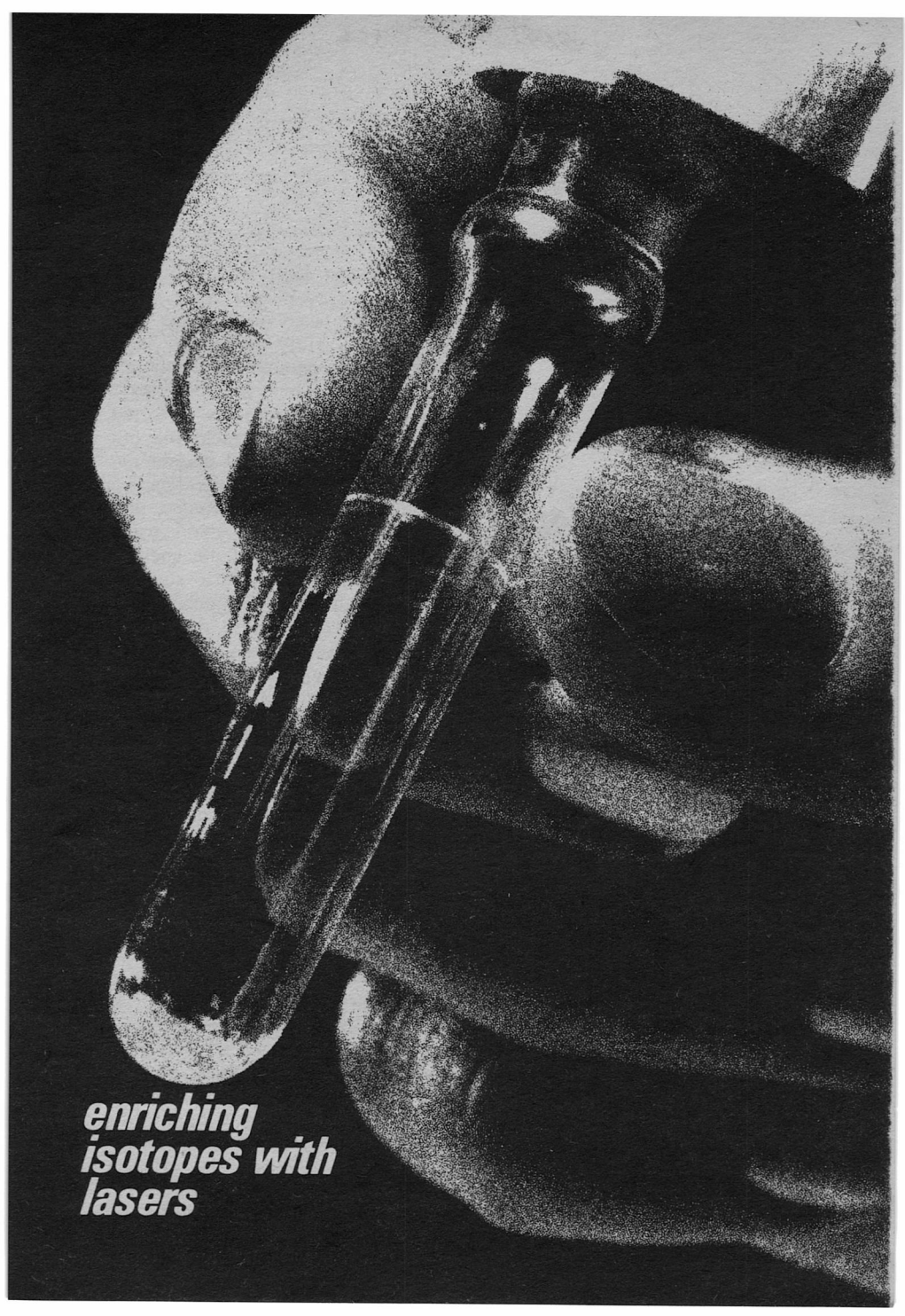
But we did knock out a typhoon . . . Moore was drifting in and out of a doze . . . *My tornadoes did that. Our tornadoes . . . We were the ones . . . to spin wind . . . Huh?*

Moore turned his eyes slowly, checking the mud-Marines, in a last, tired fulfillment of his responsibility. They were shapeless masses at their end of the carrier; blanketed bundles, turning dark with the wet; a boot or two glistening with moisture. But there wasn't a single M-16 exposed to the rain.

Moore smiled—he was bare seconds from deep sleep. Those four kids were huddled on a mobile weapons carrier that was designed to spin tornadoes . . . had just knocked out a typhoon. But they were keeping their weapons dry. *Marines.*

The wind cried around the helix, a moaning yell of frustration that drained down into Moore's sleep. He answered it defiantly, breasting the waves of fatigue with one last thought of pride.

Hell, yes! Marines! ■


enriching
isotopes with
lasers

The way to realize the real potential of nuclear energy depends on lasers. In fact, laser enrichment might be too good!

by Jeff Hecht

Since the first laser was built fifteen years ago, people have suggested using lasers to perform an incredible variety of tasks. Although the suggested applications greatly outnumber the practical ones, today lasers routinely perform such varied tasks as machining of tiny electronic parts and alignment of sewers. Meanwhile the search for new applications continues, including ways to aid in energy production. So far, most of the energy research money has gone to studies of the use of lasers in nuclear fusion. In the near future, however, the most important energy application of lasers may be in the production of the enriched uranium needed in most nuclear fission power plants.

Enrichment—increasing the concentration of one isotope in the uranium—is necessary because most reactors can't work with uranium containing the natural concentration of isotopes. Energy production in a nuclear reactor requires a chain reaction, in which certain atomic nuclei split, or fission, pro-

(on previous page)
There's about four milligrams (0.00014 ounce) of uranium in the bottom of this test tube; its uranium-235 content was enriched from 0.7% to 3% with 2 lasers in a series of experiments at the Lawrence Livermore Laboratory.

Jeff Hecht *is managing editor of* Laser Focus, *a trade magazine covering lasers and related technologies, and is a contributing editor to* Energy Research Reports, *a monthly newsletter. He graduated from Caltech in 1969 with a B.S. in electrical engineering.*

ducing neutrons which cause the fission of other atoms. Only one uranium isotope found in nature, uranium-235 (U-235), is fissionable, and only 0.7% of natural uranium is U-235. Practically all of the rest is unfissionable uranium-238 (U-238).*

Even though fission of a uranium-235 atom produces, on the average, two neutrons, in most reactors U-238 atoms and other materials absorb so many neutrons that a chain reaction cannot be sustained with only 0.7% U-235. To solve this problem, the concentration of U-235 must be enriched to 1% to 4%, with the enrichment required depending on the type of reactor. Even higher concentrations of fissionable isotopes are needed to make fission bombs.

The US government owns three enrichment plants, but even if they are expanded and their output stockpiled, by the mid-1980's they won't be able to supply the country's nuclear reactors with enriched uranium. Another enrichment plant could be built using the same technology as the existing plants, but it would cost $3 to $4 billion. Since the existing technology is inefficient as well as expensive, several other enrichment methods are being studied. Some of these techniques, such as the gas centrifuge, could be used to build an enrichment plant today. The laser technique is not yet at this stage, but it appears to offer higher efficiencies and greater cost reductions than possible with competing techniques, with prospects for lowering the cost of uranium enrichment to as little as 1% of the present cost.

Besides enriching uranium, the laser technique could be adapted to enrichment of isotopes of other elements. Enriching hydrogen isotopes, for example, could increase the economic attraction of a type of fission reactor that doesn't need enriched uranium. Further in the future and outside the scope of this article, isotope enrichment research could help develop techniques to control chemical reactions with lasers. And eventually lasers might enrich isotopes for fusion reactors.

** Uranium-238 can be converted to fissionable plutonium-239 if the nucleus absorbs a neutron, which happens on a small scale in all reactors. In theory this process could proceed efficiently and economically in reactors designed to produce or "breed" plutonium, but in practice building breeder reactors seems more difficult and expensive than was expected.*

The Trouble with Isotopes

The $3 to $4 billion cost of building another uranium-enrichment plant based on existing gaseous diffusion technology indicates how tricky and expensive isotope enrichment can be. The problem with isotopes is their very nature—differ-

ent isotopes of the same element have essentially the same chemical properties. Since the most effective way to separate substances is to use differences in their chemical properties, isotope enrichment* must rely on relatively inefficient techniques.

The most obvious difference between isotopes is their mass, and this is the property on which gaseous diffusion and most other isotope enrichment methods are based. Separation based on mass can work fairly well for an element like hydrogen, where the heavier deuterium (D or H-2) isotope has twice the mass of the lighter normal (H-1) isotope. The mass difference between uranium's 235 and 238 isotopes is only 1.3%, however, and if the atoms are in molecules the difference becomes smaller—only 0.86% for uranium hexafluoride (UF_6), the compound used in gaseous diffusion.

The technology for distinguishing between molecules with masses differing by less than 1% isn't very satisfactory, but it works. Gaseous diffusion relies on the velocity difference between molecules having different masses because they contain different isotopes. This velocity difference is small, and enrichment-per-stage of the multistage process is limited to the ratio of the velocities. For uranium hexafluoride this ratio is only 1.004—meaning that about 100 stages are needed to increase U-235 concentration from 0.7% to only 1%.

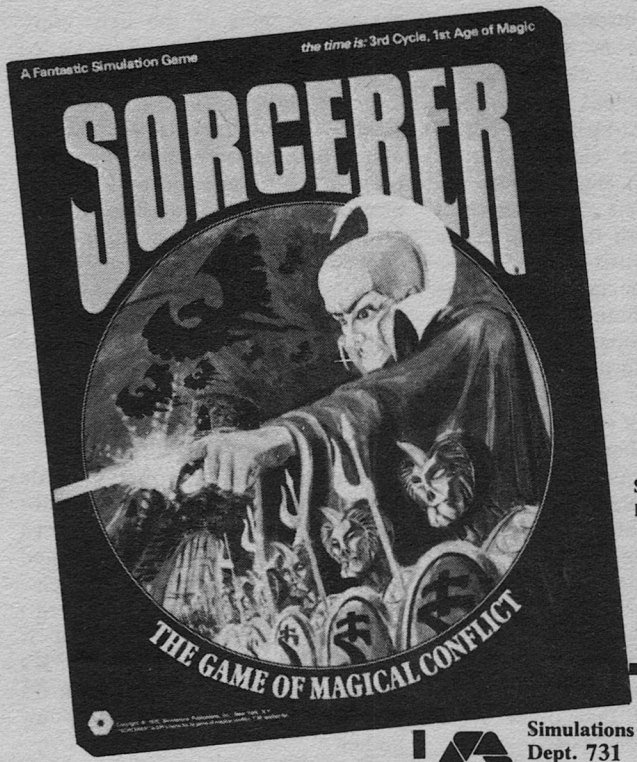
Besides hardware, gaseous diffusion requires expensive energy—three million electronvolts (MeV) per U-235 atom in the enriched uranium, so much that each enrichment plant needs its own power plant. Since fission of a U-235 atom yields about 200 MeV and about 60% of the fission energy is lost in converting to electricity, uranium enrichment alone consumes about 4% of the electrical energy available from the uranium. Gaseous diffusion also wastes material, since it can't extract U-235 after the isotope's concentration in the uranium has been reduced to 0.3%—meaning that about a third of the fissionable isotope in the original uranium winds up in wastes rather than the enriched uranium.

Most other processes being studied for uranium enrichment have the same basic problem—they have to make a very difficult distinction based on the small mass difference between isotopes. The laser technique relies on another difference between isotopes, the energies of electrons that surround the nucleus.

Energy Levels and Isotope Shift

One of the subtle differences between isotopes is in the energy levels of electrons, both in the atoms themselves and in molecules containing them. The rules of quantum mechanics say that electrons in a particular atom or molecule can have only certain amounts of energy; in other words, they can occupy only a limited number of en-

** The terms "isotope enrichment" and "isotope separation" are often used interchangeably, but the "separations" actually are enrichments of one isotope to high concentrations.*



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ergy levels. The strongest influence in determining what energy levels are allowable is the electric charge of the atomic nucleus (the number of protons or atomic number)—meaning that each element has its own unique set of electronic energy levels. Other effects also interact in complex ways with the electrons to change energy levels; two such influences are mass and spin of the atomic nucleus, both of which differ between isotopes of the same element. The effects are weak, so the differences in energy levels between isotopes are small.

Quantum mechanical rules also apply to vibration and rotation of atoms in molecules—meaning that molecules have vibrational and rotational energy levels. The energy involved is smaller than for electronic energy levels, but these levels still have their own isotope shifts. Although the following discussion centers on electronic energy levels, remember that other types of energy levels also exist.

The most readily observable manifestations of energy levels are the wavelengths at which atoms or molecules absorb or emit light. If an electron moves from a higher energy level to a lower one, it emits light; for an electron to move from a lower level to a higher one, it must absorb light. The wavelength of the photon absorbed or emitted depends on the energy difference between levels; since only certain energy levels are possible, light can be emitted or absorbed only at certain wavelengths. Differences in energy levels between isotopes cause differences in the wavelengths of the light emitted or absorbed, an effect called the isotope shift.

For isotope enrichment, absorption is the interesting process. When an electron absorbs light and moves to a higher energy level, the atom or molecule containing it goes into an "excited" state, with more energy than normal. This extra energy makes it easier for chemical reactions to occur. Lighting a gas stove with a match is an example of the same principle—at room temperature nothing happens until the match supplies the extra energy needed to start the reaction.

Thus in theory if you illuminate a substance with light that is absorbed by only one isotope, then find a way to isolate the excited atoms or molecules, you can perform an isotopically selective chemical reaction. Such a reaction is called photochemical because it's started by light. The problem in practice is to put the pieces together.

Photochemical enrichment of isotopes is not a new idea—experiments date back to about 1922. Early experimenters had little success, however, because they didn't have suitable light sources. The difference in absorption wavelengths of isotopes is small, and the sources of light then available generally emitted light in a band of wavelengths that included absorption lines of both isotopes. A few experiments did show enrichment of small quantities of isotopes, but these were more demonstrations of experimental ingenuity than of practical processes. What was

needed was a light source with a bandwidth narrow enough to resolve the isotope shift.

Enter the Laser

The stimulated emission of radiation in a laser amplifies light in a narrow band of wavelengths. The optics, the number of trips back and forth the light makes, the nature of the laser medium and other factors all combine to determine how narrow. Some lasers can simultaneously emit light at many wavelengths, but the ones useful for isotope enrichment can be adjusted to emit only at a very narrow band—narrow enough to excite one isotope but not excite others.

The laser wavelength also must match the absorption wavelength of the proper isotope. The output wavelength of any laser can be changed slightly and tuned across a small range, but usually this range is too small to be useful. There are a few lasers which can be tuned across a wide range of wavelengths while maintaining a narrow bandwidth. The most important of these tunable lasers is the dye laser, which is based on emission from a complex organic dye and has become a standard, albeit expensive, tool of spectroscopists since its development in 1966. It was development of the dye laser that began to make selective excitation with a laser look like a viable method to enrich isotopes.

The Isotope Separation Sweepstakes

Columbia University chemist Richard N. Zare called it "the great laser isotope separation sweepstakes," and it does take on aspects of a horse race at times, as researchers try to rush their discoveries into print before someone else discovers them. In other words, it's a healthy breakthrough in a fast-moving field.

So far lasers have been used to enrich isotopes of elements including hydrogen, boron, carbon, nitrogen, sulfur, chlorine, barium, bromine, krypton, tungsten, osmium and uranium. Many details vary, including laser and absorption wavelengths chosen, but these processes can be grouped into a few types:

- *Two-step photoionization:* a laser selectively excites one isotope, then a second light source provides additional light that ionizes only the excited atoms or molecules, which are then isolated by an electric field or a chemical reaction.
- *Two-step photodissociation:* a laser selectively excites molecules containing one isotope, then a second light source provides light with energy sufficient to break up (photodissociate) only the excited molecules.
- *Atomic-beam deflection:* a laser beam directed through a beam of atoms is absorbed by atoms of the desired isotope, transferring momentum to these atoms and pushing them out of the atomic beam.
- *Two-step photochemistry:* a laser selectively excites one isotope, providing enough energy for the excited atoms or molecules to engage in a chemical reaction that allows isolation of the desired isotope.

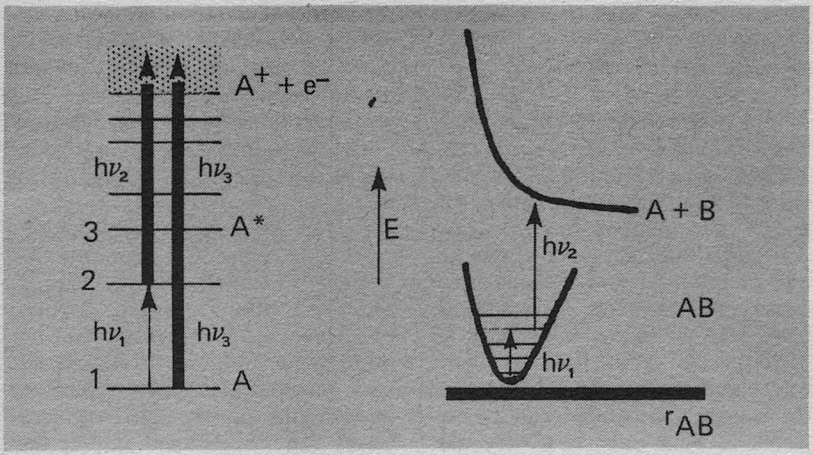

Fig. 1: *Operation of two isotope enrichment techniques is shown in these energy level diagrams. In two-step photoionization* at left *an atom A is selectively excited by light with energy $h\nu_1$, giving it enough energy to be ionized by a second photon with energy $h\nu_2$. An alternative is to use two photons with the same energy ($h\nu_3$), the first for selective excitation and the second for ionization. In two-step photoionization* at right *light with energy $h\nu_1$ selectively excites molecule AB, then a second photon with energy $h\nu_2$ provides enough energy to break apart the excited molecule. Energy in a molecule AB varies with the distance between the atoms, as shown in the curves; the extra energy supplied by the light gives the atoms enough energy to separate (forming A+B).*

• *Resonant dissociation:* a laser emitting high-intensity infrared light is tuned to a wavelength where a molecule has an isotopically selective absorption line (resonance) and focused on the gas, causing the molecules to absorb very large amounts of energy and break up. So much energy is absorbed that the molecule splits into several pieces rather than just losing a single atom or electron, as is the case in most isotope enrichment experiments. Details are not yet well understood, but this technique seems to offer the best hope for economical isotope enrichment.

Uranium and Secrecy

Because of its military and commercial significance, uranium enrichment has fallen under a cloak of government and industrial secrecy. This doesn't mean that the published research, which deals mainly with elements other than uranium, is just the tip of a top-secret iceberg. Much isotope enrichment research is intended to test processes rather than to demonstrate uranium enrichment, and for such tests other elements may be selected because they match the hardware, have well-known properties (e.g., absorption lines) or test a

particular aspect of the process.

Government secrecy requirements do mean that uranium enrichment processes being discussed openly probably won't work very well on an industrial scale. The most important such process that has been described is two-step photoionization of uranium vapor, first reported in 1971 at the Avco Everett Research Laboratory and later performed at the government's Lawrence Livermore Laboratory. One series of experiments at Livermore produced a few micrograms of enriched uranium.

At both laboratories, one laser's wavelength was tuned to an absorption line of uranium-235 and uranium vapor was evaporated through a slit. The laser selectively excited U-235 atoms, which were ionized by light from another source and collected with an elec-

LASER ENRICHMENT OF URANIUM

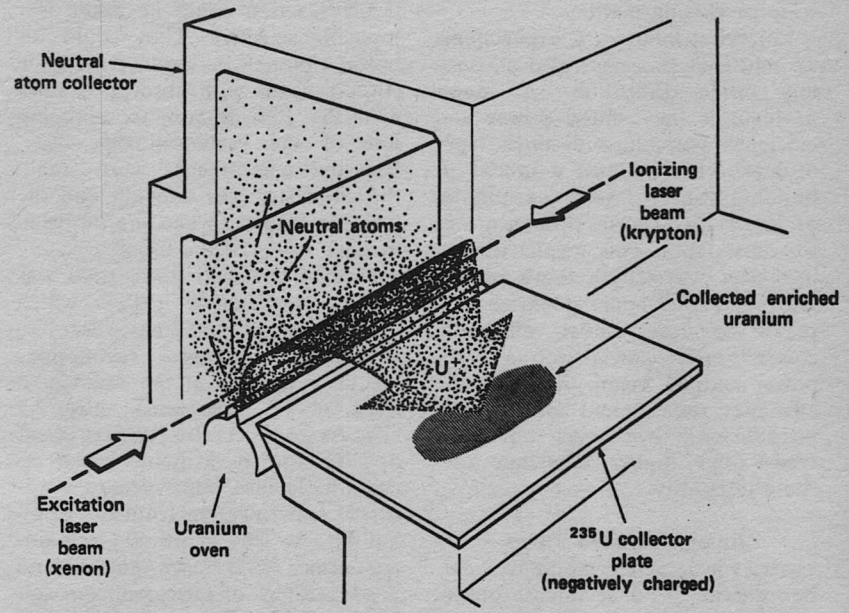

Fig. 2: *Uranium enrichment technique used at the Lawrence Livermore Laboratory. Uranium vapor evaporates from an oven and uranium-235 atoms are selectively excited by light from a xenon laser, then excited atoms are ionized by light from a krypton laser. Ionized atoms are attracted by a negatively charged collector plate; un-ionized atoms are collected by a separate plate.*

tric field. The apparatus used in one series of Livermore experiments is shown in Fig. 2.

The technique works, but it has problems, one of the biggest being uranium vapor. To get the vapor, you need temperatures above 2,000° Kelvin, which require expensive energy and hardware. At such temperatures, uranium vapor is very corrosive and does nasty things to that expensive hardware. Working with such materials is difficult enough in a carefully controlled laboratory environment; it would be even trickier in a full-scale processing plant.

Enlarging laboratory experiments to industrial processes also encounters other difficulties. A major problem is the limited power and efficiency possible with most types of lasers. It's not just a matter of building bigger lasers—the physics of lasers dictates an optimum size for most types. This means it's not just laser wavelength that's important for an economical enrichment plant—the laser must efficiently convert input power into a high-power output beam. Meeting the efficiency requirement may be impossible with dye lasers, but other types offer higher efficiency and some tunability.

Intense Infrared Fields

Lasers whose active medium is carbon dioxide produce intense output that is tunable across several bands near 10 micrometers in the far infrared.* Such lasers are relatively efficient and can be built large enough to emit very high-power beams, making them useful for material-working applications in industry. For similar reasons, carbon-dioxide lasers are used in many laboratories to produce very intense fields of infrared radiation.

Researchers studying effects of such high-intensity fields on gases observed visible emission when certain molecules were illuminated with a carbon-dioxide laser, indicating that chemical reactions were occurring. The next step was to tune the laser wavelength to see if the reaction could be made isotopically selective. They could for boron isotopes in boron trichloride (BCl_3), a gas with absorption lines near the 10.6 micrometer emission line of the carbon-dioxide laser. But the enrichments were small, the chemistry was difficult, and the isotopes tended to become unsorted in later stages of the process.

One of the next gases tried was sulfur hexafluoride (SF_6), which also has absorption lines near 10.6 micrometers. Tuning a carbon-dioxide laser to emit at the absorption lines of SF_6 containing sulfur-32, researchers at the Institute of Spectroscopy in Moscow broke up these molecules. This increased sulfur-34 concentration from the original 4.2% to 99% in the SF_6 remaining after 2,000 laser pulses, and produced tens of micrograms of sulfur-34. Sulfur-32 concentration decreased from 95% to less than 1%.

These are impressive results. Tens of micrograms may not sound like much, but it's far more than produced by laser techniques in

** Visible light has wavelengths of 0.4 to 0.75 micrometer.*

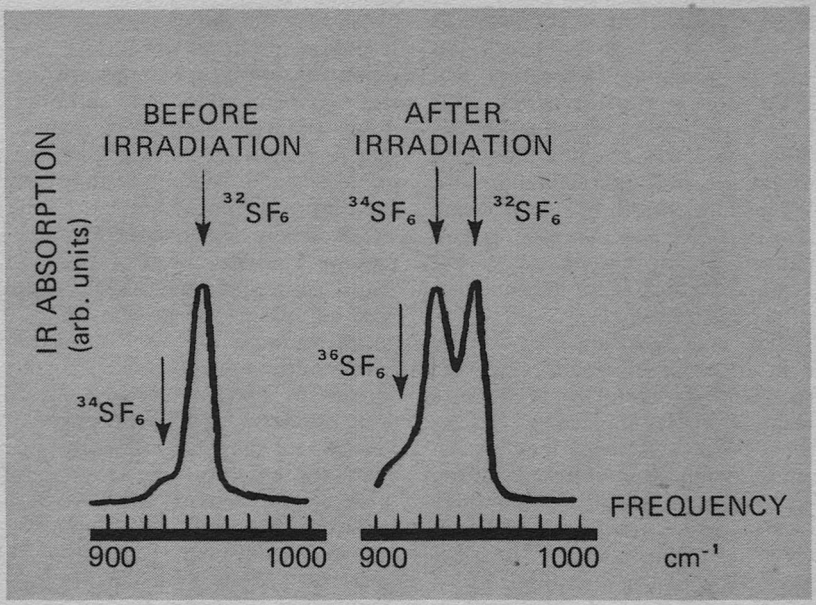

Fig. 3: *Absorption spectrum of SF_6 shows* at left *natural concentration of sulfur isotopes and* at right *isotope concentrations after enrichment experiments at the Institute of Spectroscopy in Moscow. Note that removal of sulfur-32 from the gas causes concentration of both sulfur-34 and sulfur-36 isotopes to increase. The vertical units are relative absorption and are proportional to isotope concentration. The horizontal units are inverse centimeters, which spectroscopists use to measure wavelength; they can be converted to wavelength by dividing into one. (One thousand inverse centimeters corresponds to a wavelength of 10 micrometers; 900 indicates 11.1 micrometers.)*

any other single isotope enrichment experiment. It took a series of experiments to produce *four milligrams* of enriched uranium at the Lawrence Livermore Lab, and that sample had uranium-235 concentration of only a few percent and contained eight times fewer atoms than would the same weight of sulfur because uranium has higher atomic weight. The sulfur enrichment is fast, too; Russian researchers R.V. Ambartzumian, Y.A. Gorokhov, V.S. Letokhov and G.N. Makarov enriched sulfur-34 concentration to about 47% in about a minute with 100 laser pulses.

Realizing the significance of their work, the Russian group took the unusual step of sending English translations of an article describing their experiments directly to several people in the US, thus ensuring them first place in this round of the

isotope enrichment sweepstakes. A group at the US government's Los Alamos Scientific Laboratory had been doing similar work, but hadn't tried sulfur hexafluoride because there was no indication they would get such spectacular results. When they heard of the Russian results, the Los Alamos group paused to kick themselves, but within 24 hours they, too, had enriched sulfur isotopes.

The high enrichments possible with SF_6 are fortuitous, but the resonant-dissociation technique seems broadly applicable. Besides the BCl_3 experiments, the Los Alamos group has enriched silicon isotopes in silicon tetrafluoride (SiF_4) and carbon isotopes in CF_2Cl_2. Meanwhile the Russians have enriched small amounts of osmium isotopes in osmium tetraoxide (OsO_4) gas, the first enrichments reported for heavy metal isotopes in a molecule with a laser technique.

Economics and Extensibility

Much remains to be understood about how the resonant-dissociation technique produces such large enrichments of sulfur—at this writing the experimenters are shooting down theories almost as fast as they're proposed. But the economics look good without waiting for the improvements that probably would follow understanding of the process. Paul Robinson of Los Alamos estimates that the energy used in the sulfur enrichment experiments costs 40¢ per gram of sulfur-34 produced. This corresponds to about 10,000 electronvolts per atom, 300 times less than needed for gaseous diffusion enrichment of uranium. Obviously there are other costs—the laser, the optical system and the chemicals, to name a few—but since sulfur-34 now costs about $1,000 per gram, there's lots of room left to play. There's room for improvement in energy utilization, too, since in theory laser isotope enrichment could require as little as 10 electronvolts per atom.

The next problem is extending the technique to uranium, which

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in times to come *Among the most-widely repeated canards about our field is that there are practically no women writing science fiction. Not true. Never has been, as a matter of fact. Next months' lead story, by Joan D. Vinge, is an excellent refutation of that falsehood. The novelet is titled, "Media Man," and it's a solid, sense-of-wonder tale with solid characters and enough adventure and suspense to satisfy any reader. Vincent Di Fate has turned out a knockout of a cover painting to go with it. (Now, why aren't there any women* illustrating *science fiction?)*

Thomas A. Easton's science fact article deals with the newest hot potato to hit biology, Edward O. Wilson's concept of Sociobiology.

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requires a uranium compound that is a gas near room temperature. A natural candidate is uranium hexafluoride (UF_6), used in gaseous diffusion plants, which has a structure similar to sulfur hexafluoride and becomes a gas at about 60° Centigrade.

It's not as simple as substituting UF_6 for SF_6 however, because the two molecules have different absorption wavelengths. What's needed is a laser that can deliver enough power for the process to work at a wavelength where UF_6 or another uranium compound has an absorption line with a suitable isotope shift. There are many possible laser transitions in the infrared, but producing high enough output power probably will be difficult. High enough intensities might be obtained with several lasers or by focusing large beams on a small area. A better understanding of the process might allow use of lower powers, or permit use of a second laser whose output didn't have to match the absorption wavelength.

A further extension of the technique might be to separation of the plutonium isotopes produced in nuclear reactors. Four isotopes are produced—plutonium-238, -239, -240 and -241—but only plutonium-239 is useful in reactors. Another isotope—plutonium-238, produced only in small quantities—is used in such small nuclear-powered equipment as heart pacemakers. The other two isotopes must be removed in reprocessing plutonium for reactors, since they are useless except for the fact that their presence in raw plutonium makes it difficult—but not impossible—to build bombs from the plutonium.

The problem of bombs is important because many countries say that they want nuclear power but mean that they want nuclear *bombs*. This may be the biggest drawback of the resonant-dissociation technique—it could make uranium enrichment too easy. Developing gaseous diffusion technology and building a gaseous diffusion plant would cost several billion dollars, if people with the necessary skills were available. It might cost a hundred times less—say $30 million—to build a laser enrichment plant, although the facility probably would be smaller than one based on gaseous diffusion. Development costs would have to be added, but the total might still be low enough to put enriched uranium—and fission bombs—into the reach of many more people.

Enriching Hydrogen Isotopes

Although the immediate goal of isotope enrichment research is uranium enrichment, a technique to enrich deuterium, the heavier stable isotope of hydrogen, could be more important in the long run. Deuterium would be essential for fusion reactors, and economical deuterium enrichment could help spur use of a fission reactor that uses deuterium-containing heavy water to avoid the need for enriched uranium.

In the heavy water reactor, offered commercially by Canada as the "Candu" reactor, heavy water is used as the moderating fluid

rather than normal water. Because deuterium absorbs fewer neutrons than normal hydrogen, a heavy water reactor can sustain a chain reaction in unenriched uranium, or even in fuel containing as much as 90% thorium. Because it can breed fissionable isotopes from thorium and uranium-238—uranium-233* and plutonium-239 respectively—the heavy water reactor can stretch out the fuel supply for fission reactors. Uranium-238 is about 140 times more abundant than uranium-235; thorium-232, the only isotope with a long enough lifetime to be found in nature, is about three times more common than uranium-238. Heavy water reactors don't produce as much fuel for other reactors as breeder reactors would, but heavy water reactors are operating reliably, while the fast-breeder program is plagued with delays, cost overruns and serious questions of safety and environmental impact.

A big problem with heavy water reactors is the limited supply and $50 per pound cost of heavy water. The cost doesn't sound bad compared with the $1,000 per gram price of sulfur-34 (which translates to about $450,000 per pound!), but the reactor needs one ton of heavy water per megawatt of electrical output—or about 500 tons ($50 million) for a modest 500-megawatt power plant. The supply problem is not a natural limit, since there are cubic miles of deuterium in the oceans; there just aren't enough plants producing heavy water.

** Uranium-233 decays much faster than uranium-235 and thus is not present in significant quantities in nature.*

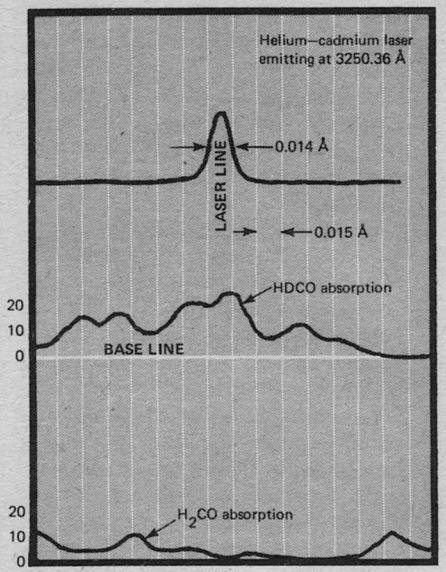


Fig. 4: *Profile of the 3250.36-angstrom emission line of a helium-cadmium laser* at top *is narrow enough to distinguish between absorption lines of formaldehyde molecules containing different hydrogen isotopes. The* middle *spectrum shows absorption of formaldehyde containing a single deuterium atom (HDCO); the* bottom *spectrum shows absorption of formaldehyde containing two normal hydrogen atoms (H_2CO). The vertical lines are only 0.015 angstrom (Å) apart and the entire spectrum is only 0.240 angstrom wide, much narrower than the range of wavelengths emitted by light sources other than lasers. This illustration was prepared by Jack Marling of the Lawrence Livermore Laboratory, who used the helium-cadmium laser to enrich deuterium isotopes in formaldehyde.*

Most of the expense of deuterium enrichment comes in the initial stages. Heavy water containing two deuterium atoms is 10% heavier than light water containing two normal hydrogen-1 atoms, making conventional separation techniques relatively easy if the initial concentration of deuterium is reasonable. The natural concentration of deuterium is 0.015%, however, and that isn't reasonable.

A laser technique to enrich deuterium probably would use the laser only to enrich the deuterium concentration in hydrogen to levels where techniques based on mass differences would work efficiently. Ideally the process should work on water molecules to avoid extra costs for chemical processing. The drop in the cost of heavy water probably would not be as great as that for enriched uranium—perhaps only to $10 per pound from the present $50. But that would be enough to reduce the cost of the entire Candu reactor by about 20%, making its initial cost about equal to that of a light water reactor. Since operating costs are lower and the fuel supply larger and less expensive for the heavy water reactor, such a cost cut could put the light water reactor in the background.

Even if construction of light water reactors slows down or stops, a market will remain for enriched uranium. Power plants cost too much to shut down just because you can build better ones. Thus laser techniques could end up enriching isotopes of hydrogen, uranium and plutonium for nuclear reactors. They could help in processing of nuclear wastes by isolating the radioactive isotopes present in such wastes, thus making storage of such wastes easier. And they could produce isotopes of other elements, too, although demand would probably remain small.

Isotope enrichment is only an example of the chemistry possible with lasers. Tuning a laser's wavelength to absorption lines of different substances should permit, for example, production of specific biochemicals. Another possibility is precise control of chemical processes by supplying just the right amount of energy needed to get a molecule to react in a certain way. Finding the proper match of laser emission and absorption lines may take a little time—now it's a rather unsystematic process. But research in chemistry, spectroscopy and lasers may make it simple to develop a laser to emit at a particular wavelength. Or new tunable lasers might provide the desired combination of wavelength and bandwidth when the proper dials are set. There's still lots left to explore.

Nuclear Safeguards

There are tradeoffs in cheaper isotope enrichment, however, and there's one we should start thinking about now—greater need to safeguard nuclear materials and agree on arms control. The basic technique now used to control the spread of nuclear weapons is to control the availability of fissionable materials. It isn't very hard to mine uranium or build a fission bomb, but it is hard to enrich natural uranium enough to use

it in a bomb. So the control of nuclear proliferation has relied on keeping weapons-grade enriched uranium (with higher U-235 concentration than reactor-grade uranium) out of the hands of potential bombmakers. Laser techniques could make it much easier and cheaper to enrich uranium—meaning that we need new safeguards.

The answer is not to forget about uranium enrichment and build heavy water reactors. Such reactors breed plutonium, which is perfectly adequate for a bomb. Even though heavy water reactors don't produce as much plutonium as breeders would, they produce enough. India built its atom bomb with plutonium refined from uranium used in a Candu reactor.

Classification of physical laws is not a viable approach either, although that won't stop the government from trying it. The current rule is that only three significant digits in the wavelengths of new lasers that might be useful in large-scale uranium enrichment are unclassified. It might take a few million dollars and several spectroscopists to find out that 16.1xxxx meant 16.13483, but it wouldn't require spies or access to classified information.

It is possible that laser-induced uranium enrichment might be more expensive or complex than expected. But hoping for technological failure is as futile as hoping that all would-be bombmakers are incompetent. We need a solution, not a way to hope that we can avoid having to find one. ■

analog

A Calendar of Upcoming Events

September 8-10, 1976:
CompCon Fall (IEEE Computer Society) at the Mayflower Hotel, Washington, DC. Info: Meetings Inquiries, IEEE, 345 East 47th Street, New York, NY 10017.

September 13-15, 1976:
Oceans-76 (Engineering in the Ocean Environment) at the Sheraton-Park, Washington, DC. Sponsored by the IEEE Council on Oceanic Engineering and the Marine Technology Society. Info: Mettings Inquiries, IEEE, 345 East 47th Street, New York, NY 10017.

September 15-17, 1976:
International Conference on the Stratosphere and Related Problems (NASA; Intl. Assn. of Met. and Atm Phys; AGU) at Logan, Utah. Info: W.T. Huntress, Jr., JPL, M/S 183-401, 4800 Oak Grove Drive, Pasadena, CA 91103.

September 24-26, 1976:
PgHLANGE VIII (Pittsburgh area SF Conference) at Viking Motel, Pittsburgh, Pa. Guest of Honor—Joe Haldeman. Registration $4 in advance; $5 at the door ($11 banquet and membership). Info: Barbara Geraud, 1202 Benedum Trees Bldg., Pittsburgh, PA 15222.

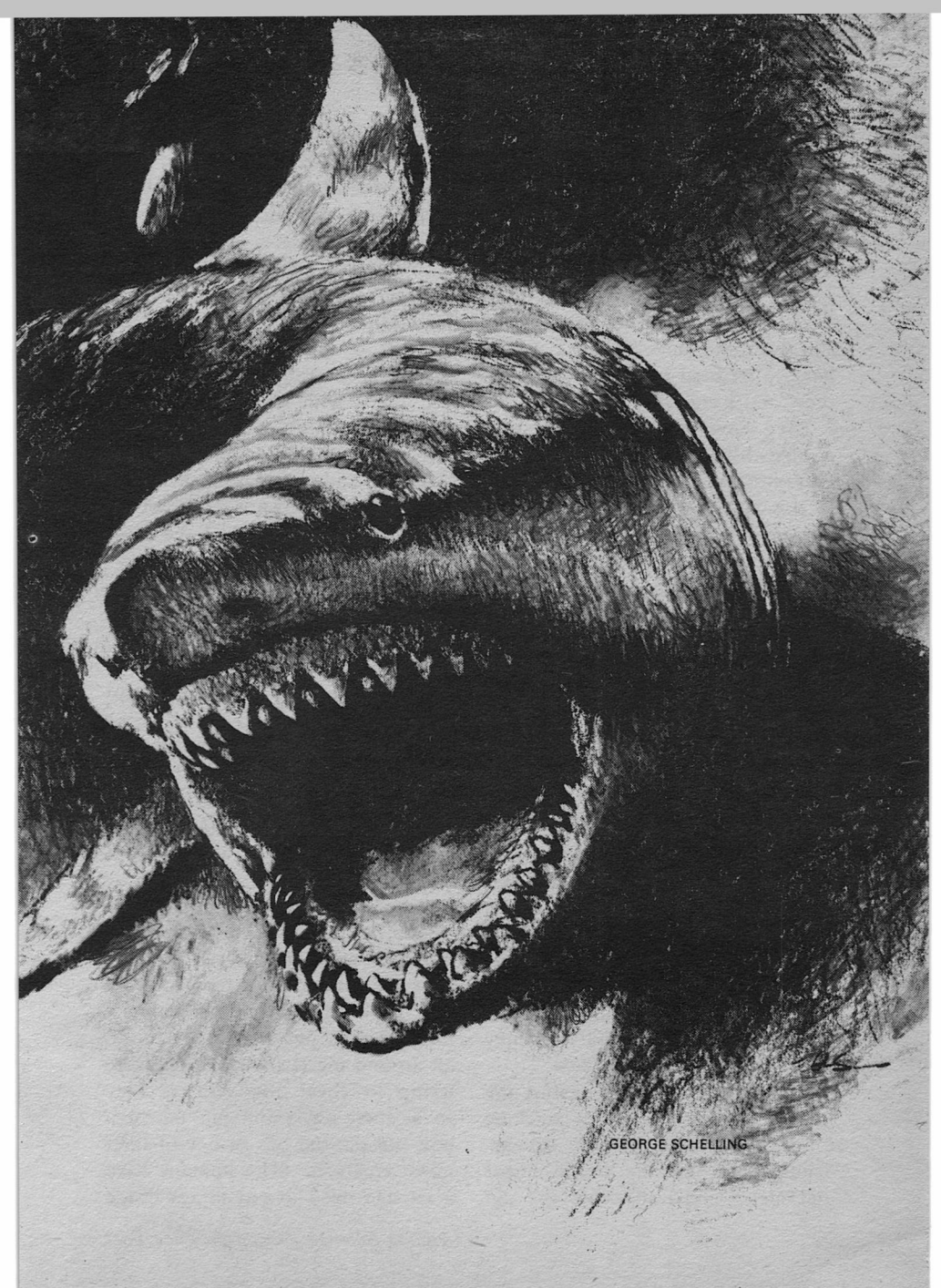
October 15, 1976:
Deadline for entries in the New England Science Fiction Association Third Annual SF Short Story Contest. Open to all non-professionals. Info: NESFA, Box G, MIT Branch Post Office, Cambridge, MA 02139.

September 1-6, 1977:
SUNCON (35th WORLD SCIENCE FICTION CONVENTION) at Miami Beach, Florida. Guest of Honor—Jack Williamson; Fan Guest of Honor—Bob Madle. Registration $7.50 attending; $5.00 supporting (subject to change). Info: Post Office Box 3427, Cherry Hill, NJ 08002. Speeches, panels, films, masquerade, presentation of the Hugos and the John W. Campbell Award for Best New Writer.

the end's beginning

If human slavery still exists, what about non-human slavery?

Vonda N. McIntyre



GEORGE SCHELLING

Through long captivity, I learned to mimic the humans' speech, but not to understand the thoughts behind it. How could anyone learn to understand the ways of those who spend their lives seeking such desperate independence? Though they have forced me to be like them, still I cannot understand. I would have to be mad to desire such solitude, and I am not yet mad.

They have made me mute and almost blind. They left me my eyes, but eyes are less than useless in this cold dark heavy sea. I still can taste and smell. Many different particles drift among the gentle salt flavor that encircles evolution: sharp diatoms, bright edible crustacean sparks (so welcome after many seasons obscured by battered chunks of fish-flesh sharp with ice), the bitter taint of the water that seeps from the humans' land (in the sea the great ones sing fading songs that tell of unfouled oceans, but the great ones are dying, murdered; their songs will die with them and no one will remember the taste of clean sea), and the gritty sediment washed toward me from a wide rain-swollen river. The sediment is what blinds my sight. The men have muted my voice so I cannot call for help, and thus they have almost blinded my ears.

No longer can I sing against the tides. The men attached a machine to me that emits an ugly squeak. Though the metallic sound mixes and melds erratically with the din that fills the ocean, it is sufficient for navigation (they tested this quite carefully). But the beauty is gone from my home. Even the stones are opaque.

I break the surface to breathe. It is dark, and the water sparkles in the moonlight. I slow to look around, for it has been a long time since I have seen the ocean or the sky. I rest with my back and eyes above the warm caressing water. But soon the men realize I have stopped, and they send a signal that forces me onward. I cannot resist it. I do not even have the satisfaction of trying, failing, to overcome pain. There is no pain, only compulsion as inescapable as the glass and concrete walls that held me prisoner.

While I was going nearly mad from solitude, I dreamed of being freed and swimming out into the wide sweet ocean. My mate would come with our people, and we would sing and leap and copulate and rejoice in my freedom. But I cannot call, I cannot sing. There is no freedom or rejoicing.

And my mate will never find me, but will wait and search in vain near the human-built prison where they kept me. No one could know that the men put wet smelly things all around me (I thought they were trying to cover my skin as they cover their own) and put me in a box and put the box in one of their metal creatures. (The humans have a terrible need to put things inside

things, to overcome the inevitable randomness of life. People know better.) The metal creature rose up in the air and took me from the Middle Ocean to the Wide Ocean, and that is where I am now, swimming along the sun's track to reach the Sunset Land. When I reach it, I will die.

My body has stopped aching from the way the men cut it. I am healed, but I still can feel the scar. The heavy weight of metal inside me disturbs my balance. They do not understand how much it hurts that I can no longer play. I cannot sing, I cannot leap. The men must have no art at all.

I hear the faint pulses of a whale's song, nearly obliterated by the harsh scream and chatter of the men's water machines. This song is fading and distorted; it has carried perhaps halfway across the Wide Ocean. It is useless for information, but it is an illusion of companionship. For the next few hours, whenever the cacophony becomes too painful or the single sound of my navigation device bores me to distraction, I will be able to seek and find the low long tones of the great one's singing. In other days it could have told its stories from halfway around the world.

Now when the great ones are not singing about the taste of the sea they sing of its sounds. A hundred years ago a song sung at midnight would reach a place in full daylight, though by the time the song traveled that far the destination would be in darkness and the source in day. The natural sounds of the sea were no impediment to the songs, which slipped through choruses of grunts and bubbles, splashes and cries, even the chatter of smaller people, my own kind. The whales were never parted from each other, no matter how far they separated. Now they are solitary, lonely creatures who cannot learn fear.

I swim, I swim. The men's signal will not let me rest. There is a schedule. Schedules are for men and machines, not for people. But now I am a machine, or little better. What else is a machine but a creature with no will?

The machine inside me is cold.

If I could find my people I could tell them—even mute, I could tell them by sight and motion—to stop me. Perhaps if they held me back long enough the humans would abandon me.

I might still have to die . . . but the men will kill me with the machine when I reach the end of my journey. Nothing would keep them from destroying me if I could not finish the mission. Destroying me would be safer for the men, who would think I had been captured by their enemies. If my kind stopped me and the machine exploded, I would not be the only one to die. So I must cease hoping to find anyone to help me.

I hear the low grumble of a

killer whale, a sound that is almost the only thing we ever feared. But it is not searching, simply lounging in the midnight sea. It must know I am here, but it is not hungry now. The men call it killer whale but that species has no taste for human flesh, only for small people.

I do not wish to do the men's will. If the loss were only my life I could accept it, I think, if there were any reason I could understand. But my life's end will be a signal for the men to begin killing each other. They no longer kill each other only. This time when they begin the killing they will kill the world as well.

They have been practicing destruction on pleasant southern islands. When they stop practicing they will send their machines to explode on the earth like storms, and the dust from them will spread over land and sea alike, poisoning everything. We who die quickly will be the fortunate ones.

If I could sing, I would taunt the killer whale and it would kill me. But I cannot attract its attention and the men will not let me deviate far enough from my path to tease it, nip its flanks, provoke it.

The men's command urges me on. I will tire sooner than I would have before I was imprisoned, but I have not yet reached my limits. The moon disappears behind a cloud and the sea turns black and bright in patches. The moon's light overpowered the glow of luminescent plankton, but in the darkness they stream in glimmering streaks against the water. I pass beneath them, swim up and leap through them. I fling drops of glowing spray in all directions. I come down flat, clumsily. I have forgotten my balance again.

I wonder if there are others like me, swimming toward the men's human enemies, trying to imagine the wish to kill a member of one's own species. Or am I the only one directed across the sunless sea? Have I the lonely duty of beginning the destruction?

If there are others, we all have similar fears. I wonder if any of us will be clever or lucky enough to discover a way to stop.

The clouds that covered the moon are thick and ominous. I can see the scatter of rain across the ocean's smooth swells. Now the rain is upon me, and I slow as much as I dare. I love to float just beneath the surface and feel the raindrops on my back.

Fresh and salt water mix in a delicious pattern of textures on my skin. But the effect only occurs when I lie still. The signal forces me to continue; the patterns disappear. I can feel only the seawater stroking my sides and back as I swim on.

A dull throb grows louder. It is the sound of a ship's engines, almost in my path. At first I cannot see it, but finally its lights appear on the horizon as I propel myself

toward it. Could this be my destination? I thought I was being sent to a harbor, so I had hoped for a few more hours of life.

Now I can see the ship clearly. It is a fishing boat.

Perhaps it will stop me. The humans' way to hunt fish is to find a place where people are feeding and herd us into their nets. The fish flee before us. We are a convenient marker, very useful to the humans, but when the nets close in there is no way for us to escape. We are captured and we drown. Many of us have been murdered this way; the men kill our youngest, those whose inexperience leaves them vulnerable to panic. The nets give a cruel death.

I swim straight at the trawler, staying near the surface. If the nets are out they are invisible at this distance; the men's sound-maker will not form a sensitive enough picture to show them to me.

How strange to think that men will prevent me from carrying out the task given me by other men.

I can smell and taste the cold metal hull and the hot-metal hot-oil of the propellers and engines. And now I can even hear the murky curtain of fish-nets, spread like great wings, sweeping the sea as they approach. I have avoided them so many times before . . .

In a few moments my life will end. My people may be safe for a short time after I die—yet I want to live. I must give up my life, but I will not do it happily, nor even bravely. The nets will close around me and panic with them, and I will thrash and struggle and silently cry out as the ropes and wires cut into me.

The nets are just above me. I touch them, and the hard mesh scrapes my skin.

Suddenly my body wrenches away, turning too swiftly, convulsed by the signal. Unwittingly I dive and turn, flee, circle the ship and fishing nets.

How can the men know so much about what is going on this far out in the ocean? Can they know where every ship is, and where each creature swims?

I move onward with powerful involuntary strokes of my tail, frightened to realize how close a control the men have over me, yet relieved to have even a few more minutes.

But there is no joy left in me. The men have given me a terrible gift that will be paid for in the lives of people. Even if the men do not begin to kill each other and the world because of my actions, if I finish this task all the air-breathers in the sea will be under more suspicion. Already the undersea machines kill us if we come too close. We have learned to avoid them, but we cannot avoid every human machine. There are too many of them, and our foolish young ones court pleasure and death riding their bow-waves.

The taste of land grows stronger

now, and the water is much shallower. The metal sounds that guide me echo loudly, quickly. The water is thick with the waste of humans and their creatures. People never visit this bay any more.

My whole body quivers with weariness and fear, driven onward. I am only a presence within it, able to guide myself around the worst islands of trash and poison, but little more. If I could shut off my hearing as I can close my eyes I would, and know nothing more until the end.

I am the only living creature in a desert world.

As I round a point of land the cry and groan of machinery washes over me, a wave of sound opposing the waves of the sea. I am swimming into a harbor full of ships and other things important to men. I surface, breathe the heavy air, listen to the air-borne sounds. The lights are bright before me.

I dive again. That is another compulsion the men have put into me, to stay beneath the surface as much as possible. They would have given me gills if they could.

This maze of shapes and echoes is not a place people would come of their own free will, though with my own voice I would not be so confused. Each note would tell me something new about my surroundings.

A shape is coming toward me.

These men have discovered me. They realize I am a creature of the other men, and they are sending a weapon to kill me. I surge forward, seeking to outrun it.

Of a sudden I cease fleeing. This is what I have sought: death by some other means than the plan of the men who captured me.

The shape comes closer and I swim as slowly as I am able. I do not want to die.

The shape does not move like a machine.

And now I can see it, through the darkness and the murk. This is no man-weapon.

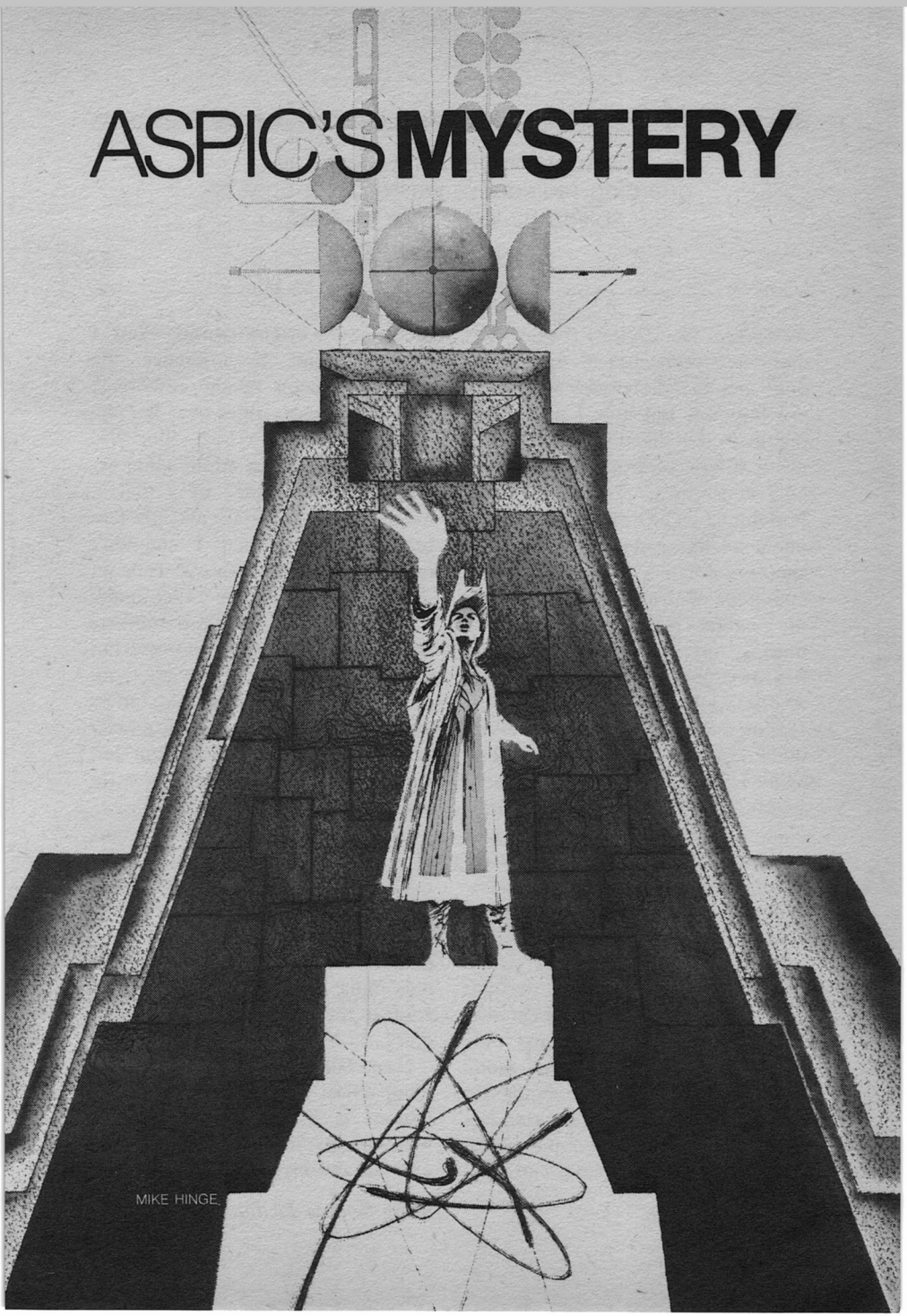
If I were free I could never swim so calmly onward, waiting for the shark. Its ancestors slaughtered mine when people decided to return to the sea. We in turn learned how to kill the only creatures we ever hated.

Better the killer whale, the nets, the weapons of men. I can smell the cold beast now. It will writhe in a frenzy at the first taste of my blood. It will kill me with whatever its tiny brain grasps as joy, for it knows my people are its only challenge in the sea. Except the men. And there is no defense for people or for sharks against the men.

The shark will stop me, but I cannot stop the men from killing themselves. When they have suicided, when their poisons have murdered all the people, the shark will remain, as it has remained for millions of years, as it will remain until the end of the world.

This is the end's beginning. ■

ASPIC'S MYSTERY



Long-term problems, such as guarding radioactive wastes, can only be solved by long-term answers.

ARSEN DARNAY

November 19, 2310. I began this diary five years ago to fight boredom and that loneliness which old age imposes. But now I note, musing over this sheaf of paper, that my writings constitute the first and only consecutive record of life in Plutonium. The realization came upon me like a flash just moments ago, and I felt a stir of excitement and hope which by rights belongs to younger men. I couldn't help musing, my eyes on the deserted Pilgrims' Camp far below, that this record might be used by someone else in some future effort to restore the Priesthood to its ancient glory. Needless to say, the record, as it stands, provides all too little information, and if I'm to achieve a posthumous "restoration," I'll have to augment my own narrow observations about the daily life of an aging archivist with some historical perspectives. Furthermore, I should quote the most pertinent portions of the Golden Age documentation in my possession. Then, and only then, a pious and energetic monk of the future might have enough to go on. I have in mind nothing less than reconstruction of Aspic's Mystery—however improbable and optimistic that might sound. And I have in mind, by inference, the proud expulsion of the revisionist rabble that today rules over the Order.

This project awes me to some extent. I am not much of a diarist, much less an historian, and my feebleness suggests that I shouldn't tackle what might turn out to be an arduous work. On the other hand, who among the surviving brothers has my skill and my resources? I'm afraid that none can do what I can do—although each of us old timers longs for the past and would gladly bring it back again. Thus I'm left with the duty, the obligation, to try my hand.

I shall start on the project tomorrow. By then I hope to be refreshed by communion with Godbod. Now the hunger gnaws me and the thought of prolonged labor makes me fearful. But I shall do one thing at once—give a general context thus far omitted from this diary.

I am Hamsters Dugout, a Plutonium Priest aged seventy-five. Plutonium is a monastic foundation with origins in the Golden Age—obscure and mysterious origins, as I

shall try to make plain. Our monastic fortress, a proud construction of seven pods, the highest (Vigilance) having eighteen levels, is situated near the settlement of Perpetual in Shashtuk Country or, as the Old Order would have called it, New Mexico. Today a mere five hundred brothers occupy a small portion of Plutonium, most of them of the revisionist persuasion, that is to say they believe in clothing Godbod round about with an abominable metal. Once this great foundation resounded with the sound of 5,000 monks, each of them a true believer, hungry and thirsty for Godbod's proximity, ever anxious to hold His Substance near. Only a handful of us still survive, and when we're gone the past will die forever—unless, as I pray and hope, a pious monk can be found who, reading this legacy, will set about to restore the past.

November 22, 2310. I have begun to do my research. Our origins are almost completely lost. What little I know of Plutonium's past comes in an ancient folder. The folder had been preserved in a very large Old Order box made of extremely thick metal. It has a door with a circular lock, but the lock has no provisions for a key. Marks on the outside reveal many attempts to get at the treasure within the box, all of them failures. In my day, however, rust had eaten through one of the walls, a fact that I discovered by accident some years ago. Several layers of wall had been eroded, and with a little help from an iron bar, I enlarged that opening enough to shine a light inside. Then, by a succession of peeks and groping reaches, I found and extracted the folder, the only item within. I tore the brittle paper as I pulled out the thing and, upon closer examination, found that it was a collection of papers.

More precisely put, it was a file of miscellany, a forgotten file, an occasional file. In other words, it appears to have been the record kept by a busy man who forgot its existence for long periods of time; or else it was a partial file containing only items of some special significance; or else a secret folder, with items of less sensitivity being stored elsewhere.

I characterize the file in such detail to indicate its limitations. It's not unlike a single bone of some fabulous creature—enough to hint that a beast once lived but not enough to say whether it flew or swam. Whatever the nature of the folder, it seems to have survived The Holocaustic War only because it had been kept inside its metal box. The box itself, according to a tradition passed down from archivist to archivist, had been found far from here, in a gully. Scavengers, apparently, had dragged it away and dropped it from a height, without success. It fell to me to extract the nut from its hard shell, some-

thing that now, in retrospect, I find luminous with hopeful significance.

November 25, 2310. This morning I rose long before dawn and tiptoed from my narrow nook filled with an intuition of impending success. The coiling hallways of Plutonium, the deserted chambers on both sides, reminded me how still it was. The fortress is an empty shell. When I came to the monastery, a mere boy of fifteen, this Holy Interface brimmed with life. I recall my first vision of the proud giant against the horizon, its seven pods reaching for the sky. Bright pennants cracked at pod tips. Smoke rose from the Pilgrims' Camp on the western frontage, the same one I can now survey from my narrow window. Long lines of peasants waited to deliver tithes at the Gift Corrals. I felt Godbod's ineffable presence and hurried toward the steaming moats, elated. I had found my paradise.

This morning Plutonium was empty and sad. Nevertheless, bent on my personal satisfaction, I was glad of it, glad that the revisionist rabble is so lazy, glad that they sleep late into the day. I hoped that I would reach my objective, and thanks to Godbod I finally did.

Last night, before the rabble had departed the caverns, I had surreptitiously stuffed a soot-darkened rag into the lock of the entry to Cavern A. This morning, to my endless delight, I found that the door had failed to lock, much as I had intended. It yielded to my old man's groaning push. I entered, looked about, a catch in my throat. From the walls glowed phosphorescent paint. The double row of familiar vats and tanks extended into deeper murk. The heat was exhilarating. I stood there thinking of the olden days when thousands filled these caverns every morning. I remembered the deep longing in the chants we used to low, the holy words spoken at the altar, the distribution of hot rocks which we'd hug and kiss before they were collected again, the joyful restoration of our happiness.

I was so lost in thought, a notion suddenly made me start. What if the rabble discovered my unauthorized visitation! They would drag me away and lecture me about my own good, about the New Theology. I quickly hid myself behind a tank and, like a child seeking its mother's safety, I embraced its girth. But this tank had already been encased in accordance with the heretical doctrine. The heavy, softish metal was cold. Godbod had been shrouded, and I felt nothing at all.

I moved deeper into the cavern, stealthily, on tiptoe. At last I found tanks, vats, and pits not yet covered by the Abomination. Godbod boiled and bubbled inside them, invisible to me but not intangible. The radiation penetrated my ancient skin and bones. I fell into a

trance-like exaltation that lasted for a timeless moment. I don't know how long I stood there. But suddenly the flicker of torches in motion brought me rudely back. I caught a glimpse of the revisionist rabble come to do its unholy work. The monks wore metal plates over chest, arms, and thighs. Their heads were stuck in oblong tubes pierced for eyes and mouth. They resembled ghosts and goblins. I hid myself until they passed, caught by a feeling of pity for these men who wished themselves protected from Godbod's touch—a touch I cannot taste enough. Then, reluctantly, I moved away.

Now I feel the wonderful contentment which comes from contact with Grace Divine. The biting hunger in my innards is satisfied. I can set to work with unwonted energy.

* * *

Today I wish to introduce the documents and to give a general summary of Plutonium's history. I shall begin with a note about language.

When in the year 2006 The Holocaustic War left earth empty and charred, filling the sky with dust that still obscures the sun, not everything was lost. I've been on fourteen excursions into the land as a sweeper, looking for hidden Godbod. And each time I have brought back some item of interest I'd found in now deserted ruins. One of these was a dictionary dated 1919. I have often wished that it had been a later edition. Then again I've blessed what treasure I had. Between the year 1919 and 2006 (much as between the latter and today), the meaning of many words had changed. This presents a problem in the interpretation of my documents, which I'll illustrate with a discussion of the word "brain."

In the 1970's, the period when my records begin, Old Order people evidently meant something other with that word than we do now. "Brain," to us, is the substance in the skull where thoughts are made. We share that interpretation with the people of 1919 but not with the people of the 1970's. I have sets of other writings, not related to the Priesthood, mere bits and snippets without much context, that mention such things as "brainwashing," "brain drain," and "brainstorm." I gather from this that to the men of the late 20th century "brain" stood for some kind of liquid, possibly a very large body of water, perhaps even the ocean which encircles earth (as hinted by the use of the word "storm"). But the meaning of that word did not stand still. It continued to evolve.

Thus, for instance, I found some years ago (or perhaps someone brought it to me, knowing my interest in antiquities) a narrow strip of paper not unlike some I have in the folder. The strip is dated 2005. Most of its contents deal with people or places called "China"

and "USSR," but there is a clear reference to "brain-missiles." Checking my 1919 dictionary, I've discovered that a missile is something thrown, flung, hurled. A *brain*-missile is quite incomprehensible to me and will remain so until fortune gives me a later dictionary, something I can barely hope to see at my advanced age.

This introduction will remind my future reader that much of what I have to say about the origins of Plutonium is based on my interpretation of texts that are hopelessly obscure. The texts extend in time from 1974 to 2006. And even if I had the complete file, I am afraid the language would remain a formidable hurdle. I am consoled by the hope that the pious monk for whose eyes this record is intended will have access to better works of reference, will understand the ancient documents more clearly than I, and will revise our history in light of new research.

* * *

The origins of the brotherhood must be sought in documents. It is my opinion that we began soon after 1974. By 2006 a tremendous store of Godbod had been accumulated at this site, suggesting a very large Priesthood and thousands upon thousands of yearly sweeps. Thirty-some-odd years are barely long enough to gather so much Grace. Therefore I am certain that the Priesthood began soon after the idea first surfaced in the first of the documents I shall present. From some date in the 1970's until this day, the brotherhood has existed with one brief hiatus, and because of that gap, no oral tradition exists to augment the fragments in my folder. The Holocaustic War seems to have scattered the brotherhood. But thanks to the unutterable mediations of Aspic's Mystery, monks congregated at this spot as if beckoned by an invisible finger. They set to work and built the current fortress over a period of a hundred years, raising its seven pods over the caverns where the Golden Age had hidden its stores of Godbod.

Aspic's Mystery was clearly the heart and center of our cult. Its development is Master Aspic's great contribution. Its destruction must be the cause for the steep decline in our numbers and the loss of our support.

The Mystery was destroyed forty years ago under puzzling circumstances which I hope to relate. At the time few of us understood how crucial Mystery was for our well-being. The effect of its obliteration wasn't felt for sixteen years. Then, suddenly, novices stopped coming to Plutonium.

I have spent much time pondering that fact. Nevertheless, I almost hesitate to offer the best explanation I have. Novices entered the monastery at age fifteen, more or less. If one adds another year, roughly, it might be concluded that men *conceived* before the destruc-

tion were still drawn to our gates. But men *conceived* thereafter no longer felt the urge. Such an explanation exceeds the bounds of belief. It would mean that a mystery could influence a man before his birth. Once I had thought that novices were brought to us by special radiations sent out by the Mystery, a kind of call. After it had been destroyed and novices still came, I changed my mind. But when they stopped coming after sixteen years, I fell to wondering again. Now, of course, it might be

November 26, 2310. I was interrupted yesterday by one of our younger monks. His entrance rattled me badly, I'm afraid, as witness that wild scratch mark and the unsightly blot of ink on the page. Visitors to my isolated nook are so rare, the sudden motion of someone behind me is enough to make me jump. I am extremely hard of hearing. Knocking on the door won't rouse me.

My visitor was a young revisionist, a bright-eyed enthusiast; I guessed at once that he had come to look at my picture books. These are items I found on my ninth sweep; they show scenes of the Golden Age and much exercise the younger monks. He shouted at me for a long time before I understood his real intent. (Visits embarrass me. I'm forced to squint at my guests, head inclined, a hand cupped behind my ear. I compulsively go "Eh? Eh?" when I don't understand. I know how ridiculous I must appear to them. Old age should have reconciled me to the ridicule I think I detect behind my back. But some things are never cured.)

At last I understood the monk. He wanted to borrow one of my books, the one with the buildings.

I shook my head with stern determination. The picture books had never—until yesterday—left my nook. But yesterday I loaned him the thickest and largest of my treasures. Seeing my initial refusal, he pulled from his pocket a small bottle filled with Godbod sludge wrapped in that abominable metal. No doubt he could see the light rise in my eye. I took the stuff and gave him the book. He left and I removed the metal, flung it with disgust across the room. I held in my hand one of those little containers we used to take on sweeps with us—unable, unlike this revisionist rabble, to leave Plutonium for any length of time without a bit of Godbod to satisfy our innate needs.

Now that bottle is safely lodged over my heart, beneath my fraying suit. I need no longer lurk about the caverns, hoping to find an open door. But I'll probably never see that book again.

After the monk left I gave myself over to the enjoyments of Godbod while my thoughts turned on the youth of today. They are

touched by a new, rebellious spirit. They claim that men have discovered again the "principles" that made Old Order mysteries work. This young man had recently returned from Californica with a report about a tower that touches the sky. He hasn't seen it with his eyes, but friends of friends report . . . ! Inside it, supposedly, mysteries hum and sing again. Whether the story is true or false, that Tower bends the minds of simple youths. They speak about a "resurrection." I agree with Jimsons Hare, another old man like myself. Hare believes we have degenerated. We are a mongrel breed and won't succeed in bringing back the Golden Age.

* * *

Today I shall copy the first set of documents. I have neglected this task too long already. The ancient pages are extremely brittle and faded. Some are broken along the places where they had been folded. Entire lines of writing are consequently illegible. Other pieces in the folder are written on paper so thin they remind me of the skin of onions. Unless I transfer the words, they will not last more than another year or two.

The first record consists of four large sheets and one small one. The small one (first of a series in the folder and unusually well preserved) was evidently used to transmit the others. All the items are held together by a small bit of bent metal. The large sheets are obliterated so that almost nothing is legible with the exception of two passages. One of the legible passages is underlined:

. . . long-lived. Strontium 90 and cesium 137 both have approximately 30-year half-lives; there is so much of them within . . . substance, plutonium 239 . . . fantastically long half-life . . . will have to be contained for at least 250,000 years . . .

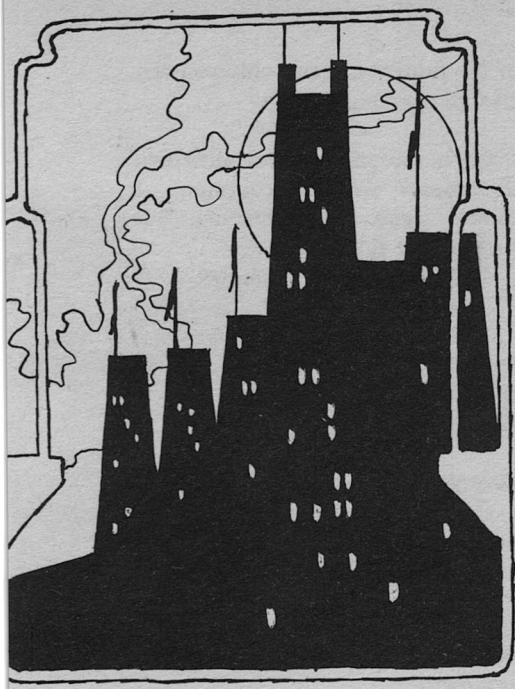
The second legible portion, slightly better than the first:

. . . question that intrigues . . . seriously proposed that society create a new kind of "priesthood" to watch over the waste, much as medieval monks watched over mankind's written history . . . somehow insulated from the rise and fall of nations through the centuries. Other scientists think the solution lies not so much in recruiting but . . . making a storage vault that . . .

Legible on the bottom of one of the pages, in handwriting, are the words "Dennis Farney, Smithsonian Magazine."

The smaller sheet transmitting the pages is headed by the words "Interoffice Memorandum" and "Future Now, Consultants in Science and Technology." The text is as follows:

Dear Teddy [Teddy is Theodore Aspic, our Master Aspic.] *Here's another one on rad waste disposal.*



Check that far-out notion on p. 24. Turn you on? Why don't you try to sell the idea to those dunderheads at AEC. Better yet, to that new Contingency Group at Commerce. If anyone can sell it, you can. Might be worth 100K in a feasibility study. I know it's nutty, but you ought to see this overhead. BJ 6/24/74

I shall have neither the time nor the energy to analyze each of these documents, line by line, as they deserve it. Rather, I shall leave that work to the monk of the future, who'll still have the youth I've spent. I shall make two points and let the matter rest.

It is clear from the above that in the year 1974 the words "plutonium" and "priesthood" were already linked in a "proposal" by "Scientists." Thus we can establish a point of origin for the Order.

Second, the "priesthood" would be created to watch over "waste." The use of that word is highly instructive. My dictionary defines waste as "refuse, offal, garbage, trash, unwanted residue"—the very opposite of that precious substance, Godbod. From this I infer that even in those ancient days men were jealous in the service of the Holy Interface. The word "waste" was clearly a code name to hide the real meaning from the uninitiated. This practice is carried forward and elaborated on in later records.

December 10, 2310. For a number of days I have been in the clutches of the revisionist rabble and couldn't return to these secret labors. My age would excuse me from work, but I consented to do the chores the Abbot thrust upon me. I exult in my little bottle and don't wish to draw undue attention to myself.

I have been drawing maps. The mongrel breed needs maps for an excursion.

In my day we went about the earth without such bits of paper. We knew where we were. We always knew Plutonium's position. The new monks know nothing

about that fire in the gut which gave us such a precise sense of orientation. These men could get lost. And to prevent such a deplorable situation, I have been scratching away with pen and brush.

I returned moments ago from the gates of God Pod where all of us had gathered to see the expedition off. Two weeks ago a monk returned after a two-year journey to the east. He had been sent to find more of that abominable metal my brethren use to hide Godbod. A good supply of the metal had been found near Plutonium buried underground, panels and sheets of it made in the Golden Age. But that store has been consumed. Now the monk brought news of ancient mines located in Mokan Country where the Miss-A-Sip flows. Fifty brothers left today to work the mines. They will stay in Mokan for some years, digging ore and smelting the metal. The Abbot plans to organize a transport column which will leave in the spring to bring the first yield of metal back. I wish him luck. The Order is dirt poor. We no longer hold the sons of Shashtuk Country in the ineffable thrall of Godbod. The tithes trickle, no longer flow. The Abbot will have trouble finding horses.

Drawing those maps has no doubt loaded me with sin. Indirectly I have helped the rabble after all. Will Godbod leave me now that I have lent a hand to the forging of His chains? Pious monk of the future, you and only you can cleanse my shame.

* * *

Let me resume by presenting two documents without comment. I cannot glean their meaning, but perhaps the future will:

June 19, 1975

Mr. John Clark, Chief
Contingency Planning Section
Office of Energy Analysis
Department of Commerce
Washington, D. C. 20419

Dear John:

I am pleased to submit herewith five (5) copies of our revised proposal titled "The Feasibility of a Permanent Hereditary (or Quasi-Hereditary) Cadre for Long-Term Institutional Supervision of Hi-Rad Wastes."

Please note the changes in the scope of work (and also on the general flow-diagram PERTing the tasks). We've overhauled the sections on Ritualistics and Ceremonial quite a bit. I know you still don't like the religious flavor of parts of this study, but frankly I cannot escape the thought that real permanence cannot be achieved without a little mumbo-jumbo. We cannot rely on good will and a sense of duty alone . . . however detestable, a kind of compulsion is nec . . . They should want *to be near the stuff, to seek it out . . . And . . . through.*

I, like you, would prefer some kind of mechanistic solution. I've considered the notion of robots, but

if this idea is ever going to be implemented, we can't wait . . . cybernetics . . . and hope the changes will go a long ways toward meeting your objections.

. . . would consider hiring a psychic, astrologer, or someone with that kind of background. Parapsychology, whatever you might think of it, is emerging as a potential tool. The Russians are said to be using . . .

The rest is missing, apparently because the paper tore at the crease. The next document, equally obscure, is one of those well-preserved pieces of "Interoffice Memorandum," although the message on this one is written by hand.

Teddy—Clark called me. Why me? Foaming at the mouth. Said you didn't change a goddamned thing. Wants me to know he resents the way you use political pressures to get this thing funded!!! Can you give him a call? Smooth the feathers? BJ

* * *

I shall pass over two other fragments that intervene between these and the next longer record. Both are narrow columns of printing on greyish paper with ragged edges. Only the bold lettering at the top is legible. The first one says: *ERDA SWALLOWS AEC; NEW AGENCY TO LEAD ON ENERGY.* The second: *DEMO BY INTERIOR WOULD DUMP A-WASTE ON RESERVATION.* In smaller letters: *Chief of Shashtuk Tribe to Appeal Decision.*

I cite the last item merely because it identifies Shashtuk Country, the first such mention in the documentary record. Before The Holocaustic War, as I've already stated, this region was called New Mexico. And the nearest settlement—now grown much smaller with the falling off of pilgrimages—had the name Perpetual. To my knowledge the term "Shashtuk Country" was never employed with reference to this area in the Golden Age—suggesting again that possibly a code was used, comprehensible to the Priesthood (or those engaged in planning its establishment) and no one else.

* * *

Dinner is behind me now, and I am back again. There is still light enough to write, if not to read. I shall spend my time describing Aspic's Mystery as it was in my day.

Before it was destroyed, the Mystery was housed beneath the roof of Vigilance Pod, the central and highest of Plutonium's seven. It was an aggregate of many smaller mysteries. The only visible portion consisted of four strange baskets of thin metal which were placed on the roof, one pointing in each direction of the sky. I had always thought that those strange dishes sent out those radiations I've mentioned before, that inaudible call youngsters in puberty felt as a hunger or a thirst in the gut.

Unlike my fellow brothers, I was

lifted up into the hierarchy at a relatively early age. From childhood on I have been blessed by skill in penmanship and letters, and when the Holy Writ, hung on chains in our prayer chambers, had begun to fade after the passage of centuries, I was set to work renewing the books.

Despite my status as a hierarch, I was never permitted to see the rest of the Mystery. Only the highest-ranking monks—the Abbot and his closest advisors—were permitted inside the rooms that housed it. Nevertheless, like any other brother, I sought to learn something about it. I questioned the plutojacks assigned to guard the access corridors, picked up this and that in conversation, listened to old men's speculations. Immediately before the vandalism took place, the brotherhood swarmed. We were trying to recover the Prophet (also called the "needle," "the talking Godbod," and other things besides). But after the failure of that expedition, we all came back again, and then I too joined the long snake of brothers shuffling forward slowly to see the destruction. But what I saw gave me no more information than I had heard in the past. The Agents of Damnation had smashed everything. Fire had done the rest.

The stories had it that the Mystery consisted of three rooms. Each room was named, as follows: Power, Signal Acquisition, and Conditioning. The monks used to talk mostly about Power. In that room, so the rumors went, was a dense mass of Godbod more powerful in its emanations than anything in our caverns. Only the Abbot could enter Power (or so the brothers speculated), and that explained why abbots had so brief a life. Godbod's love called them to an early bliss.

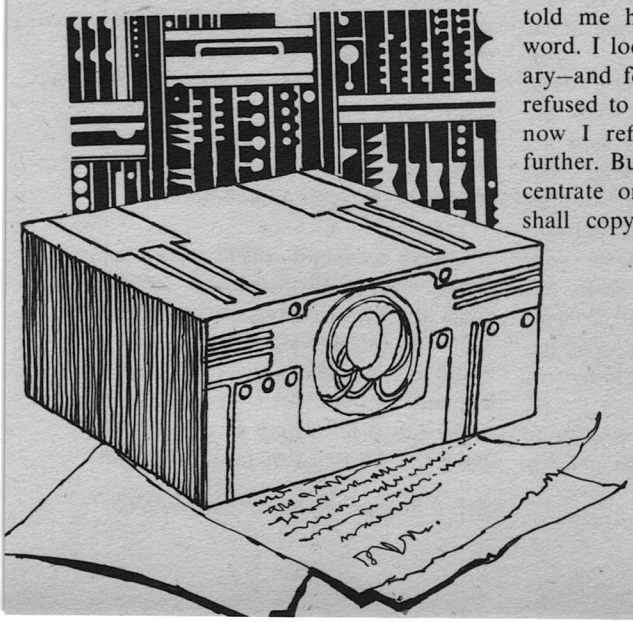
(Let me here inject a note on age. For reasons unknown to me, Godbod has neglected me—perhaps so that I might witness our fate and record it for posterity. In the old days few men survived their 30th year. I did—and it was my shame. Holy sickness has always passed me by. And to confound my miseries, I was never blessed with sores. I chafed under this cruel judgment so long now that it no longer hurts. I see it as part of His design.)

My own interest in Mystery centered on Signal Acquisition—perhaps because it was an open room with tables in the center and a wall on which lights glowed. A "signal" is a message. "Acquisition" means to get, obtain. What message was obtained in that odd room? What were those lights flickering behind tiny panes of glass? None of the brothers knew or cared. But I'm a

man with mystic leanings and drawn to the ineffable. The murkier the better. I would probably be disappointed if I learned the answer. Sometimes I think the quest is all.

I had hoped to record tonight all manner of stories about the Mystery. But the light is failing. I see the sun as a streak of rust on the horizon. The page is a dim grey beneath my hand. I can't go on although I've yet to describe Conditioning. Let me do that before I turn in: All the monks who claimed to know agreed that it was the smallest of the rooms and filled entirely by tightly coiled tubes. They resembled a nest of snakes. Opaque, silvery snakes, one on another, intertwined. "Conditioning" is not a word in my dictionary.

December 25, 2310. Birthday of Superstar. It is a sign of our declining power that this cult is spreading all over Shashtuk Country. It's a testimony of our dying shame that the Abbot and his revisionist rabble have consented to take part in the festivities now unfolding down below. The people have gathered despite the bone-chilling wind and the heavy drifts of snow. They trample all over the Pilgrims' Camp, or what is left of it. Several bonfires have been lit. And the Priesthood of Plutonium is down below serving hot wine from cauldrons. Jimsons Hare told me this morning over bread that our blessed Abbot hopes to win the people's favor by his heretical participation in the cult festival. He serves the peasants wine so that they'll lend him horses in the spring. *Lead.* That's the name of the heavy metal the Abbot wants to fetch from faraway Mokan. Hare told me he'd heard them use the word. I looked it up in my dictionary—and found it, to my surprise. I refused to join the celebration. And now I refuse to watch them any further. But I am too upset to concentrate on composition. Instead I shall copy some more documents



and comment on them later.

* * *

Trip Report
Organization: National Science Foundation, RANN Project
Date: February 19, 1976
Person(s) Visited: Dr. Nathaniel Wakethorn

Purpose of this trip was to get a reading from Nat on the Trans-biological Heredity Concept. I went with some trepidations, wondering how Nat would react to such a notion. He thinks Future Now *is filled with kooks, but it seems that since our success with synthetic neurons he has warmed up a little. Nevertheless, I expected him to go right through the roof if I so much as* whispered *the word "reincarnation" in those hallowed halls. So I approached the matter obliquely. Nat was a little puzzled at f . . .*

. . . totally unexpected reaction. Later, over lunch, he told me about his brother's death in a . . . last summer. (We worked with Fred Wakethorn when he was with the State of New York.) Nat told me about some "strange" things that had happened in the wake of that accident. (A fairly standard pattern: a medium, materializations, cold patches of air in his living room, etc. I sent a summary to Cam Templar to plug into the data bank.) The upshot is that Nat was not only . . . but also . . . suggestions.

. . . most notably the suggestion that we should explore the analogy of neutrinos. His idea is that failure to detect the "soul" may be a consequence of . . . of funding prospects. Which is extremely encouraging. The only string attached, if I read Nat right, is that we've got to plug in Professor Stump as a consultant. (Stump is at North Carolina, a physicist who's been bitten by the occult recently.)

My general assessment . . . as a subcontract.

T.J. Aspic III

I can't go on. They are singing down below, and the Priesthood is singing along. I can't hear them, of course, but I see their mouths opening and closing in concert. What has become of you, Plutonium!

December 26, 2310. The cursed festival continues, but fortunately it has moved out of sight. People and Priesthood have journeyed to Perpetual. Jimsons Hare tells me that three oxen will be roasted there tonight in honor of the Superstar. I shall have time and leisure to relate the story of Mystery's destruction. But first a brief comment about the foregoing document.

* * *

I have read and reread it several times. Among all the records left us from the Golden Age, this one excites and puzzles me most. I understand it less than many of the others, and yet, and yet . . .

To put it as simply as possible, I have the strongest of intuitions that

this "trip report" marks the start of Master Aspic's labors on the Mystery. I infer this from the phrase "trans-biological heredity." "Trans" means beyond. "Biological" means something that pertains to biology or the science of life. Hence the body? Heredity, of course, is a word we also use. But I am most interested in what "heredity" implies, namely the "getting," the "obtaining" of something from our parents. Getting, obtaining . . . ? Doesn't that suggest the phrase "Signal Acquisition?" I wonder. . . . But to translate: "Beyond-body acquisition?" What is acquired beyond the body? The love of Godbod's unutterable emanations? I leave it to you, monk of the future, to decipher this "signal."

As I will show later, there are other records which seem to be referring to the Mystery. One of them, for instance, mentions some strange object called a "psychotron," which might well have been a technical term or code word meaning the Mystery. Despite such other hints in my fragments, I continue to believe that the last document is the crucial one and holds the secret.

* * *

The Mystery's destruction was linked directly with one of the most glorious and yet most tragic episodes in the Order's history—discovery of the Prophet.

The Holocaustic War left behind it many a great crater, some filled with water, some of them dry. I have seen a good many myself. Monks who left the fortress on a sweep liked these huge concavities. Godbod's Spirit hovered over their waters or over their brittle, glassy dirt. Sometimes we found rocks that brimmed with His divine Life, and those we brought back to place in the caverns. Sometimes we found nothing. But craters were wonderful camping places nonetheless.

Forty years ago a group of sweepers saw a swampy lake in the distance somewhere in Texahoma. They discovered later that it wasn't a crater, but they went to its shores nevertheless, thinking it one. As they drew nearer, all of them felt that unspeakable tingling in the gut, and they covered the last stretch at a run. But in their feverish search around the lake's periphery, they discovered nothing at all. Godbod radiated his presence but couldn't be seen. At last the leader of the sweep pulled off his suit and jumped into the water. A growing excitement led him directly to the spot. Less than the width of a hand below the surface, resting on a hammock of swamp vegetation, lay the Prophet.

By any measure, it was the greatest and most miraculous discovery of Godbod ever made. I've never seen it with my eyes, but its image is imprinted on my brain as if I had been there myself.

The Prophet was long and slender—the length of four men laying head to foot, the thickness of two men standing back to back. It had a dull, silvery sheen, a tubular form, a pointed tip. All those who'd stood in its vicinity or had helped in its aborted trip home swore that some power oozed through its hull—a power stronger than any they'd ever felt before. But that was only part of the story.

The Prophet could speak. I don't know how it spoke—it had no mouth. But its voice was heard the moment they moved it. They moved it many weeks later when a large party from Plutonium had arrived at last with carts and oxen. Then it began to speak and held forth incessantly—but in a strange and frightening way . . . like old village women troubled in the head . . . like someone touched by fever. It also spoke with an oddly distorted inflection, like a stranger from the North who lives where the ice starts.

The Prophet has also puzzled me much, but on that subject I have reached a conclusion. Godbod Himself must have been inside that hull or, more precisely, Godbod's Spirit. His voice had warned of impending disaster. But no one listened to the Prophet. The Hierarchy gloried in the find. They went forth to get the needle shouting their luck to one and sundry, in every village and presidency along that way. It is no wonder, then, that disaster struck Plutonium and that our Abbot roasts oxen in Perpetual with devotees of Superstar.

I must defer relating those events. My inkwell is dry. I have an abundant supply of soot-black, but I can't get vinegar until they all return.

March 18, 2311. I have been ill—and gloriously happy. Godbod has heard me at last. Shortly after I made that last entry, a sore appeared above my eye, the left one, and spread to cover my forehead. Another sprang up on my wrist and ate its way forward to cover my fingers. I couldn't lift a pen. Now the sores have dried out, shriveled. But in my guts I feel the end approaching. I have little time left—but time enough, I think, to finish this labor. He has preserved me for this work. His finger has touched me, gently warning of the end. But He shall let me finish. I'm sure.

I must be quick and set to work. I must hurry and finish before the Abbot's men return with their cargo of abomination loaded on horses bought with heresy. I shall lay down on this cot and pass away to Godbod's bliss before that *lead* is mounted over every crack and fissure of Plutonium and His awesome emanations are bottled up forever. No! Not forever. Only until that pious monk, so rich in wisdom I don't possess, finds these pages and sets to work recreating Aspic's Mystery.

Now that I am in a hurry, I shall choose only four documents to copy before they disintegrate. I may not have time for more. Then I shall go on to finish the story of the Prophet, and how the Hierarchy's bragging brought about its loss. I should be done before the month has passed.

Here, first, another note from that unidentified BJ to Master Aspic. My file contains several more which I shall not copy. This is the last of the series:

Teddy—You've got to get to *someone in ERDA or DOD about Prof. Stump. I know* damn well *he deserves the Nobel Prize. But he'll just have to do without it. This stuff is dynamite. I know we're* legally *clean. You can't very well brainwash something that isn't there. Particle conditioning doesn't violate anybody's civil rights. But strict legality is one thing, public opinion another. If Stump writes up his findings, it won't be long before the cat's out of the bag. And this is no time to let cats out—the Chinese thing, all that. This is the worst possible time to inject an irrelevant issue into diplomatic discussions. Get someone to sit on Stump. He's got to keep his mouth shut. If DOD can't do it, I'll personally drown that s.o.b. in his bubble chamber or whatever the hell he uses. Please get on it right away. BJ 2/2/2004.*

I copy this "memorandum" because it contains the word "conditioning." It appears in this document and nowhere else. Yet I am certain that this word refers to one of the rooms in Mystery, the one with the coiling snakes.

Next comes a very puzzling, suggestive document. I have copied others of its type already: grey, narrow pieces of paper. But this one is affixed to the center of a larger sheet. It says:

Phoenix (AP). Chief Bull, leader of the Shashtuk Indians, accused federal officials here of operating what he dubbed a "spirit-catcher" at the nuke-waste complex near Perpetual, NM. Preston Richards, Regional ERDA Administrator, refused comment. An ERDA spokesman labelled Bull's charge "preposterous mysticism."

Next to the narrow strip of paper, written into the blank space by hand, is the following comment: "How the hell does *he* know!"

I think I know, vaguely, darkly, what Chief Bull might have had in mind with that phrase "spirit-catcher." It has the same ring, the same feeling, as "signal acquisition." Is spirit a signal? A message? Did Master Aspic's Mystery capture and record Godbod's voice, transmitting it to the pious? That might be an explanation. But the puzzle won't be solved until my future, pious monk understands the word "conditioning."

Finally, the last two items in my scant pile of papers from the past. These are two separate pages from a larger work the rest of which is

missing. Here we find a reference to a "psychotron," which I take to mean the Mystery.

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volunteers. The rooms used by the control group were carefully shielded to prevent entrance of all measurable electro- as well as psycho-magnetic radiation. Intercourse was achieved no more than once by each couple. Impregnation occurred in 85% of instances (236 incidents) where couples occupied unshielded cubicles (Blocks A, C, E, and G). The results are highly significant ($p < 3x10^{-9}$, i.e. odds against chance occurrence three thousand million to one). By contrast, couples in shielded cubicles (Blocks B, D, F, and H) achieved 2 impregnations during the entire course of the experiment, traceable to a shielding failure in Block E. Based on Schoenbaum and Bastur, a value of 12.9 impregnations had been predicted for both groups before experiments commenced.

Experimental results dealing with the origin of the psychons active in the impregnations are uncertain because tracking equipment between the psychotron and the cubicles malfunctioned during 17% of elapsed time. However, high probability exists that a preponderant number of the psychons originated in the psychotron.

DESCRIPTION OF THE PHYSICAL LAYOUT. All blocks were located in a circular pattern precisely 800m from the periphery of the psychotron. Those on the eastern periphery were equipped with special panels to

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were simultaneously monitored, with teams assigned to each operating room and intensive care unit within an 80km radius of the psychotron.

The results indicate a psychotron efficiency of 58%, i.e. the psychotron captured 58% of the psychons with masculine predisposition released by known incidents of mortality within a time-band of 19 min. following termination of vital functions.

March 30, 2311. Flames of insight have licked my feeble brain in the last few days. Now that I have strung them up like beads on a chain, these documents, together with my recollections, appear to give a new insight—an insight I've never had before—and still don't really have. It trembles on the edge of my awareness, almost . . . just almost. . . . But then it's gone again.

A warm wind blows outside. I have opened my window to feel the spring. Outside the world renews itself. Pregnant odors recall that sense of adventure we always felt this time of year, getting ready for the sweep. But the sweep itself is obsolete. Nowadays, alas, we sweep for *lead.* I am too old and feeble even to sit, much less to walk. But time runs out and I must finish.

* * *

I left the Prophet in its lake and

recalled the triumphal march to fetch, to get, obtain, acquire it. I said that the Hierarchy's braggery ultimately spelled our doom.

A future monk may find it difficult to understand how much things have changed in Plutonium. Today the Priesthood tells the people that it exists to serve *them.* The Abbot hasn't said it in so many words (perhaps in deference to old men like myself), but he has implied that the brotherhood exists to *protect* the people *from* Godbod! Blasphemies are piled on blasphemies. Those few novices who come to us come to serve "society." They flute in mellow tones about the "resurrection" and dream of towers in Californica. They lack all religious passion, fervor. Their eyes don't turn up in their sockets when Godbod's wondrous vibrations bite the bone. They are hollow men, mere wraiths compared to the giants of the past.

In the Prophet's day it was all different. We rode the peak of power. *We* served Godbod and the *people* served us. Most families hereabouts had sons in the fortress. We claimed one of two. And the people fed their own. Our reputation reached into all corners of the earth, and many presidencies were jealous of our might.

I well recall stories told by Master Nose. In my time he was the monk who interrogated new novices and returning sweepers, and he got his name because he had a "nose" for enemy agents. Nose told me that not a week passed without an attempt at penetration. The Agents of Damnation tried to enter this Holy Interface with theft in mind. No presidency worthy of the name could exist without its Godbod shrine, heavily guarded against monkish attack. And they sought us out looking for Substance.

(Most of those shrines, I'm happy to report, contained nothing more than lifeless rocks or, at best, a little bottle or two, of the type I treasure above my heart, taken from murdered sweepers.)

Against this background, it is understandable that the Hierarchy's triumphal march should have aroused the presidencies to action. Had our ranking monks been careful, had they brought the Prophet home beneath a cloak of secrecy, the Mystery might still be running beneath the roof of Vigilance. But it didn't turn out that way.

To this day it is not known who organized the armed attack on our caravan or how, simultaneously, the Agents of Damnation entered Plutonium right under the nose of Master Nose. But on that day of shame, July 31, 2271, two events occurred, no doubt carefully coordinated.

Despite the years, the scene is still fresh in my memories. It happened at bread time in the early morning. In those days we used to fill ten eating halls arranged around the girth of Vigilance Pod, and

even then there was no room for tables. We sat on narrow benches while monks passed up and down between us with baskets. Only the Abbot and his closest masters sat at a table on a platform in Sludgelove Hall. I was present at the time, munching bread and a piece of carrot. Voices rumbled in low contentment as we ate. We had just come from the caverns after morning service. Suddenly a man burst in. He was haggard and blood-stained. He ran between the monks and stopped at the Abbot's table. In the sudden hush the man's entry had occasioned, we saw him lean low over the table. The Abbot had inclined his head forward to hear the message. Then the Abbot lurched back in his seat, pale as a piece of paper. After a moment he turned to the Chief Theologian and whispered in his turn. Then all of them rose and left the table empty. They took the haggard man along.

We milled around, aroused, disturbed, for quite a spell. Then the danger-whistles blew, all of them at once, and in a body we ran—pushing, trampling, clawing our way—down to the caverns.

It happened while we were down there, listening to the Abbot. The Abbot told us how a mass of soldiers had overwhelmed our glorious caravan and had made off with the Prophet. We growled with rage down there while the Abbot further aroused our battle ardor with a proud harangue. Then we collected bits of Godbod and picked up clubs from the weapons room. Thus we swarmed out of Plutonium, prepared for war.

Meanwhile the Agents of Damnation were busy below the roof with ax and firebrand. They knew full well how we'd react to their treacherous deed.

We were less than an hour's march from the fortress when word came of the Mystery's destruction. The news went through our ranks like a knife. We continued on, urged forward by the Abbot, but the spirit had left us. We never caught the thieves. The Prophet disappeared. Years later I heard stories that it had been set up far to the north of here, where the ice starts, in a shrine where oracles are sold. I could never confirm the story, and by that time the brotherhood had begun its fast decline.

* * *

I feel myself close to the end. Moments ago I rose from my cot and stared out through my window at the landscape. It still has a wintry look, but deep in the earth one can almost sense the thundering rumble of new energies. Jimsons Hare tells me that a caravan of rabble is on its way back from Mokan Country bringing *lead.* To cover Godbod altogether. To shield the mongrels of this day of degeneration from His unmentionable touch. It is a caravan of shame. I hope to be with Godbod when it arrives. ■

JOHN SCHOENHERR

Part Two of Three Parts

shadrach in the furnace

George Bernard Shaw pointed out that a fanatic, who is willing to give his life for his cause, thinks nothing of giving your life for his cause.

by Robert Silverberg

SYNOPSIS

Shadrach Mordecai, born in Philadelphia in 1976, is thirty-six years old, tall, slender, agile, and black. His current place of residence is Ulan Bator, Mongolia, which in the year 2012 is the capital of the world. By profession he is a doctor. Shadrach Mordecai has just one patient: Genghis II Mao IV Khan, Prince of Princes, Chairman of the Permanent Revolutionary Committee, ruler of the earth.

Shadrach has been Genghis Mao's personal physician for several years. It is a taxing job, for the Chairman, a lean and charismatic Mongol, is a man of great age—some say 80, some say he's past 100—whose body, although amazingly tough and resilient, is a patchwork of artificial and transplanted organs that is constantly in need of surgery. Genghis Mao wishes not to die until his work of organizing mankind is complete, that is to say, never. In order better to look after his extraordinary patient, Shadrach has consented to have an array of subminiaturized sensors implanted in his body: they bring him a constant flow of telemetered data, minute-by-minute reports on the state of Genghis Mao's health. It is a taxing round-the-clock responsibility, but there are advantages. Shadrach, as a member of the elite surrounding the Khan Genghis Mao, is entitled to be treated with the Roncevic Antidote, which makes him immune to organ-rot, a loathsome disease that plagues the rest of the world's population—two billion survivors of the Virus War of the 1990's. It was the Virus War that let the organ-rot loose on the world, destroyed the traditional structures of government everywhere, and opened the way for the coming to power of Genghis Mao.

Another of Shadrach's responsibilities is to oversee the three projects by which Genghis Mao hopes ultimately to cheat death. The old warlord, a believer in redundancy as the main avenue of survival, knows that he can last only so long on constant organ transplants, and so he has established these parallel programs:

Project Phoenix, *which seeks a body-renewal technique that will allow rejuvenation of the living cellular matter of Genghis Mao. Its director is Irayne Sarafrazi, a Persian gerontologist.*

Project Talos, *which is attempting to develop a mechanical analog of Genghis Mao operated by a digitalized equivalent of the Khan's mental process. It is led by Katya Lindman, a somber and fiery woman with whom Shadrach is always uncomfortable, though he has had brief affairs with her.*

Project Avatar, *the goal of which is to perfect a personality-transfer*

technique that will permit the consciousness of Genghis Mao to be transplanted into another, younger body. In charge here is Nikki Crowfoot, a handsome woman of Amerindian ancestry. She and Shadrach are lovers.

Of the three projects, the one closest to success is Avatar. Preliminary experiments have worked well, and matters have gone so far that the future recipient of Genghis Mao's spirit has already been chosen. He is Mangu, Genghis Mao's young, athletic, amiable viceroy. This is a secret known only to a few, and known not at all to Mangu, who confidently expects to succeed Genghis Mao, and will, but not in the way he is expecting: the consciousness of the Avatar donor-body will be extinguished before Genghis Mao's mind is transplanted into it.

At the Grand Tower of the Khan, Genghis Mao's skyscraper headquarters, Shadrach and a team of surgeons perform a successful liver transplant on Genghis Mao on the morning of May 14, 2012. For relaxation afterward, he and Nikki Crowfoot go off to Karakorum, the pleasure-city of the ruling elite. There they indulge in transtemporalism, a popular cult of the day, a kind of drug-induced spell taking the participant into history. Shadrach finds himself witness to the eruption of Cotopaxi, an Ecuadorian volcano, whose spectacular explosion in 1991 served as symbolic herald of the apocalyptic war that destroyed civilization; Crowfoot experiences the burning of Joan of Arc. Afterward, still in the grip of his powerful experience, Shadrach is harangued by Roger Buckmaster, the microengineering expert who designed his telemetering implants. Buckmaster, evidently now in the grip of revolutionary urges, assails Shadrach for helping to prolong Genghis Mao's life, calling him a Judas. Shadrach, defending his role as the Khan's doctor, breaks free at last and returns to Ulan Bator.

Where he is awakened, the next morning, by a tremendous internal jolt: Genghis Mao's body is telemetering a furious alarm reaction. Rushing to the Khan's side, Shadrach discovers him surrounded by underlings and struggling against severe shock touched off by a surprising event. Mangu, Shadrach learns, has just fallen from his 75th-story bedroom window in the Grand Tower.

Or was he pushed? Genghis Mao, tense and trembling, is positive that the viceroy was assassinated and that Ulan Bator is honeycombed with conspirators out to get him next. Even as Shadrach struggles to restore the Khan's tranquility, Genghis Mao is ordering mass arrests, wholesale interrogations, tightened security measures.

After leaving Genghis Mao, Shadrach talks briefly with Avogadro, the cool, ironic security chief. Avogadro sees no way that assassins could have reached Mangu. It must have been suicide, he says. Nevertheless, Avogadro will follow orders: arrests will be made. In fact, within minutes the first suspect is taken into custody. He is Buckmaster, the microengineering man. Tapes of his inflammatory outburst at Karakorum have been recorded; his hostility to

Genghis Mao, so freely expressed, makes him a likely scapegoat for Mangu's death.

Shadrach is summoned by Avogadro to Buckmaster's interrogation. The Karakorum tape is played. Buckmaster agrees that he spoke out against Genghis Mao, but denies any connection with the supposed assassination of Mangu. Shadrach believes he is sincere. So does Avogadro; but Genghis Mao's wrath must be appeased. Shadrach's pleas on Buckmaster's behalf leave Avogadro unmoved. The interrogation ends. Buckmaster will be sent to the organ farms—where he will be dissected so that his organs will be available for transplant use. "Go and relax," Avogadro tells Shadrach. "I have work to do. I have a dozen more suspects to question before dinner."

"And the real murderer of Mangu—"

"Was Mangu himself, nine to one. What's that to me? I'll continue to find his killer and interrogate him and ship him to the organ farms until I'm told to stop. Go, now. Go. Go."

Part Two

Word circulates, the next day, that thirteen conspirators have been sent to the organ farms, including Roger Buckmaster, the ringleader. Such rumors generally have a way of being accurate, but Shadrach Mordecai, still finding the idea unpalatable, goes to the extent of keying into the master personnel register to find out where Buckmaster is. He tries the engineering department code, but is told by the master computer that Buckmaster has been reassigned to Department 111. Shadrach tries that code next, though he knows what it is likely to be, and yes, Department 111 is the euphemism for the organ farms. Buckmaster has joined the human stockpile. Spike through the foramen magnum, *zap.* Poor silly red-faced fool.

Dr. Mordecai chooses not to bring up the subject of Buckmaster when he pays his morning call on the Chairman. Buckmaster's fate seems beside the point now. "The conspiracy is crushed!" Genghis Mao declares vehemently as Shadrach enters. "The guilty have been punished. The threat to our regime has been met. The principles of centripetal depolarization will not be challenged." His eyes gleam with lunatic satisfaction. His ancient patchwork body throbs with triumphant good health, reverberating in Shadrach's implants as furious freshets of resurgent energy.

Shadrach takes blood samples, administers medicines, checks reflexes; the Khan pays no more heed to him than if he were an orderly changing the bed linens. He is altogether preoccupied, it appears, with his proliferating schemes for the deification of Mangu. Already blueprints for Mangu monuments have been drawn up, and they are spread everywhere in rustling heaps across the Chairman's bed, over his bony upjutting knees and on both sides of him and tumbling to the floor. Humming tunelessly, Genghis Mao turns the documents this way and

that, nodding, scribbling marginal notes, muttering private observations.

"Hah! I like this!" Genghis Mao exclaims sharply. "Patterned after the Great Pyramid of Gizeh, but twice the size, with statues of Mangu twenty meters high rising out of each of the four faces. What do you think?" He shoves the blueprint toward Mordecai. "It's Ionigylakis' idea. He's trying to improve on antiquity, like everyone else. How do you like it, Shadrach?"

"The statues, sir. They—ah—tend to break the line of the pyramid, wouldn't you say?"

"What's wrong with that?"

"Pyramids are so graceful," Shadrach says. "So compact."

"The original pyramid is an exhausted concept," the Chairman snaps. "What I like about this is the contrast in angles, the slope of the pyramid's face versus the upright statue working against it, do you see? Mangu rising upward, outward, away from the center—it's centripetal, Shadrach! Do you see?"

"Centrifugal, I'd say, sir."

Genghis Mao gapes as though his doctor has struck him. "Centrifugal? Centrifugal? Are you serious?" He breaks into frantic laughter. "A joke! My earnest Shadrach makes a joke! Tell me: do you think Mangu was in great pain?"

"He must have died instantly. I doubt that he was conscious as he fell. The acceleration—"

"Yes. Look at this one, will you? A helical spire, it says here, nine-hundred-meters high, a great metal coil through which a magnetic field flows, and a perpetual bolt of lightning flickering at the tip—"

"Sir, if you would, the tritetrazol injection—"

"Later, Shadrach."

"The absorption levels are already slightly above optimum. If I could have your arm—"

"—and here, yes, I like this. A giant sarcophagus of alabaster, inlaid with onyx—"

"—clench your fist, sir—"

"—build a tomb worthy of—"

"—if you'd hold your breath, count to five—"

"—a scale befitting Alexander the Great, Tut-ankh-Amen, even Genghis Khan himself. Yes, why not? Mangu—"

"—and relax now, sir—"

"—Ch'in Shih Huang Ti! There's our prototype! Do you know him, Shadrach?"

"Sir?"

"Ch'in Shih Huang Ti."

"I'm afraid I—"

"The First Emperor of China, the Unifier, the builder of the Great Wall. Do you know how they buried him?" Genghis Mao scrabbles through the documents on his bed and comes up with a sheaf of pale green printouts, which he brandishes wildly in Shadrach's face. "A great hill of sand, south of the River Wei, at the foot of Mount Li. Or was it Mount Wei, River Li? Wei. Li. In the mound a palace, and the palace contained a relief map of China modeled in bronze, depicting the rivers, mountains, valleys, plains. The Yangtze and the Huang Ho had channels four meters deep, filled with quicksilver. Models of cities and palaces along their banks, and a great

dome of bright copper overhead, yes, with the moon and the constellations engraved on it. The coffin of the First Emperor, then, floated on one of the quicksilver rivers, Shadrach! An endless journey across China. Silent, slippery—oh, bathe me in quicksilver, Shadrach, let me sleep on quicksilver! Do you see the coffin? And a powerful bow mounted at the coffin's side, ready to hurl an arrow at any intruder. Trapdoors and hidden knives waiting for the grave-robbers, too, and thunder-making machines—and hundreds of slaves and artisans buried in the mound with Ch'in Shih Huang Ti to serve him, yes. Grandeur! What do you think? Should I build this for Mangu?" The Khan blinks, frowns, moistens his lips. Shadrach Mordecai perceives changes in skin temperature and blood pressure. "On the other hand—if I build such a tomb for Mangu, what could I provide for myself? Surely I deserve something finer. But what—what—" Genghis Mao breaks into a broad grin. "There's time to plan it! Twenty, fifty years! Why should I think now of tombs for Genghis Mao? It's Mangu we bury. I'll give him the finest!" The old man pushes the blueprints into a heap. "Forty-one guilty conspirators to the organ farms so far, Shadrach."

"I had heard thirteen."

"Forty-one, and we're not finished. I've told Avogadro to bring in at least a hundred. Think of the livers going into storage! The kilometers of intestine. How beautiful the farms are, Shadrach. I hate waste of all kinds. You know that. To conserve. It's a kind of poetry. Forty-one more tanks filled. And the threat to the government is put down." Genghis Mao's voice grows dark, hollow. "But Mangu—what have they done to Mangu? My other self—my self-in-waiting—my prince, my viceroy—"

"Sir, perhaps you're becoming overexcited."

"I feel fine, Shadrach."

"But some rest—"

"Rest? I don't need to rest. I could get out of bed now and run from here to Karakorum. Rest, for what? Are you worried about me, Shadrach?" The Chairman's laughter bursts forth, booming, resonant. "I feel fine. Never better. Stop worrying. What an old woman you are, Shadrach. Are you a Christian?"

"Sir?" Shadrach says blankly.

"A Christian. A Christian. Do you accept the Only Begotten Son of God as your Savior? What? Can't you hear? The ears going bad? I'll ask Warhaftig to give you new eardrums. I asked you, Are you a Christian?"

Baffling. "Well—"

"You know. You know. Pater noster qui art in heaven. Ave Maria full of grace. Whoever eats my flesh and drinks my blood has life eternal, and I will raise him up on the last day, says the Lord. Yes? You know of this? Lamb of God you take away the sins of the world. Ite missa est. Well?"

"Well, my parents sometimes took me to church, but I can't really say that I—"

"Too bad. Not a believer?"

"In the narrow sense of the word, perhaps, but—"

"There's only one sense of the word, it seems to me."

"I don't think I'm a believer, then."

"Well, hallowed be thy name. Would you like to be Pope anyway?"

"Sir?"

"Is that all you can say? *Sir? Sir?"* Genghis Mao mimics his obsequiousness with devastating ferocity. The Khan's pulse is rising, his face is flushed. "The kingdom and the power. Oh, and the glory. You Christians, you understand. I am the way, the truth, and the life, says the Lord; no one comes to the Father, except through me." This manic volatility disturbs Dr. Mordecai, who surreptitiously boosts the Khan's tranquilizer intake, hitting the 9-pordenone pedal while pretending to examine the base of the life-support system. Genghis Mao, sitting up, shouting now, cries, "Answer yes, answer no, but no more sirs! Pope! I asked you, would you like to be Pope? The Pope is dead in Rome, old Benedict. The Cardinals will meet this summer. I am invited to offer a nominee. I'll send them the name of my doctor, my beautiful black doctor, yes? *Le Pape Noir. Il Papa Negro.* There have been black saints, why not a black Pope? Pick your own regnal name. It's one of the little dividends of the power and the glory. What do you say to Papa Legba? Eh? Eh?" Genghis Mao claps his hands. "Papa Legba! Papa Legba!"

The new liver, Shadrach thinks. Could it have been the liver of a madman?

He says mildly, "I'm not Roman Catholic, sir."

"You could become one. Is that so hard? A week of coaching and you'd know how to mumble the right words. *Kyrie eleison. Credo in unum deum. Om mani padme hum."*

There is something ominous in all this crazy talk of poping. Genghis Mao's lightning shifts of subject, his hectic flow of fantasies, his volcanic verbal outpour, do not inspire confidence in Genghis Mao's mental stability. This is the man who rules the world, Shadrach reflects. Such that it is.

Shadrach says, "If I became Pope, who would be your doctor?"

"Why, you would, Shadrach."

"From Rome?"

"We'd move the Vatican to Ulan Bator."

"Even so, I don't think I could do justice to both jobs, sir."

"A young man like you? Of course you could. What are you, thirty-five years old, thirty-eight, something like that? You'd be a splendid Pope. I'd become Catholic myself, and you could hear my confession. Don't refuse the offer, Shadrach. I think you don't have enough to do as things are now. You need distractions. You spend too much of your time doctoring me, because your days are otherwise idle. You fill me with needless medicines. Why are you staring at me like that?"

"I'd prefer not to become Pope, sir."

"Final decision?"

"Final."

"All right. I'll name Avogadro."

"At least he's Italian."

"You think I'm insane, Shadrach?"

"Sir, I think you're overtaxing yourself. I prescribe two hours of total rest. May I give you a sleep tab?"

"You may not. You may leave and amuse yourself in Karakorum. Gonchigdorge will be Pope, yes, a Mongol, do you like that? I like that. You, up there, sainted old Father Genghis, old Temujin, do you like that? Leave me, Shadrach. You annoy me today. *I am not insane.* I am not overtaxing myself. The death of Mangu distresses me. I grieve for Mangu. I will make the world remember Mangu forever. Forty-one to the farms, and it's only morning! Will you take yourself to Karakorum?"

The metabolic levels are rising on a dozen fronts. Shadrach is alarmed. He manipulates the tranquilizer pedal once again. The old man must be awash in 9-pordenone now, but somehow Genghis Mao overrides it, remaining in the manic mode despite the drug. It is at last taking effect, though. At last, some sign of calming. The Khan subsides. Shadrach departs, troubled, but confident that the Khan's temperament will stabilize for a time. As he goes out, Genghis Mao calls after him, "Or King of England! What do you say? There'll be a vacancy in Windsor soon!"

He goes to Karakorum with Katya Lindman. Ordinarily he spends his free evenings with Nikki Crowfoot, but not always; they are not husband and wife, there is no monogamy between them. He loves Crowfoot, or believes he does, which amounts to the same thing for him. But he has never been able to escape Lindman for long. Now she is in the ascendant, like baleful Saturn rising into the house of Aquarius. This night will be hers. Nikki is elsewhere, anyway, he knows not where; he is free, accessible, vulnerable.

"You'll do the dreams with me tonight?"

Why not? Her harsh forceful contralto has maimed his will. He shall allow himself finally to be indoctrinated into the mysteries of dream-death. Her dark eyes sparkle with savage succubal glee as he nods his agreement.

The dream-death pavilion is a wide many-poled tent, black cloth with trim of rusty orange stripes. Over its entrance is mounted a great jutting image of a ram's head, heavy, glowering, aggressive, spearing the chilly spring air with massive superprepotent coiled horns. Shadrach knows the ram is Amon-Re, lord of fear, king of the sun, patron of dream-death; for this cult is said to be derived from Pharaonic Egypt, secret rites never lost since first they were practiced along the shores of the sluggish, sweltering Nile in the time of the Fifth Dynasty. Within the tent, surprisingly, all is light. The place is ablaze with glowing fixtures from floor to ceiling—hanging lamps, floor-poles, spots, cascading lavalieres of radiance, so that the air burns with a numbing blue-white brightness and all shadows are obliterated. Shadrach, remembering

the murky atmosphere of the trans-temporalists' tent, is taken aback by this intense luminosity. But in the realm of Amon-Re a solar brilliance must prevail.

A costumed figure approaches, a slender Oriental female who wears nothing but a twist of white linen around her hips and a huge gilded lioness-mask that rests ponderously on her slim shoulders. Between her dainty breasts hangs a pendant, the crux ansata, in fiery gold. She does not speak; but with expressive gestures she leads Mordecai and Lindman through the crowded tent, past scores of sleepers who lie on fluffy mattresses of white cotton surrounded by high barriers of golden rope strung through ebony stanchions, to a vacant cubicle that is to be theirs. Within the ring of rope lie two thick mattresses side by side, a neatly folded dreaming-costume beside each one, and an ornate wooden trunk which, their guide indicates, is for their street-clothes. Katya immediately begins to strip, and Shadrach, after a moment, does the same. The guide stands aside, showing no interest in their nakedness. Shadrach feels foolish in his costume—a single handkerchief-sized square of linen to cover his loins and thighs, a beaded belt with which to fasten it around his hips, and two narrow strips of cloth, one green, one blue, which the guide helps him fasten crosswise over his chest.

Lindman dons a one-piece loincloth similar to his and a looped-cross pendant identical to the guide's. These enhance, rather than mask, her nakedness. As always, her body disturbs him, wide-hipped, heavy-rumped, a peasant-woman's body, the center of gravity quite low, the navel deep, hidden in smooth slabs of belly-fat, the breasts full and somewhat elongated. It is a strong and voluptuous body, powerful without being at all athletic, as exaggeratedly female as those primordial Venuses out of the Cro-Magnon caves. What bothers Shadrach most, he suspects, is the contrast between that robustly sexual earth-mother body and those thin, predatory lips, those sharp, threatening teeth. Katya's mouth is untrue to the archetype that the rest of her body projects, and that contradiction makes her a mystery to Shadrach. *Falsus in uno, falsus in omnibus*, perhaps.

The lioness-headed one invites them to kneel on their mattresses and hands each of them a polished metal talisman. It seems at first to be no more than a mirror, a bright blank planchet with quasi-Egyptian motifs around its rim, small engravings of the Horus-hawk, serpents, scorpions, scarabs, bees, the ibis of Thoth, interspersed with tiny portentous-looking hieroglyphs; but as he stares Shadrach begins to perceive a dizzying pattern of almost invisible dotted lines spiraling around the middle of the amulet; these lines, he realizes, may be seen only when the angle at which he holds the talisman in relation to a certain brilliant lamp over his head is just right; and, by moving the device ever so slightly, he can make the lines appear to move, to swirl in a counterclockwise eddy, to create a vortex—

—sucking him toward the center of the disk—

So they work by hypnotism here rather than by drugs, he thinks, feeling smug, scientific, Shadrach the scholar, the detached observer of all human phenomena, and then he feels an irresistible tug, he finds himself caught, drawn helplessly inward, a mere speck blown on the cosmic winds, a mote, a phantasm—

—one moment kneeling here admiring the cleverness of the mechanism and a moment later gripped, held, pulled, altogether incapable of objective considerations, *animula vagula blandula hospes comesque corporis*—

As he goes under, the priestess, for so he must think of her, begins a rhythmic chant, fragmentary and elusive, a mingling of English words and Mongol and bits of what might well be Pharaonic Egyptian, invocations of Set, Hathor, Isis, Anubis, Bast. Figures out of myth surround him in the sudden shadows, the hawk-headed god, the great jackal, the dog-faced ape, the vast clicking scarabaeus, desiccated deities exchanging knowing comments in opaque tongues, nodding, pointing. Here is Father Amon, bright as solar fire, turbulent as the skin of the sun, beckoning to him. Here is the beast with no face, radiating streams of starflame. Here is the dwarf-god, the buffoon, the protector of the dead, capering and guffawing. Here is the goddess with a woman's body and the heads of three snakes. The gods dance, laugh, pass water, spit, weep, clap hands. Still the priestess chants. Her words, chasing one another round and round, seize and control him. He can barely comprehend anything any longer, all structures having dissolved and become formless, but yet he is remotely aware that he is being programmed, being propelled, being given by this slim naked yellow girl who speaks in impassive sing-song certain attitudes toward death and life that will shape his experience in the hours just ahead. She has him, she leads him, she guides and aims him as he tosses on the eschatological breeze.

He is being pulled apart. Something is gently and painlessly severing him from himself. He has never felt anything like this before, not in the tent of the transtemporalists, not when taking any of the traditional psychedelics, not on kot, not on yipka: this is new, this is unique, a shedding of mass, a dropping away of the flesh, a liberation into weightlessness. He knows he is—

—dying?—

Yes, dying. That's the commodity offered here, death, the actual experience of departing from life, of having life depart from oneself. He can no longer feel his body. He is beyond all exterior sensation. This is the true death, that ultimate sundering toward which his life has moved throughout all its days, no simulation, no hypnotic trick, but real and actual death, the going-forth of Shadrach Mordecai. Of course, on a deeper level he knows it is only a dream, a night's amusement purchased for sport; but under that awareness lies the realization that he may be dreaming that

he is dreaming, dreaming the talisman and the tent and the lioness-girl, that he may really have fallen through the illusion of an illusion and really is dying here tonight. It does not matter.

How easy dying is! There is a cool moist gray mist about him, and everything dissolves in it, Anubis and Thoth, Katya and the priestess, the tent, the amulet, Shadrach himself, invaded and interpenetrated by the grayness until he is part of it. He floats toward the center of the void. Is this what Genghis Mao fears so much? To be a balloon and nothing but a balloon, so much helium surrounded by a nonexistent skin, to put aside all responsibility and, liberated wholly, to float and float? Genghis Mao is so *heavy*. He carries so much weight. It may be hard to relinquish that. Not for Shadrach. He passes through the center and emerges on the far side, congealing nicely out of the mist and resuming his human form. He is altogether naked now, not even a scrap at the waist. Katya, naked also, stands beside him. At their feet lie their discarded bodies, relaxed, limp, seemingly asleep, even giving the appearance of slow rhythmic breathing, but not so: they are actually dead, truly and really dead, Shadrach Mordecai beholds his own corpse.

"How quiet it is here," Katya says.

"And clean. They've washed the world for us."

"Where shall we go?"

"Anywhere."

"The circus? The bullfight? The marketplace? Anywhere?"

"Anywhere," Shadrach says. "Yes. Let's go anywhere."

Effortlessly they float into the world. The lioness waves farewell. The air is mild and balmy. The trees are in bloom, fire-flowers, little cups of flame sprouting at the tips of the branches; they break loose and drift down, swirl about, approach them, touch them, sink sweetly into their bodies. Shadrach watches the passage of a blazing red blossom through Katya's breastbone; it emerges between her shoulders, falls lightly to the ground, goes to seed, sprouts. A skinny sapling rises and bursts into flaming flower. They laugh like children. Together they stride across the continent. The sands of the Gobi sparkle. The Great Wall stretches before them, a wriggling stone serpent humping its back.

"Why, it's Nigger Jim and Little Nell!" cries Ch'in Shih Huang Ti, who stands atop the Wall. He does a little dance of joy, doffing his silken black skullcap, letting his long elaborate pigtails wave about.

"Chop-chop," Shadrach says. "Kung po chi ding!"

"Which way to the egress?" Katya asks.

"There," says the First Emperor. "Past the chains, over the spikes."

They go through the gate. On the far side of the Great Wall are flooded rice-paddies glittering in rosy sunlight. Women in black pajamas and broad coolie hats move slowly through ankle-deep water, stooping, planting, stooping, planting. Invisible chorus off screen. Swelling crescendo of celestial

sound. Katya scoops rich yellow mud and hurls it at him. Glop! He throws mud at her. Glip! They plaster each other with it and embrace, slippery and wriggling. What sweet slime! They laugh; they romp; they tumble and topple, landing in the rice-paddy with a splash, and the Chinese women dance around them. Huang! Ho! She reaches for him. They couple in the mud like rutting buffalos. Gripping one another, rolling over and over. Snorting. Slapping flesh. Wallowing in the primeval ooze. Very gratifying. Nostalgia for the mud.

They rise, bathe, move on to New York. A hot wind blows through this city of sky-stabbing towers. Confetti showers down upon them; it stings, it burns. Cheers of the inhabitants. Everyone has organ-rot here, but it is accepted, it causes no alarm. The bodies of the New Yorkers are transparent and Shadrach sees the red lesions within, the zones of corruption and decay, the eruptions and erosions and suppurations of intestines, lungs, vascular tissue, peritoneum, pericardium, spleen, liver, pancreas. The disease announces itself in radiating waves of low-spectrum electromagnetic pulsations, hammering dully at his soul, red red red. These people are full of holes from fetlock to gunwale and yet they are happy, as why should they not be? Shadrach and Katya do a buck-and-wing down Fifth Avenue. Shadrach's skin is white. His lips are thin. His hair is straight and long; it blows across his face, momentarily blinding him, and when he clears it he sees that Katya now is black. Flat broad-flanged nose, splendid steatopygous rump, yards of chocolate skin. Ruby lips, sweeter than wine.

They dance on swords. They dance on pineapples. He sells her into slavery and redeems her with his first-born.

"Are we dead?" he asks her. "Really and truly dead?"

"As doornails."

"Is it supposed to be this much fun?"

"Are you having fun?" she asks.

They are in Mexico. Frangipani, flamboyans. It is spring: the cacti are in bloom. Towering spiny green poles topped by crazy clusters of fragrant yellow petals. Loops and whorls of thorniness exploding in gaudy firecracker bursts of red and white. They sleepwalk through the prickly pears. They somnambulate among the pitahayas. The pace is frantic but restful. Often they make love. He could waltz all night. Crossing the Pyrenees, they meet Pancho Sanchez, squat and greasy, who offers them green wine out of a leather bota and giggles shrilly when they spill it on themselves. Katya gives him a merry shove and he somersaults into Andorra. They follow. Commemorative coins of high denomination are struck in their honor by the adoring populace. "I thought death would be more serious," Shadrach says.

"It is."

Dead, they can go anywhere, and they do. But the journey is an empty one and the food at the feast is mere spun air, less sweet than cotton candy. He wishes for

more substance and the servants bring him stones. He is black again, and so is Genghis Mao, enthroned in a seat of glistening jade ten meters overhead. Ficifolia is black, Buckmaster, Avogadro, Nikki Crowfoot; Mangu is the blackest of all; but the black of their skins is not Negro-black, not African-black, it is black-black, ebony-black, the color of a dark closet, the color of the air between the worlds. Black as the pit. They look like beings from some other galaxy. Shadrach goes among them, slapping palms, touching elbows. They speak nigger-Mongol to one another, they laugh and sing, they shuffle and shake. Ficifolia is on guitar, Buckmaster on jew's-harp, Avogadro on banjo; Shadrach plays the bongos, Katya the tambourine:

Drop your body off—Step outside your bones. So—easy to die—Such—a groovy trip—Man, man, man, man.

"It isn't really this good," Shadrach tells Katya. "We're fooling ourselves."

"It has its points."

"I can't help feeling suspicious," he says.

"Even dead you can't really let yourself go, can you?" She takes him by the wrist and pulls him along with her, through a desert of sparkling sands, through a river of leaping white water, through a thicket of dense aromatic brambles, into the ocean, the great salty mother, and they lie on their backs, looking up into the sun. He is utterly becalmed.

"How long does it go on?" he asks.

"Forever."

"When does it end?"

"It doesn't."

"Really?"

"Nature of the state. Death is nothing but a continuation of life by different means."

"I don't believe it. *Dopo la morte, nulla.*"

"Then where are we now?"

"Dreaming," he says.

"Sharing the same dream? Don't be a fool."

The snouts of sharks poke through the gentle surface of the sea. Toothy jaws gape. Shadrach practices fearlessness. These beasts can do him no harm. He is, after all, dead. He is also a doctor of medicine. He gulps ocean until the shining sandy floor is laid bare and the sharks, beached, morosely flop about, munching on crabs and starfish. Shadrach laughs. Death is real, death is earnest! Out of the north come frosty winds, roaring down the flanks of the Himalayas. Indefatigably they continue the ascent of the North Cwm, clawing up the rocky face piton by piton, staring constantly at the formidable tapering peak rising like a giant whelk at the head of the valley. They shiver in their parkas; they clutch their ice-axes with weary hands; their oxygen tanks press inexorably against their aching shoulders; and still they climb, now into that giddy realm above 7000 meters, where only the splay-footed snowmen dare to go. The summit is in sight. Vast crevasses loom, but they have no meaning; where crampons and

pitons will not serve, Shadrach and Katya simply launch themselves into great sky-spanning leaps. It is too easy. He had not thought death to be so frivolous a place. Indeed now the sky is darkening, the pace is slowing; he hears solemn music, he experiences a lessening of the frenetic urges that have driven him thus far, he settles into a glacial calm, an Egyptian timelessness. He is one with Ptah and Osiris. He is a twanging Memnon beside the mighty river, waiting out the eons. Katya winks at him and he scowls his disapproval. Death is serious business, not a holiday. Ah, yes, now he has it, the proper pace. He is wholly absorbed by the task of being dead. He does not move. Vital signs nil; intellection nil; he has reached the core of the event. *Hic jacet. Nascentes morimur, finisque ab origine pendet. Mors omnia solvit.* Let there be trombones, please. *Missa pro defunctis. Requiem aeternam dona eis, Domine.* It is very quiet here. When they speak at all, they speak in Sanskrit, Aramaic, Sumerian, or, of course, Latin. Thoth himself speaks Latin. Doubtless other tongues too, but the gods themselves have whims. How sweet it is to be immobile and to think, if at all, only in languages one no longer understands! *Nullum est jam dictum quod non dictum est prius.* What a good sound that has! If you would, a little more volume on the basset-horns:

Dies irae, dies illa • Solvet saeclum in favilla • Teste David cum Sybilla.

Gradually the voices diminish. The music becomes subdued and abstract as it fades; the sound of the instruments now is hollow, a mere outline of sound, blank within, the idea of sound rather than sound itself, and the chorus, far away, sings the terrible words of the ancient prayer in a faint, chittering, rustling, elegant tone, poignant and penetrating:

Quantus tremor est futurus
Quando Judex est venturus
Cuncta stricte discussurus

And then all is silent. Now he is at peace. He has reached the essence of the dream-death, an end to striving, an end to seeking. The chase is over. He could go, if he wished, to Bangkok, Addis Ababa, San Francisco, Baghdad, Jerusalem, traveling with no more effort than it takes to blink an eye, but there is no reason to go anywhere, for all places have become one, and it is better to remain here, at the still point, motionless, swaddled in the soft sweet woolly fleece of the grave. *Consummatum est.* He is in perfect equilibrium. He is finally, truly dead. He knows he will sleep forever.

Instantly he wakes. His mind is clear, tingling, painfully alert. Katya lies not far away, propped up on her elbows, watching him. Her smile is sphinxlike. He sees her broad fleshy bare back, and instantly the tranquility of dream-death is gone; lust rules him. "Let's go," he says hoarsely.

"All right."

"It isn't far to the lovers' hospice."

"No. Not there." She has already begun to dress. The lioness-guide is across the aisle, greeting new-

comers. The brightness of the air leaves Shadrach dazzled. Anubis and Thoth still lurk somewhere nearby, he is convinced. He struggles to regain that vanished equilibrium, to find his way back to the still point, but he knows it will take many more dream-death sessions before he can reach that calm place on his own.

"Where?" he says.

"At the Tower. I hate making love in rented rooms. Didn't you know that?"

So he must stifle his longings another hour or two. Perhaps that's the lesson of dream-death: delay gratification, purify the spirit. Or perhaps not. It is a jolt, stepping from the radiant ambiance of the dream-death tent to the darkness without, and the night is cold, very cold even for the Mongolian May, just a hint of snow in the air, a few hard little flakes whipping on the breeze. Riding the tube-train back they say almost nothing to each other, but as they come into the Ulan Bator station he says, "Were you really there?"

"In your dream?"

"Yes. When we met Pancho Sanchez. And the First Emperor. And when we went to Mexico."

"That was your dream," she says. "I was having other dreams."

"Oh. Oh. I wondered. It seemed very real, talking to you, having you beside me."

"The dreams always seem that way."

"But I'm surprised at how playful it was. Frivolous, even."

"Is that how it was for you?"

"Until the end," he says. "It got solemn then. When things grew calm. But before then—"

"Frivolous?"

"Very frivolous, Katya."

"For me it was solemn all the time. A great quietness."

"Is it different for everybody?"

"Of course," she says. "What did you think?"

"Oh."

"You thought, when you met me in your dream, that I was actually there, talking with you, sharing your experiences?"

"I confess that I did."

"No. I wasn't there."

"No. I suppose not." He laughs. "All right. I wasn't thinking. For you it was somber. For me it was all games. What does that say about you, about me?"

"Nothing, Shadrach."

"Really?"

"Nothing at all."

"We don't express something about our inner-selves in the dreams we choose for ourselves?"

"No," she says.

"How can you be so sure?"

"The dreams are chosen for us. By a stranger. I don't know more than that, but the woman in the mask told us what to dream. The broad outlines. The tone."

"And we have no choice about the content?"

"Some. Her instructions are filtered through our sensibilities. But still—still—"

"Is your dream always the same?"

"In content? In tone?"

"Tone."

"The dream is always different," Katya says. "And yet the flavor is

the same, for death is always the same. Different things happen each time, but the dream brings you always to the same place, in the same way, at the end."

"To the still point?"

"You could call it that. Yes. Yes."

"And the meaning of what I dreamed—"

"No," she says. "Don't talk about meaning. Dream-death gives no oracular wisdom. The dream is without meaning." The tube-train has reached Ulan Bator. "Come," Katya says.

They go to her suite, two floors below Nikki Crowfoot's, a dark place, three small rooms furnished with stark, heavy hangings. Once more they are naked before one another, once more he feels the overwhelming pull of Katya's thick sturdy body; he moves stiffly toward her, embraces her, digs the tips of his fingers into the deep flesh of her shoulders and back.

Afterward he dozes, and wakes to find her quietly sobbing. How strange, how unlike her! He had never imagined Lindman to be capable of tears.

"What's wrong?"

She shakes her head.

"Katya?"

"Nothing. Please."

"What is it?"

Sullenly, face against pillow, she says, "I'm afraid for you."

"Afraid? Why? What about?"

She looks toward him and shakes her head again. She clamps her lips. Suddenly her mouth looks not at all fierce. A child's mouth. She is frightened.

"Katya? What *is* it?"

"Please, Shadrach."

"I don't understand."

She says nothing. She shakes her head. She shakes her head.

Over a week goes by before Shadrach sees Nikki Crowfoot again. She claims she is very busy in the laboratory—problems of recalibration, necessary compensatory adjustments in the Avatar persona-transplant system now that the donor body will not be Mangu's—and therefore she is too tired in the evenings to want company. But he suspects she is avoiding him. Crowfoot has always been at her most sociable when she is most overworked; it is her escape from pressure. Shadrach does not know why she would want to avoid him. Surely the night he spent with Katya Lindman has nothing to do with it. He has been to bed with Lindman before, and with others; Crowfoot too has had other partners; such things have never mattered between them. It baffles him. When they speak by telephone Nikki is wary and aloof. Beyond doubt something has gone wrong in their relationship, but he has no theories.

A new Genghis Mao crisis distracts him briefly from these matters. For the past several days the Khan has been leaving his bed to work in his office, to visit Surveillance Vector One, to direct the Committee activities from the headquarters room. His recuperation was proceeding so smoothly that there seemed no reason to

confine him. But now Dr. Mordecai's sensitive implants are picking up early warnings of trouble—epigastric pulsations, faint systolic murmur, general circulatory stress. Too much activity too soon? Shadrach goes to the Chairman's office to discuss the problem. But Genghis Mao, still busy with his Mangu monuments and his roundup of assassins, does not feel like conferring with his doctor, does not want to talk about symptoms. He brushes Shadrach's queries aside with a brusque declaration that he has rarely felt better. Then he turns back to his desk. The arrests, he tells Mordecai proudly, now total 282. Of these, ninety-seven have already been found guilty and sent to the farms. "Soon," the Khan says, "the lungs and kidneys and intestines of these criminals will serve to extend the lives of loyal members of the government. Is there not poetic justice in that? All things are centripetal, Shadrach. All opposites are reconciled."

"Two hundred eighty-two conspirators?" Shadrach asks. "Did it take that many to push one man out one window?"

"Who knows? The actual crime, perhaps, required no more than two or three perpetrators. But a great network of subordinate plotters must have been needed. Security devices had to be altered, guards distracted, cameras deflected. We believe it may have taken a dozen conspirators simply to remove the bodies of the killers from the plaza after they jumped."

"To do what?"

Genghis Mao smiles blandly. "We believe," he says, "that the assassins, after hurling Mangu from the window, deliberately jumped from the same window themselves to keep from being captured in the building. Confederates in the plaza immediately gathered up their bodies and drove off with them, while others removed all signs of their deaths from the pavement."

Shadrach stares. "Horthy saw only one man falling, sir."

"Horthy did not remain in the plaza to observe further developments."

"Even so—"

"If the killers of Mangu did *not* leap after him," the Khan says, eyes bright with the brightness of reason triumphant, "what did become of them? No suspicious persons were found in the Tower after the crime."

Shadrach is unable to find an appropriate reply to this. No comment he might make, he suspects, would be constructive. After a pause he says, clearing his throat, "Sir, if we could talk about your health again for a moment—"

"I told you. I feel fine."

"The symptoms I've begun to detect are fairly serious ones, sir."

"Symptoms of what?" Genghis Mao snaps.

Shadrach suspects that the Khan may be developing an aneurysm of the abdominal aorta—a defect in the wall of the great vessel that conveys blood from the heart. He asks Genghis Mao if he has felt any unusual discomfort, and the Chairman grudingly admits recent sharp pains in the back and sides.

Dr. Mordecai does not point out how this contradicts Genghis Mao's claim of being in good health; but the admission does give Shadrach the upper hand, and he orders the Chairman back to bed for rest.

Peering through the eye of a fiber probe extending into Genghis Mao's catheterized aorta, Shadrach confirms his diagnosis. The recent liver surgery, perhaps, has released emboli into the Chairman's bloodstream, and one has somehow made its way against the arterial flow, lodging in the abdominal aorta and causing infection. Or perhaps not, but at any rate a tumor is taking form, and more surgery will be necessary. If it were anyone else, the risks of an operation so soon after a major organ transplant might be even greater than the risks of letting the aneurysm expand. But Shadrach has become amazingly casual about delivering his venerable patient up to the knife. Genghis Mao's resilient body has been opened so often that it accepts frequent surgery as the natural state. Besides, the aneurysm is not far from the liver, and Warhaftig will be able to enter through the recent incision, which is only now beginning to heal.

The news annoys Genghis Mao. "I have no time for surgery now," he says, irritated. "We're still finding new conspirators every day. I must give my full attention to the problem. And next week is Mangu's state funeral, at which I intend to preside in person. I—"

"The danger is critical, sir."

"You always tell me that. I think you enjoy telling me that. You're too insecure, Shadrach. Even if you didn't manage to find some new crisis every few weeks I'd still keep you on the payroll. I *like* you, Shadrach."

"I don't invent the crises, sir."

"Even so. Can't this wait a month or two?"

"We'd have to make a fresh cut in healed tissue then."

"What of it? What's one more slice?"

"Aside from that, the risks—"

"Yes," Genghis Mao says. "The risks. What risks do I run by letting this thing sit?"

"Do you know what an aneurysm is, sir?"

"More or less."

"It's a tumor containing blood or a blood clot, in direct contact with the wall of an artery and causing deteriorative changes in the tissues surrounding it. Think of it as a balloon, gradually being inflated. When balloons get too big, they explode."

"Ah."

"Eventually this aneurysm could rupture—into the intestines, the peritoneum, the pleura, or the retroperitoneal tissues. Or it might cause an embolism of the superior mesenteric artery, producing intestinal infarction. The aorta itself could rupture spontaneously. There are several other possibilities. All fatal."

"Fatal?"

"Invariably fatal. Agonizing pain, death usually within minutes."

"Ah," Genghis Mao says. "Ah. I see."

"It could come at almost any time."

"Ah," Genghis Mao says. "Without warning."

"I see."

"We'd be helpless, once the aneurysm goes. No way of saving you, sir."

"Ah. I see. Ah."

Does he see? Yes. Certainly, visions of erupting aneurysms are floating before Genghis Mao's basilisk eyes. The lean leathery cheeks contract in profound speculation; somber frowns furrow the bronze forehead. The Khan is troubled. He had not planned on being confronted with potential extinction this morning. Now, obviously, he contemplates the going of Genghis II Mao IV Khan from the world, and likes the idea no more than ever. The Permanent Revolution that has transformed the aching world requires a Permanent Leader; though Genghis Mao has often said, echoing Mao I's similar words, that when one participates in a revolution one attains revolutionary immortality, one transcends the death of the individual by living on indefinitely within the permanent revolutionary ferment one has helped to create, it is plain that Genghis Mao prefers the other, less metaphorical species of immortality for himself. He glowers. He sighs. He gives his consent to this latest surgical interruption of his revolutionary labors.

Warhaftig is summoned. There are conferences; schedules are rearranged; details of the surgery are explained to the Khan. The blood vessels will be clamped above and below the aneurysm to arrest circulation temporarily while Warhaftig removes the aneurysm and installs a dacron or teflon prosthesis.

"No," the Khan says. "Not a prosthesis. You can use a tissue graft, can't you? There's not much of a rejection problem with arterial tissue. It's like stitching in a length of hose."

Warhaftig says, "But dacron and teflon have proven perfectly—"

"No. I have enough plastic in me already. And the organ banks are overflowing with new material. Give me real aorta." Genghis Mao's eyes gleam. "Give me aorta from one of the recently convicted conspirators."

Warhaftig looks at Shadrach Mordecai, who shrugs.

"As you wish," the surgeon says.

Shadrach has lunch soon afterward with Katya Lindman. When they have eaten, they stroll in Sukhe Bator Square. He has spent more time than usual with Lindman since the night they went to Karakorum, although he has not slept with her again. He finds her more gentle, less threatening, now, and is not sure whether she has changed or simply his attitude toward her; waking up and finding her sobbing may have had something to do with it. Certainly she has become warm and friendly, so much so that he suspects and fears she may even be falling in love with him: yet there is something reserved at her core, some ineluctable holding back, a zone of silence within her that strikes him as the enemy of love. There never were such sealed places in Nikki Crowfoot when Shadrach's relationship with her was going well.

The midday sun is bright, the air soft, the day warm; golden flowers gleam in the terra-cotta tubs of shrubbery that decorate the plaza. Katya walks close to him, but their bodies do not touch. She has already heard of the new crisis. News of all sorts travels inordinately swiftly through the Grand Tower of the Khan, but especially news of the health of Genghis Mao. "Tell me what an aneurysm is," she says. He gives her an elaborate explanation and describes the operation that will be performed. They are standing near the place where Mangu fell. When he finishes, Shadrach looks up and tries to imagine two or three assassins plummeting in Mangu's wake, while lurking confederates spring forth to sweep up the shattered bodies and escape with them. Madness, Shadrach thinks. And this is the carefully considered theory propounded in all seriousness by the ruler of the world. Madness. Madness.

He says, "There've been almost three hundred arrests so far. Ninety-seven sent to the organ farms. Last week Roger Buckmaster was alive, healthy, his own master as much as any of us is. Tomorrow we may be using his aorta to patch Genghis Mao's. And still the arrests continue."

"So I gather. Avogadro's men bring them in, day and night. When will the Khan be satisfied?"

"When he decides that all the conspirators have been caught, I suppose."

"Conspirators?" Katya says scathingly. For a moment she has the old frightening intensity again. "What conspirators? What conspiracy? The whole thing is insane. Mangu killed himself."

"You think it was suicide too, then?"

"Think? I know it was," she says in a low voice, turning away from the Grand Tower as though to avoid cameras that might read her lips.

"You talk as if you were there when he jumped."

"Don't be silly."

"How can you know it was suicide, then?"

"I know. I know."

"*Were* you there when he—"

"Of course not," Lindman says.

"Then why are you so sure you're right?"

"Good reasons. Sufficient reasons."

"You know something that the Security people don't?"

"Yes," she says.

"Then why don't you speak up about it, before Avogadro arrests the whole world?"

She is silent a moment. "No," she says at last. "I can't. It would destroy me."

"I don't follow."

"You would if I told you the story." She studies him. "If I told you, would it stop with you?"

"If that's what you wanted."

"I feel I should tell someone. I'd like to tell you. I trust you, Shadrach. But I'm afraid."

"If you'd rather not—"

"No. No. I'll tell you. Walk with me across the plaza. Keep your back to the Tower."

"There are cameras everywhere. It doesn't matter which way we

face. But they can't pick up everything, I guess."

They start across the plaza. Lindman raises her arm, holding it across her face as though to scratch her nose with the back of her wrist, and says, mouth covered, voice muffled, "I saw Mangu the night before he jumped. We talked about Project Avatar. I told him he was going to be the donor."

"Oh, Jesus. You didn't!"

She nods grimly. "I couldn't keep it to myself any longer. It was a Monday night, just before Genghis Mao's liver transplant, right? Yes. Mangu had made a speech that night, something about worldwide distribution of the Antidote. Then he and I went for drinks somewhere. He was afraid Genghis Mao might die during the operation and he'd have to take charge of things—*I'm not ready,* Mangu kept saying, *I'm not ready.* And then we started talking about the three projects, and he began to speculate about Avatar. What his role would likely be in the government if they transplanted Genghis Mao's mind into some other body. Whether Genghis Mao would still want him as viceroy after the transition, things like that. It was so sad, Shadrach, so filthy sad, the way he kept poking at it, trying to figure out what was in store for him, working up all sorts of hypotheses and scenarios. Finally I couldn't stand it and I told him to stop worrying about it, that he was wasting his time, that after the transition he wasn't going to be around, that Genghis Mao was going to use his body as the donor."

Shadrach is stunned by this confession. He can barely speak; his legs tremble, his skin is chilled.

He says, "How could you have done it?"

"The words just came out. I mean, here was this man, this pitiful doomed man trying to understand his future, trying to see what his role would be, and I knew that he had no future. Not if Project Avatar worked out. We all knew it, all but him. And I couldn't hold it back any longer."

"What happened then?"

"His face seemed to cave in. His eyes went dead—blank—empty. He sat for a long time and didn't say anything. Then he asked me how I knew. I said it was known to a lot of people. He asked if you knew and I said I thought so. I want to talk to Nikki Crowfoot, he said. She's at Karakorum with Shadrach, I told him. Then he asked me if I thought Avatar really would work out, and I said I didn't know, I had a lot of faith in my own project, with any luck Talos would head Avatar off. It's all a matter of time, I said. Avatar's ahead of Talos now, and if anything serious happens to Genghis Mao in the next few months they might have to activate Avatar, because the Talos automaton needs at least a year of further development work and Project Phoenix isn't getting anywhere. He thought about that. He said it didn't matter to him whether he actually became the donor or not, the thing was that Genghis Mao had let him think he was the heir apparent while secretly approving what amounted to his mur-

der. That was what hurt, he said, not the idea of dying, not the idea of giving up his body to Genghis Mao, but being tricked, being treated like a simpleton. And then he got up, he said good night, he went out. Walking very slowly. After that I don't know. I suppose he spent the whole night thinking things over. Thinking about how he had been duped. The prize lamb, fattened for the slaughter. And in the morning he jumped."

"And in the morning he jumped," Shadrach says. "Yes. Yes. It sounds right. Some truths can't be faced."

"So there are no conspirators. The conspiracy exists only in Genghis Mao's paranoia. Those three hundred arrested people are innocent. How many sent to the organ farms so far? Ninety-seven? Innocent. All innocent. I've watched it happen, but there's nothing I can do. I can't speak out. They say the Khan refuses even to consider the suicide hypothesis."

"He wants there to have been a conspiracy, yes," Shadrach says. "He enjoys punishing the guilty."

"And if I told him what I've just told you, he'd have me killed."

"You'd be in the organ farm tomorrow. Yes. Or else maybe he'd pick you as the new Avatar donor."

"No," Katya says. "That isn't likely."

"It would suit his philosophy. It would be very centripetal, wouldn't it? Your loose tongue costs him Mangu's body, so you become Mangu's replacement. Very fitting. Very neat."

"Don't be foolish, Shadrach. It's unimaginable. He's a barbarian, isn't he? He's a Mongol. He thinks he's the reincarnation of Genghis Khan. He'd never let himself be transplanted into a woman's body."

"Why not? The old Mongol khans weren't sexists, Katya. As I recall, the Mongols let themselves be ruled by female regents now and then when the male line gave out. Of course, there are problems of adaptation he'd have, changing sexes, all the bodily reflexes, all the million little masculine things that he'd have to unlearn—"

"Stop it, Shadrach. It isn't a serious possibility, the Khan's taking my body."

"But it's amusing to consider—"

"It doesn't amuse me." She halts and swings around to face him. She is pale, drawn, tense. "What can we do? How can we stop these hideous arrests?"

"There's no way. The thing has to run its course."

"Suppose an anonymous tip is sent to the Khan, telling him merely that Mangu had learned what was in store for him, that some unnamed person had revealed to him that he would be used for—"

"No. Either Genghis Mao will ignore it, or else he'll begin a vast and bloody interrogation of everybody who might have knowledge of the Avatar plan."

"What if the arrests don't stop, though?"

Shadrach says, "Avogadro's running out of suspects. It's almost over."

"And the prisoners awaiting sentence?"

Shadrach Mordecai sighs. "We can't help them. They're lost. Nothing can be done, Katya. One way or another, we're all awaiting sentence."

He is haunted all afternoon by the vision of Mangu, pitiful deluded Mangu, stripped of all delusions, confronted at last by frosty reality. Why had Lindman tipped him to his true fate? Out of compassion? Did she really think she was helping him, for God's sake? Had she thought that receiving such knowledge could do Mangu any good? Could she have failed to see how cruel, how merciless, she was being? No. She must have known that a man like Mangu, genial, shallow, unquestioning, a man who was living an impossible fantasy of eventual succession to the world's most powerful office, believing he enjoyed the esteem, even the love, of Genghis Mao, would collapse totally if that structure of fantasy were ripped away.

She must have known.

Of course. An hour after lunching with Katya Lindman, Shadrach finally grasps the pattern. Lindman, good chess-player that she is, had foreseen all the consequences of her move. Tell Mangu the truth, pretending compassion and claiming a compulsion to frankness. Mangu—out of humiliation, chagrin, fear, even vengefulness, whatever—reacts by putting his body beyond Genghis Mao's reach. No Mangu, and Project Avatar is dealt a mighty blow. Nikki, Lindman's rival, is discomfited; Avatar, set back by many months, loses its primacy to Lindman's Project Talos; Shadrach, already mysteriously estranged from Nikki, is drawn inevitably closer to Katya as her star rises. Of course. Of course. And all the rest, Katya's pretense of concern for the hapless victims of the mass arrests, Katya's show of grief for poor pathetic Mangu—all part of the game. Shadrach shivers. Even in the harsh and perverse climate of the Grand Tower of the Khan, this seems monstrous, and Lindman a baleful and alien figure, malevolent enough to make a suitable consort for Genghis Mao himself. Or, if not a mate, then a fitting housing for the old ogre's devious and sinister mind. Yes! For a moment Shadrach does seriously consider urging the Khan to take Lindman's body in place of Mangu's: *An appropriate choice, sir, very centripetal, very apt.* Though he is puzzled by one still obscure motive: why has Lindman revealed all this to him? If she is so calculating a monster, would she not have calculated the likelihood that he would sooner or later come to see her for what she is? Can that have been her ultimate aim? Why? He is dizzied by the multiplicity of speculations.

He wants to turn to Nikki, but Nikki has continued to hold herself aloof, and he has not even spoken to her by telephone for two or three days. He phones her now, on the pretext that he needs an update on Project Avatar progress, but one of her assistants appears on the screen, a Dr. Eis from Frankfurt. Eis, classically Teutonic, pale blue eyes and soft golden hair, does an odd little take of—surprise? dismay?

distaste?—at the sight of Shadrach, forehead furrowing and corner of mouth pulling in, but he recovers quickly and gives him a cool, formal greeting.

Shadrach says, "May I speak with Dr. Crowfoot, please?"

"I'm sorry. Dr. Crowfoot is not here. Perhaps I can be of assis—"

"Will she be back this afternoon?"

"Dr. Crowfoot has left for the day, Dr. Mordecai."

"I need to reach her."

"She is in her apartment, doctor. An illness. She has asked that she not be disturbed."

"Sick? What's the matter?"

"A mild upset. A fever, headaches. She has asked me to tell you, if you called the laboratory, that we are still studying the recalibration problem, but that at present there is nothing to report, no—"

"*Danke*, Dr. Eis."

"*Bitte*, Dr. Mordecai," Eis replies crisply, as Shadrach blanks the screen.

He starts to phone Nikki's apartment. No. He's had enough of evasions, excuses, procrastinations, deflections. It's too easy for her to run numbers like that when he calls. He'll simply go down there and ring the doorbell, uninvited.

She lets him stand in the hallway a long time before she responds, though she must know, from her doorscreen, who's there. Then she says, "What do you want, Shadrach?"

"Eis told me you were ill."

"It's nothing serious. Just a bad case of the lousies."

"May I come in?" he says.

"I'm trying to take a nap, Shadrach."

"I won't stay long."

"But I feel so awful. I'd rather not have visitors."

He starts to turn away from the door, but, although he knows his maniac persistence can do him no good, he finds it too painful to leave without seeing her. Helplessly he hears himself saying, "At least let me see if I can prescribe something for you, Nikki. I *am* a doctor, after all."

Long silence. Desperately he prays that no one he knows will come upon him here, out in the hall like a lovesick Romeo pleading to be let in.

The door opens, at last.

She is in bed, and she really does look sick, face flushed and feverish, eyes bloodshot. The air in the bedroom has that stale sickroom quality, stuffy and congested. He goes at once to open the window: Crowfoot shivers and asks him not to, but he ignores her. He sees when she sits up that she is naked under her blanket. "I'll find your pajamas for you if you're cold," he says.

"No. I hate wearing pajamas. I don't know if I'm cold or hot."

"May I examine you?"

"I'm not all that sick, Shadrach," she insists.

"Even so. I'd like to make certain."

"You think I'm coming down with organ-rot?"

"There's no harm in checking things out, Nikki. It'll take only a moment."

"Pity you can't diagnose me the way you do Genghis Mao, just by reading your own internal gadgets. Without having to bother me at all."

"No, I can't," he says. "But this'll be quick."

"All right," she tells him. She has not once met his eyes during this interchange, and that bothers him. "Go ahead. Play doctor with me, if you have to."

He uncovers her, and finds himself curiously reticent about exposing her body this way, as though their recent estrangement has somehow deprived him of a doctor's traditional privileges. But of course he has had only one patient in his career, having gone straight from medical school to the service of Genghis Mao, having done nothing but gerontological research until being elevated to serve as the Khan's personal physician, and he has never developed the practicing doctor's traditional indifference to flesh: this is no anonymous patient, this is Nikki Crowfoot whom he loves, and her naked body is more than an object to him. After a moment he attains some impersonalilty, though, transforms her breasts into mere globes of meat, her thighs into sexless columns of flesh and muscle and checks her over without further unsettling himself, reading her pulse, tapping her chest, palpating her abdomen, all the routine things. Her self-diagnosis turns out to have been accurate: no incipient organrot, just a trifling upset, some fever, nothing remarkable. Plenty of fluids, rest, a couple of pills, and she'll be back to normal in a day or so.

"Satisfied?" she asks mockingly.

"Is it so hard for you to accept the fact that I worry about you, Nikki?"

"I told you I didn't have anything serious."

"I still worried."

"So examining me was really therapy for you?"

"I suppose," he admits.

"And if you hadn't rushed over to give me the benefit of your high-powered medical skills, I might be asleep now."

"I'm sorry."

"All right, Shadrach."

She turns away from him, curling up sullenly under the bedclothes. He stands by the bed, silent, wanting to ask a thousand unaskable questions, wanting to know what shadow has fallen between them, why she has become so mysteriously remote, so cool, why she will not even look straight at him when she speaks to him. After a moment he says, instead, "How's the project going?"

"Didn't Eis speak to you? We're recalibrating. It'll take us a while to gear up for a new donor. The whole thing's a colossal pain in the ass."

"How much of a setback is it, actually?"

She shrugs. "A month, if we're lucky. Or three. Or six. It all depends."

"On what?"

"On—on—oh, Christ! Look, Shadrach, I don't really want to talk shop right now. I feel sick. Do you know what being sick means? My

head hurts. My belly hurts. My skin tingles. I want to get some rest. I don't want to discuss my current research problems."

"I'm sorry," he says again.

"Will you go now?"

"Yes. Yes. I'll phone you in the morning to see how you're coming along, okay?"

She mutters something into her pillow.

He starts to leave. But he makes one last attempt to reach her before he goes. At the door he says lamely, "Oh—have you heard the newest rumor making the rounds? About Mangu's death?"

She groans stoically. "I haven't heard anything. But go on. Go on. What is it?"

He frames his words carefully, so that he will not feel he is breaching Katya Lindman's confidence: "The story that's going around is that Mangu committed suicide because somebody connected with Project Talos tipped him that he was to be the Avatar donor."

Nikki sits upright, eyes wide, face animated, cheeks blazing in excitement.

"What? What? I hadn't heard that!"

"It's just a story."

"Who's the one who's supposed to have tipped him?"

"They don't say."

"Lindman herself, was it?" Nikki demands.

"It's only a rumor, Nikki. Nobody specific has been named. Anyway, Katya wouldn't do anything so unprofessional."

"Oh, no?"

"I don't think so. If it happened at all, it was probably some ambitious underling, some third-echelon programmer. If it happened at all. There may not be a shred of truth to it."

"But it *sounds* right," she says. Her breasts are heaving, her skin is glossy with new sweat. "What better way could Lindman find to sabotage my work? Oh, why didn't I think of it! How could I not have seen—"

"Stay calm, Nikki. You aren't well."

"When I get hold of her—"

"Please," Shadrach says. "Lie down. I wish I hadn't said a word. You know what sort of wild rumors go floating around this building. I absolutely don't believe that Katya would—"

"We'll see," she says ominously. She grows more calm. "You may be right. Even so. Even so. We should have had much tighter security. However many people knew that Mangu was the donor, five, six, ten people, that was too many. Much too many. For the next donor—" Crowfoot coughs. She turns away again, huddling into her pillow. "Oh, Shadrach, I feel lousy! Go away! Please go away! Now you've got me all stirred up over something altogether new, and I—oh, Shadrach—"

"I'm sorry," he says once more. "I didn't mean—"

"Good-bye, Shadrach."

"Good-bye, Nikki."

He bolts from the apartment. He plunges through the hall, fetching up finally against a stanchion near the stairs. He grasps it, steadies himself. The visit to Nikki has

hardly improved his state of mind. Her attitude toward him, he realizes, ranged from indifferent to irritated; never once did she express any pleasure that he had come to see her. He was tolerated at best.

And now, he knows, he must hurry back to Katya.

She seems surprised to see him again so soon. She greets him warmly, unsubtly, as though automatically assuming he has come here to make love. His mood is far from sexual, though. He disengages himself from her embrace as soon as is politic, and gently but firmly establishes a psychic distance between them. In quick earnest blurts he reports the essence of his conversation with Nikki, stressing that the "rumor" he had invented did not in any way incriminate Katya herself in the tipping-off of Mangu.

"But of course Crowfoot immediately guessed I was the one, right?"

"I'm afraid so. I argued that it was inconceivable you'd do any such thing, but she—"

"Now knows I did, and will hold the grudge against me forever, and will do whatever she can to pay me back. Thanks a lot."

Quietly Shadrach says, "If she's angry, you can't entirely blame her. You have to admit there was an aspect of sabotaging Avatar in your passing the word to Mangu."

"I passed the word to Mangu out of pity for him," Lindman says flintily.

"Pity and nothing but pity? You didn't consider at all that he might react in a way that would upset the Avatar program, and that that would create problems for Nikki?"

Katya is silent for some while.

At length she says, in a more yielding voice, "I suppose that that crossed my mind too. But it was very secondary. Very very secondary. Mainly I couldn't bear to face Mangu any more, listening to him talking about his future and knowing what I knew. I had to warn him or I'd saddle myself with full responsibility for what was going to happen to him. Can you believe that, Shadrach? How evil do you think I am? Do you think my life begins and ends with these insane projects of Genghis Mao's? Do you think that the only motivations that operate in me are Talos motivations, how I can push my own career, how I can wreck Nikki Crowfoot's? Do you?"

"I don't know. I suppose not."

"You suppose?"

"I don't think you're like that, no."

"Fine. Splendid. Thank you. And what happens now? Will she denounce me to Genghis Mao?"

"There's no proof you ever said anything to Mangu," Shadrach Mordecai replies. "She knows that. She knows also that whatever accusations she makes against you will be discounted as professional jealousy. I don't think she'll take any action at all, actually. Except that she did say she'd maintain tighter security on the identity of the *next* Avatar donor, so that there'd be no chance the same thing would—"

"It's too late," Lindman says.

"The next donor's already been picked?"

"Yes."

"And you know his name?"

"Yes."

"I don't suppose you'd care to tell me," Shadrach says.

"I don't think I should."

"Are you planning to tell *him?*"

"Would you say it was sabotage again if I did?"

"It depends on the circumstances, I guess. Who is he?"

Katya Lindman trembles. Her lips quiver.

"You," she says.

It seems like a joke, and not a very good joke. He is unable to accept it at all, despite the strident note of conviction in Katya's voice, that shrill, almost desperate note of certainty that Shadrach had also heard when Roger Buckmaster was trying to deny his complicity in Mangu's death, that tone that says, *You won't believe this no matter how heavy an oath I swear, but what I'm telling you is true, is true, is true, is true!*

Yet if he *has* been selected as the new donor, it would explain why Nikki has been avoiding him, why she is remote and short-tempered when they speak, why her eyes will not meet his—

"No," he says. "I don't believe you."

"So don't believe me."

"It's absurd, Katya."

"Undoubtedly it's absurd. And it'll be just as absurd the day they come for you and put the electrodes on your head and obliterate every trace of Shadrach Mordecai and pour the soul of Genghis Mao into your pretty brown body."

"My pretty brown body," Shadrach says, "is full of complicated and irreplaceable medical devices that register every twitch of Genghis Mao's metabolism. It took Roger Buckmaster a couple of years to design and build that system, it took Warhaftig weeks to implant it in me, it took me a year to learn how to use it. Using it, I can protect Genghis Mao's health in a way that was never before possible in medical history. With all the warm bodies Avatar has to choose from, do you think Genghis Mao would let them choose the one body that's indispensable to his—"

"Think, Shadrach, *think*! Avatar won't be activated unless Genghis Mao's present body is on the threshold of death. He won't *need* all your fancy implants once he moves into your body. He won't need you as his doctor; he won't really need a full-time doctor at all, not for many years. And he can find another doctor. He can find another Buckmaster to build a new set of implants when the time comes. He's probably got a replacement for you in training already, somewhere in Bulgaria or Afghanistan. Remember what he always says about redundancy, Shadrach? The avenue of survival. Genghis Mao understands survival very well. Better than you, I'm afraid."

Shadrach Mordecai's mouth opens. Says nothing. Closes.

"If Avatar is activated," Katya says, "you go. I swear it."

"When was this decided?"

"More than a week ago. I found out about it a few hours before we

left for Karakorum," she says.

Which was just about the time Nikki Crowfoot began finding excuses for not keeping company with him, Shadrach reflects. He remembers waking up in this very room, Katya's room, the night of the dream-death excursion, and discovering Katya sobbing beside him in bed, and hearing her tell him that she was afraid for him, without offering further explanation. Yes. And he remembers all that lunatic talk of Genghis Mao's about nominating him for Pope, for King of England—what was that about? Disguised and displaced intimations of the real nomination? He remembers, too, and the memory chills him, running shirtless into Genghis Mao's bedroom just after the news of Mangu's death had broken, remembers seeing the Khan eyeing his bare torso with interest, with admiration, Genghis Mao saying, *You look very healthy, Shadrach.* Yes. Shopping for a new body already, was he, minutes after learning of the loss of Mangu?

He thinks of Buckmaster screaming, *You'll finish in the furnace, Shadrach, in the furnace, in the bloody furnace!*

No. No. No.

"I can't believe this," he says.

"Start learning how."

"It makes no sense to me. I literally can't grasp the meaning of the whole thing."

"Does it frighten you, Shadrach?"

"No. Not at all." He holds out his hands. Steady. As steady as Warhaftig's. "See? I'm entirely calm. I am without affect. It doesn't register on me. It's unreal."

"But it isn't, Shadrach."

"Nikki knows?"

"Of course."

"She's not the one who picked me, is she?"

"Genghis Mao picked you."

"Yes. That figures. Yes." He laughs. "Do you notice how I begin to talk as though I believe this? As though I accept it, on some level?"

"What will you do, Shadrach?"

"Do? Do? What should I do? Should I do what Mangu did?"

"You're not Mangu."

"No," he says. "Even if I had absolute proof, even if they came to me with an engraved scroll signed by Genghis Mao, nominating me for Avatar, I wouldn't choose Mangu's way. I'm not in the least a suicidal person. Maybe it sets in later, Katya. First I have to feel something. I don't feel anything yet. I don't feel betrayed, I don't feel endangered, I don't think I even feel surprised."

"Could it be that you want to be the Avatar donor?"

"I want to be Dr. Shadrach Mordecai. I want to go on being him for a long time."

"Then keep Genghis Mao healthy. So long as his body is functioning, he won't need yours. Meanwhile it'll be my task to make Avatar altogether superfluous by bringing Talos quickly to perfection. You know, Genghis Mao may actually prefer the Talos idea. I think it suits his particular brand of paranoia to be transferred into a machine, an imperishable, flawless machine. After all, even your beautiful body is going to decay and

crumble. He knows that. He knows he might have twenty or thirty good years in you, and then it'll be the same route all over again, organ transplants, drugs, constant surgery, whereas the Talos simulacrum will spare him all that. So Avatar is just a contingency plan for him, a redundancy that he hopes not to have to use, and that's why he can pick people he values as the donors—Mangu, you—a kind of honor, in its way, the blessing of the Khan, not at all the jeopardy that it might be thought to be. I tried to tell that to Mangu, too, that Avatar wouldn't necessarily happen, but he—"

"Why did you tell me about this, Katya?"

"For the same reason I told Mangu."

"To help wreck Avatar?"

Her eyes flash the old Lindman fire. "Don't be a bastard. Do you think I want you to jump out a window too?"

"What good is it, telling me?"

"I want you to be on guard, Shadrach. I want you to know what danger you're in, now. So long as there's even a slight likelihood that Avatar will have to be used, you—"

"What does it matter to you, though? A sore conscience? You don't like hanging out with men who you know are secretly earmarked for destruction?"

"That's part of it," Katya says quietly. "I hate living a lie."

"What's the rest?"

"I love you," she says.

He stares with glassy eyes. "What?"

"I'm not capable of it? I'm good only for building automatons, is that it? I have no emotions?"

"I didn't mean that. But—you seemed so cold all the time, so businesslike, so matter-of-fact. Even when—" He pauses, decides to finish. "Even when we would have sex. I never felt any emotional warmth from you, only, well, physical passion."

"You were Nikki's. Getting involved with you would only have been painful to me. You didn't want me except for the occasional fling in Karakorum."

"And now?"

"Do you still love Nikki? She helped sell you out, you know. She went to Genghis Mao, she heard him select you for Avatar, she probably tried to get him to change his mind—we ought to give her that much credit—and she failed, and then she accepted the order. Her career comes before your life. She could have come to you and said, *This is what Genghis Mao wants to do, but I can't do it, I rebel, let's both get out of this hideous place.* She didn't, though, did she? She simply started keeping away from you. Because of the guilt she felt, right? Not out of love, but out of guilt, out of shame."

Numbly Shadrach shakes his head.

"This is unreal, Katya."

"I have told you no lies today."

"But Nikki—"

"Is afraid of Genghis Mao. As am I, as are you, as is everyone in this city, everyone in the world. That's the measure of her love for you: her fear of that crazy old man is greater. If I'd been in her posi-

tion, I might have made the same choice. But it's not my project. I'm not faced with the option of betraying you versus defying the Khan. I'm free to go behind his back, to warn you, to let you make your own decisions. But it's strange, isn't it? The warm tall beautiful loving Nikki agrees to sell you out. And the bitter vengeful squat ugly Katya risks her life to warn you."

"You aren't ugly," he murmurs.

Katya laughs. "Come here," she says. She sits on the edge of the bed, tugs him down beside her, roughly presses his head against her. "Rest. Think. Make plans, Shadrach. You're lost if you don't." She caresses his aching forehead.

He stays there, immobile, gathering strength, pasting himself together, until at last he is ready to move.

The next day is the day of Genghis Mao's aorta transplant. Shadrach, after the usual brief fitful sleep, awakens, exercises, breakfasts, dresses, negotiates passage through Interface Three, pauses to inspect the doings in the Trauma Ward by means of Surveillance Vector One—the standard morning routine. The dancing lenses display for him the world's two billion, perhaps twenty percent of them stricken with organ-rot, the walking dead, shambling about with perforations and lesions and corruptions, and most of the others who are still whole living in the shadow of the universal disease, going through a semblance of ordinary life with sullen courage, waiting for the spitting of blood and the fire in the guts, looking toward the demigods of Ulan Bator in envy and bewilderment. While he, lightfooted Shadrach Mordecai, the pretty doctor of the Khan, has nothing worse to worry about than being evicted from his own nimble body, being kicked out on his black ass so that a Mongol usurper can move into his skull. Other than that, Shadrach, everything's fine, right? Right. Yassuh, boss.

Shadrach wonders, as he goes to fetch Genghis Mao for the traditional and familiar gurney-ride from the imperial bedchamber to the Surgery, how he will react when he comes face to face with the Khan. Surely his expression will betray his new knowledge; surely Genghis Mao, nearly ninety years canny, will see at once that his designated victim is in on the scheme. But Shadrach discovers that his mysterious tranquility of spirit does not desert him even when he is eye to eye with the Khan. He feels nothing, neither fear nor anger nor resentment: the Chairman is the patient, he is the doctor, the sensors are twitching away, loading him with information, and that's all, no change in their relationship. He looks at Genghis Mao and thinks, *You have secretly plotted to steal my body,* and there is no effect, none. It remains unreal to him.

"And how am I this morning, Shadrach?" Genghis Mao booms jovially.

"Splendid, sir. Never better."

"Going to cut out my heart, are you?"

"Only the aorta this time," Sha-

drach says. He signals to the attendants. They wheel the Chairman away.

And there they all are once more gathered in the Surgery—the Chairman, the physician, the chief surgeon, the anesthesiologist, the nurses and other miscellaneous medical spear-carriers, everyone scrubbed and gowned and masked, the bright lights gleaming, the transparent aseptic bubble sealed, the filters and pumps pumping and filtering, the computers flashing green and red and yellow like gaudy movie props, the new aortal section—Buckmaster's?—sitting in its container, fresh and plump, ready to be installed in Genghis Mao's abdomen.

Warhaftig, confident, serene, prepares once more to open the spare, slight body of Genghis Mao.

"Blood pressure?" he asks.

"Normal," Shadrach says.

"Respiration?"

"Normal."

"Platelet count?"

"Normal. Normal. Everything normal."

Shadrach is aware that if Genghis Mao should die on the operating table, there would be no Project Avatar to menace him: none of the three projects is ready yet to be put into effect, and if the Khan does not survive the transplant, that will be the end of him without hope of reincarnation, perhaps even the end of the Permanent Revolutionary Committee, the entire fragile society of centripetal depolarization polarizing and centrifuging into chaos the instant the legendary figure of Genghis Mao vanishes from the scene. It would not be hard to manage it. Jostle Warhaftig's elbow, maybe, as he aims the surgical laser at the Chairman's gut; apologize profusely afterward, but the damage will be done. Or, more subtly, feed the operating team misleading information, cockeyed reports from Genghis Mao's ostensible interior: they trust Dr. Mordecai, they will follow his data without bothering to check it against the numbers on the scopes and meters, and he could probably cause irreversible injury to the Chairman, fatal oxygen shortage or the like, before Warhaftig realizes what is taking place. And then the apologies, I simply can't *understand* why my readings were off so badly. He has no need to worry about a malpractice suit: topple the Khan and the whole fabric comes apart, every man for himself in the aftermath. But he will not. No harm will come to Genghis Mao by way of Shadrach Mordecai today, not even if he knows the Khan intends to activate Project Avatar before next Tuesday. Dr. Mordecai, in peril or not, is nevertheless a doctor, a dedicated doctor, still young and naive enough to take his Hippocratic oath seriously. He has sworn to keep pure and holy both his life and his art. He has vowed to help the sick and to abstain from all intentional wrongdoing and harm. So be it. Shadrach Mordecai, M.D., Harvard '01, is no traducer of sacred trusts. Genghis Mao is his patient; Genghis Mao will not die at Shadrach Mordecai's hands this day. Perhaps this is foolishness, but

there is also a certain grace in it.

The operation proceeds smoothly. Snip, and the weakened section of Genghis Mao's aorta comes out. Stitch stitch, and the replacement is grafted in. Heart-lung machines keep the circulation bubbling. The Khan watches, conscious and beady-eyed, through the whole thing, now and again nodding to himself as Warhaftig executes some particularly admirable veronicas and entrechats and passades. He seems to know what is going on; he has spent more time observing surgeons at their trade than I have, Shadrach realizes, and can probably do the job pretty well by himself by now. Warhaftig's elegant fingers elegantly close the incision. The tissues are raw and reddened, having been cut into for the liver transplant less than two weeks earlier, and this calls for some special prophylactic measures, but the surgeon brings everything off with his customary finesse. Genghis Mao grins approval when all is over. "Good show," he tells Warhaftig. "Two ears and the tail!"

Shadrach makes off with the Khan's discarded abdominal aorta. He tells Warhaftig, not that Warhaftig cares, that he intends to run some tests on it, but what tests would tell him anything about this drooping length of ancient tissue, this tired hose, that he doesn't already know? He covets it because it's an authentic piece of the body of the authentic Genghis II Mao IV Khan, and Shadrach has the collector's itch: this will be an ornament to his little museum of medical memorabilia. A relic of one of history's most famous patients. There is a tale Shadrach knows, probably apocryphal, of how the doctor who performed the autopsy on Napoleon removed the imperial penis and kept it as a souvenir of the late emperor, bequeathing it to a fellow physician who ultimately sold it at an immense price, and so on and on, passing from one doctor's collection to another, until it disappeared altogether during the confusions of some twentieth-century war. Similar stories, he knows, have been told of odd scraps of Hitler, Stalin, George Washington, Catherine the Great. Shadrach regrets that he attained his present post too late to collect some of the really significant organs of Genghis Mao—a kidney, say, or a lung, the liver, the pancreas—but all of them were gone long before Shadrach's time, the native organs of the Khan's body removed and replaced, sometimes several times over, with transplanted substitutes. Shadrach does not see much value in preserving Genghis Mao's fourth liver in his collection, his eighth spleen, his thirteenth kidney, though he recognized that these temporary residents of the Khan are more intimate artifacts of Genghis Mao than, say, his bedroom slippers or his wristwatch. But he prefers the genuine somatoplasm, and a piece of authentic aorta is the best he can do just now.

There's the aneurysm, big and ripe, ready to pop. Another few days and it might have ruptured, *poof!* and no more Genghis Mao. The Chairman and Mangu might

have shared the same funeral, come Saturday, if Shadrach hadn't felt odd twitterings in the circulatory-system sensors and correctly guessed their import. So I have saved the Khan's life, not for the first time, and he is once more restored to perfect health. Fine. Fine. May he live five hundred years, and may I be his physician always!

Alone in his office, ruminating over his medical treasures, his books and old instruments and now this bit of bottled aorta, Shadrach feels safe and comfortably entrenched. This Avatar disturbance will blow over. The Khan, after all, is conservative; he will cling to his own Mongol body, the well-loved and sturdy patchwork carcass, as long as he can, whatever the temptations may be for him to jump into Shadrach's strong, young, and vital frame. So there will be no precipitous exit for Shadrach, and in the months or perhaps years ahead he can try to shift the Khan's fantasies entirely away from Project Avatar and toward Project Talos. Which will mean aborting the researches of Nikki Crowfoot, but Shadrach can't feel too guilty about that, all things considered.

He gives the aorta pride of place on his shelves. Centuries from now it may be sacred, enshrined in a reliquary of ivory and platinum, and the groveling faithful will chant thanks to the sainted Shadrach Mordecai for having saved for posterity this shred of divine meat. Who knows? There is an apocryphal story that many of Genghis Mao's original organs are preserved in some labyrinthine secret tunnel, kept in cold storage or perhaps maintained in vivo, for eventual use in cloning the Khan. Shadrach doubts this. If Genghis Mao had any serious interest in being cloned, huge budgetary appropriations would be going to support tissue-culture research, and, so far as Shadrach knows, not much is going on in that area. Or, more likely, there would already be a battalion of genetically perfect duplicates of Genghis Mao lying in suspension tanks on five or six continents, waiting to be summoned into life.

Mordecai has often thought of writing a scientific monograph on his patient, a medical biography of Genghis Mao, a full record of the myriad transplants and implants, the infinity of surgical jugglements, that are responsible for the Khan's longevity and perhaps for his terrifying vitality. There would be nothing in the literature to compare with it, not even Beaumont on Alexis St. Martin's digestive tract, not even Lord Moran on Churchill: had ever there been so single-minded and long-sustained a medical effort, spanning so many decades, to keep one human being alive and well? Already the achievement verges on the miraculous, but the real miracles still lie ahead, as Genghis Mao, ageless and eternally renewed, lives on to be 100, 110, 120—

There is another, greater temptation—to write not merely a medical study but a full-scale account of Genghis Mao's life. No biography

of the Chairman exists, other than vague, sanitized publicity pamphlets, mere recitals of his political accomplishments and other exterior events, avoiding all details of his private life. It is as though the Khan has a superstitious fear of having his soul captured on paper. And so Shadrach's impulsive fantasy: to nail the Khan in words, to pin him down with literary juju. It is one means of gaining control over the world's most powerful man, at least in a metaphorical way.

The trouble is, no source material is available. The computer banks of Ulan Bator are gorged with intimate data about every human being alive—except Genghis Mao. Press the right button and platoons of facts march forth—but none about Genghis Mao. The facts of his life are unknown and maybe unknowable, beyond the most elementary public milestones, his promulgation of the philosophy of centripetal depolarization, his founding of the PRC, his election to the Chairmanship. All the rest has been suppressed, even obliterated. When was he born? In what obscure village? What was his childhood like, what were his boyhood ambitions? What was his original name, in the old People's Republic days before he proclaimed himself to be Genghis Mao? What was the early course of his career? What sort of education did he have? Did he ever travel abroad? Was he ever married? A father? Yes, that's a good question—are there, somewhere in Mongolia, middle-aged men and women who are in fact the blood children of Genghis Mao, and, if so, do they know who their father is? No one can answer these questions. No one can answer any questions about Genghis Mao except with hearsay, apocrypha, and myth. He has very carefully covered his traces, so carefully that the utter success of the attempt at total concealment argues a kind of madness.

But is anyone, even Genghis Mao, really willing to expunge from the world all traces of his private self? Criminals are said to return compulsively to the scene of the crime; possibly those who seek to shroud themselves in mystery tend also to undo their own mystifications by burying, for history's sake, a full account of all they have tried to hide. Is there no place where Genghis Mao has secreted a concealed record of everything he has kept from the knowledge of his subjects? Say, a diary, an intimate and revealing diary, a repository for the essence of Genghis Mao's masked soul. Shadrach imagines himself stumbling across such a document among the Khan's effects—a single billion-bit bubble-chip, smaller than a fingertip, on which is implanted the raw red stuff of Genghis Mao's life, his confessions, his unvarnished memoirs, out of which the faithful doctor Shadrach Mordecai will construct the first and only true account of the strange and sinister man who came to dominate the dying civilization of the early twenty-first century.

Of course there is no such diary. Ordinary thieves and felons may

compulsively jeopardize their own safety, but Shadrach knows Genghis Mao well enough to realize that if he wants to live in secrecy, he will leave no hidden memoirs around for others to find. The private Genghis Mao is just as secretive as the public one: open one empty box and another, even more empty, lies within. No matter. In his fantasy-role as the biographer of Genghis Mao, Shadrach will fantasize the Khan's memoirs as well, inventing the source material that Genghis Mao has neglected to provide. He closes his eyes. He lets his imagination slip free of the leash. He creates the diary of the Khan within the crucible of his own throbbing brain.

November 11, 2010. My birthday. Genghis Mao is 85 today. No. No. Genghis Mao is—what—twenty years old? About that. It's Dashiyin Choijamste who is 85 today. Dashiyin Choijamste who I carry about within me like an internal twin. Who remembers him, that fat little babe in his proud father's arms? So long ago, the village of Dalan-Dzadagad on a snowy night in 1925. That's down in the province of Southern Gobi, Dalan-Dzadagad. I haven't been there in fifteen years. My birthplace, but who knows that? Who knows anything? I know. Dashiyin Choijamste is 85 today. How many others are still alive, of those born on 11 November 1925? Not many, no. And those who remain are ancient doddering wrecks. Whereas I am still in my prime, I Dashiyin Choijamste of Dalan-Dzadagad, son of Yumzhaghiyin Choijamste, director of the camel-breeding station at Bogdo-Goom. I Genghis Mao. I feel strong today, oh, yes, 85 and robust. Not altogether because of the transplants, either. It's heredity that does it. The good old Tatar blood. Don't forget, you were almost 70 when the Virus War broke out, and not at all old, tremendous vigor, all your teeth, jet-black hair, twenty-kilometer hikes every week; you hadn't had any transplants yet. You were still Dashiyin Choijamste then. Strange syllables, awkward now on the tongue, though that was your name for more than six decades. And I lived right through the Virus War untouched by the rot. People fell apart all around me. Sickening to behold. I didn't go in for transplants until later, much later, natural ravages of time, eventually, but not until after the power had come to me. The power. I have attained the highest power. And now clever doctors aid my natural Tatar vigor. I might live another fifty years.

I might live much longer than that.

Do I remember my childhood? How much snow piles up in 85 years! I think I can see my father's face, lean like mine, strong eyebrows, strong cheekbones. Yumzhaghiyin Choijamste of the camel-breeding station at Bogdo-Goom. Hero of the Order of Lenin, later. Wounded at the battle of Khalkhin Gol in 1939, afterward Third Secretary of the Agricultural Agency—see, father, I remember, I remember! The father of Genghis Mao killed in 1948 in a plane crash, be-

tween Moscow and Ulan Bator, coming home from a wheat conference. Those miserable Soviet jets, forever falling from the sky. Or was it a jet? So long ago: the jets were already in service then, weren't they, the Ilyushins, the Tupolevs? I could look it up. You are dead 62 years, Yumzhaghiyin Choijamste. Babies born the night your plane fell are old people now. And I am still here, father. I am Genghis Mao. I remember you at the camel station. I am standing in new snow and my father tugs on a camel's halter. The camel looms above me like a mountain, long homely face, rubbery lips, sweet dull eyes with undertones of subtle contempt. The camel leans toward me and its enormous tongue slurps across my cheeks, my lips. A kiss! Its sour breath. My father's laughter. He scoops me in his arms, gives me a crushing hug. How huge he is! Bigger than the camel, to me. I am three, four years old.

And my mother? My mother? I never knew her. Trampled by yaks in a wild snowstorm when I was an infant. I have forgotten even your name, mother. I could look it up. But where . . . where. . . ?

Shadrach pauses, reflects, reconsiders. Is it plausible? Does it have internal consistency? The tone is right, but what about the "facts?" He will test them. Shall he alter some significant details? Will that make any difference? Let's see—

October 17, 2012. My birthday. Genghis Mao is 92 today, though officially I am said to be a mere 87. On the other hand, some of them believe I'm well over 100. Meaning that I was born in 1905 or so. Can they believe that? Isn't 1920 bad enough? Wilson, Clemenceau, Henry Ford, General Pershing, Lloyd George, Lenin, Trotsky, Sukhe Bator . . . men of my time. And I am still here, anno domini 2012, I, the former Namsan Gombojab, born in Sain-Shanda, youngest son of the yak-herder Khorloghiyin Gombojab, who—

No. Changing the details is trivial. Let his original name be Choijamste, Gombojab, Ochirbal, whatever; let him have been born in 1925, 1920, 1915, even 1910; let him have spent his career in the Ministry of Defense, the Agency for Agrarian Redistribution, the Commissariat of Telecommunications; slather on any kind of factual decoration you like; none of it will make any difference. The essential patterns of the soul of Genghis Mao run deep and heavy, and they, his perceptions, his world view, are your subject, Shadrach. Not the trivia of time and place.

May 14, 2012. Just two hours ago the liver transplant was finished and here lies Genghis Mao, old and leathery, not dead yet, no, not by much; he is alert, full of energy, wide awake. I am proud of him. The unquenchable vitality of him. The insufferable resilience of him. I hail you, Genghis Mao! Ha! I feel pain in my abdomen but it's nothing to moan about. Pain is the signal that we live, we feel, we re-

pond to stimuli. The heaviness that came over me when the old liver began to fail is already going. I feel my system flushing itself clean. It is as if I float two meters above my own bed. Hovering over all the beautiful machinery that pumps healing fluids into my earthly husk. How beautiful is the pain. That throb, low and to one side . . . boom, boom, boom, a bell tolling within old Genghis Mao, urging him on to long life. Ten thousand years to the Emperor! My clever doctors triumph again. Warhaftig, Mordecai.

My doctors. Warhaftig is a mere machine. He bores me, but he is perfect. I love to see his hands disappear into the hole in my belly. And come forth grasping some limp red lump full of disease, throw it aside, stitch a new organ into its place. Warhaftig never fails. But he is ugly, with that flat nose, those downturned lips. Sick, dead, white skin. A genius, but ugly and boring, a mere machine. Was Warhaftig ever young? Crouching behind a bush to spy on the naked women bathing in a stream? Not him. Oh, no. not him. Laughing, tumbling on the grass? Warhaftig? Never.

Shadrach is more interesting. Graceful, witty, a fine strong body, a clear cool mind. He is pleasing to look at. His black skin. I never saw a black until I was forty and a delegation from Guinea visited my department. Their shiny faces, almost purple, their dense knotty hair, their tribal robes. Dazzling white eyes, pink palms like gorillas, deep voices, strange, strange. They spoke French. Shadrach is not like those Africans except that he has the same sort of keen, serious intelligence. He is brown, not black, very tall, very American, nothing of the jungle about him. Sometimes he lectures me as if I am a child, a naughty babe. Always worrying about my health. Conscientious, he is, earnest, dedicated, boyish. He is too sane for us here. He lacks—what? Darkness, can I say that of *him*? Yes. Interior darkness is what he lacks: there are no demons in him. Or do I underestimate him? There must be demons in everyone, even the robot Warhaftig, even the calm and good-humored Shadrach Mordecai. He is very young. I like that. He is at least fifty years younger than I am, and yet we are contemporaries, we are both men of the present moment, both of us unknown until relatively recently, though I waited so long to become who I am and he became himself so young. He smiles well. There is nothing cynical about him yet. He has lived through the Virus War and all the ugly things that followed and yet he is tranquil, he has faith in the future, he thinks only of healing people. He would heal those who enslaved his ancestors, even. Whereas I would avenge myself against the oppressors a thousand times over; but then, I am of Tatar stock, and we are fierce, we are Gobi wolves, while he is the child of placid jungle farmers. Every morning he goes into Surveillance Vector One and stares at the rotting people all over the world. Thinks I don't

know. I watch him watching. His lean mobile face, his sad intelligent eyes. He feels such sorrow for the rotting ones. A man of compassion. Childlike. Not saintly but he has the stuff of martyrs in him.

January 23, 2012. The Committee in plenary session. Horthy, Labile, Ionigylakis, Eyuboglu, Lapostolle, Farinosa, Parlator, Blount. All the finest bureaucrats. Drone, drone, drone, and I listened, not listening, to it all. They are machines. The Committee itself is a machine which I have constructed, a delicate and useless mechanism, like a clock without hands. When I die it will fall apart, if I die when I die. I allowed Mangu to preside. Bit by bit I ease him into the pretense of responsibility, the shadow of authority. He is fascinated by that mob of dreary bureaucrats, those *apparatchiks*, as a boy is fascinated by the buzzing of dungflies, and never mind the dung. Was this what I had in mind when I seized the reins of the world, that I would father upon it a Permanent Revolutionary Committee of dungflies? Revolutionaries! Lapostolle sleeps; Farinosa longs for Karakorum and sits twitching his long nose; Ionigylakis' belly rumbles. I should have named more Mongols to the Committee; these white foreigners have no fire. But I need my Mongols elsewhere. I should not let them turn into drones. Snore, snore, snore! It snows again today. I could slip from the Committee room, out of the building, secretly into the snow, lie in it, roll in it, throw handfuls in the air. Summon a horse and ride all night, no saddle, hooves silent on the whiteness, man and beast crossing the steppe without a pause, crust of bread for me, a goatskin full of airag to gulp along the way—aye, I am still a boy, I who am so ancient, and they are old men! But of course Shadrach would forbid it. I rule the world, he rules me. What if I insisted? Must I endure these droning flies when there is fresh snow on the Gobi? You can replace a crumbled kidney, I will tell him; surely you can repair an old man's frostbit nose. Yes. Yes. I will go. I will. I must escape from this boredom.

Is this what I had in mind, when I seized the reins?

What did I have in mind? Did I have anything in mind, except that everything was falling apart, and it was my task to hold it together? I think that was it. The world had descended into chaos. How I abhor disorder! Such turmoil, such confusion: the dying people, the dead nations, hordes of wild men sweeping across the land, nothing simple, all simplicity gone from the world. I love simplicity, a neatly organized structure, harmonious and satisfying, one nation, one government, one code of laws, everything one, onward to the horizon. I was 73 years old, and strong. The world was millions of years old, and weak. I could not bear the chaos. I think all those who have ruled the world were basically haters of chaos rather than mere lovers of power. Napoleon, Attila, Alexander, great Genghis, even

poor crazy Hitler, all of them wanted things to be neat, to be simple, had a vision of order, that is, and saw no other way to attain that order except to impose it themselves upon the world. As did I. Of course, most of them eventually spawned more chaos than they were removing, and they had to be removed themselves. Hitler, for example. I have not made that mistake. To the end, I do battle against entropy, I offer myself, Genghis II Mao IV, as the symbol of oneness, the focus of worldwide energy, the crystal of simplicity. But oh, Father Genghis, these plenary sessions, this droning, these dung-flies! Father Genghis, did you have a Horthy to harangue you? Did you sit idle, dreaming of a swift horse and an icy wind, listening to a Parlator and a Blount? Oh! Oh! Was it for this that I took upon myself the chaos of the crumbling rotting world?

Shadrach rises. He can sit here in reverie no longer; he has responsibilities, obligations, reports to file, projects to oversee. To begin with, he must update the Genghis Mao dossier with a concise account of today's aorta transplant, which means collating a vast sheaf of print-outs and selecting from that mass of raw and fragmentary data the significant outlines of a useful medical profile. Very well. He taps keys, summoning the out-takes of this morning's operation. But as he works, he finds his mind invaded at times by the spurious voice of Genghis Mao, dictating stray shreds of imaginary memoir:

May 27, 1998. The People's Republic is leaderless this morning and I think the government will collapse before noon. Shirendyb, the fifth prime minister in the past six weeks, succumbed to the organ-rot late last night. No one is left in the politburo; the presidium has been decimated; the streets of Ulan Bator are choked with refugees, a slow steady stream of ox carts and dilapidated trucks heading—where? It is the same everywhere. The old society is dying. Only ten years ago I thought fundamental change was impossible; then came the volcano, the terror, the uprisings, the Virus War, the organ-rot, and three billion human beings are dead and institutions are crumbling like shoddy buildings struck by earthquakes. I will

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Place	Title	Author	Points
1.	A Thrust of Greatness	*Stanley Schmidt*	1.934
2.	Brains Isn't Everything	*Christopher Anvil*	2.382
3.	Minotaur in a Mushroom Maze, Part 2	*Richard and Nancy Carrigan*	2.454
4.	Side Effect	*Hayford Peirce*	4.000
5.	Longevity	*Scott W. Schumack*	4.044

not leave Ulan Bator. I think my time is at last at hand. But the government I will proclaim will not be called a People's Republic.

November 16, 2008. To celebrate the tenth year of my reign I journeyed to Karakorum and dedicated the new pleasure complex. They invited me to experience the amusements they call "dream-death" and "transtemporalism." I chose dream-death. The irresistible fascination of the morbid. Especially the illusion of the morbid. It takes place in a tent full of pseudo-Egyptian motifs. The ugly old monster-gods hovering like gargoyles over the place; you can practically smell the reek of Nile mud, hear the buzzing of the flies. Attendants with masks. Bright lights. Much fuss made over me. Naturally I was the only one having the experience at that time. I allowed myself to be hypnotized behind a phalanx of picked Security guards. A sensation as of dying, very convincing, I think. (What does any of us know about it?) And then a dream. But in my dream the world was exactly as it is when I am awake. They promised me gaudy illusions and surreal fantasies. None. Have they deceived me? Are they afraid to let Genghis Mao taste the true experience?

June 4, 2010. Today the new physician began his duties. Shadrach Mordecai, a strange name. American, bright, earnest. He is terrified of me but that may pass. He holds himself so stiffly when he is with me! His training is in gerontology and he has been in the staff of Project Phoenix for several years. I told him, this morning: "We make a deal, you and I. You keep me healthy, I keep you healthy, all right?" He smiled but behind that he was plainly upset. Too heavy-handed of me, I suppose.

Somehow Shadrach finishes dictating the profile and moves along to the next task, which is to look over a project report from Irayne Sarafrazi. Nothing much new there: her project continues to wrestle with the brain-cell-deterioration problem, and, as Shadrach has foreseen, is getting nowhere. All the same, he must read the report through and find some encouraging comment to make. Still the insidious voice resonates in his head, distracting him with bursts of fantasy. Doggedly he works on, trying to ignore the mental static.

May 15, 2012. The most terrible news! Assassins have murdered Mangu. Comes now Horthy, bleating hysterically about falling bodies. How could this have happened? Into Mangu's bedchamber, silently, seize him, to the window, out! Oh, my fury. Oh, my bitter grief. What will I do now? My plans for Mangu thwarted. Shadrach tells me Project Phoenix is stymied, probably forever, on biological problems. Project Talos moves slowly, and Talos I have never really liked. Which leaves Avatar, and Avatar without Mangu is—

Ah. I will use Shadrach. A fine

body—I'll be happy in it. And black. A novelty. I should experience all the varieties of humanity. Perhaps when Shadrach's body is old I should move on into a white one—even a woman, perhaps—perhaps a giant some day, or a dwarf—all possibilities—

Shadrach has been a good doctor and a pleasant companion. But there are other doctors, and companionship becomes ever less important to me. Shall I feel guilty about snuffing him out? For a while, perhaps, a day, two days. But I must put myself beyond such feelings.

May 16, 2012. More thoughts on the choice of Shadrach to replace Mangu. Obviously some residual guilt lurking in me. But why? I propose not to murder him but to ennoble him by making his body the vehicle for immense power. Of course he might object that what I propose for him is, if not murder outright, then at best a form of slavery, and his kind has endured slavery enough. But no: Shadrach is not his ancestors, and all old debts have been canceled by the Virus War, which destroyed slaves and masters indiscriminately, struck down generals as well as babes, and left those who survived in the condition of pure survivors, pastless, liberated into a new dispensation in which history is born fresh and virgin each day. What do the sins of the slavemasters mean to anyone today? The society, the network of relationships, that evolved under the stimulus of slavery and its consequences, even of emancipation and *its* consequences, is wholly gone. And I am Genghis Mao and I require his body. I need not vex myself with the guilt of others. I am not German; I can send Jews to the oven if the need arises, without making apologies for past sins. I am not white; therefore I am free to enslave a black. The past is dead. History is blank pages now. Besides, if historical imperatives do still exist, I am a Mongol: my forefathers enslaved half the world. Can I do less? I will have his body.

May 27, 2012. I monitor this week's conversation tapes and find that Katya Lindman has told Shadrach the truth, that he is the next Avatar donor. Katya talks too much. It wasn't my intention to have him find that out, but let it go. I will watch him closely, now that he possesses the knowledge. The sufferings of humanity instruct me in the arts of government. Or, to put it more harshly, I enjoy watching them squirm. Is that not ugly? But I have earned the right to indulge in some ugly pastimes, I who have borne the burdens of power for fourteen years. I haven't been Hitler, have I? I haven't been Caligula. Yet power does entitle one to certain amusements. By way of compensation for the murderous burden, the awful responsibility. The odd thing is that Shadrach isn't squirming, yet. He is oddly calm. Doesn't yet believe that what Katya told him is true, I guess. Doesn't accept it in the viscera. He will. Wait. Just wait. It'll

hit him, sooner or later.

Suddenly this game is not in the least amusing to Shadrach. There is no fun, any longer, in these subtle exercises in ironic parallax, these experiments in psychological perspective. The distance between himself and what he has been inventing has narrowed abruptly, and indeed it is all suddenly very painful, it cuts much too close to the nerve, it hurts, it hurts with astonishing intensity. He has managed in the last ten minutes to puncture his own affectless equanimity, and he is not merely squirming, now, he is bleeding. Pain, fear, and anger assail him. He feels that everyone has conspired to sell him down the river. He—witty, urbane, handsome, humane, dedicated Shadrach Mordecai—is just another expendable nigger, it turns out. If what Katya has told him is true. If. If. Shadrach is in anguish. This, now, here, is the furnace, and he is in it for sure. The heavy shadow of Genghis Mao weighs upon him. One day they will come for him, they will put the electrodes to him, they will wipe out his unique and irreplaceable soul, and shortly thereafter they will pump that crafty old Mongol into his skull. Is that how it really will be? Yes, Katya says. And can he believe that? Should he believe that? He trembles. Terror whips through him like a cold gale. He craves peace; he could use a jolt of Genghis Mao's tranquilizer now, a hefty jolt of 9-pordenone or maybe something stronger. But Shadrach dislikes drugging himself in crisis. He needs his sharpest wits now.

What shall he do?

The first step is one he knows he should have taken yesterday. He will go to Nikki Crowfoot again. And ask her some questions.

She is pale and peaked-looking, still in the grip of yesterday's illness, but on the mend, definitely on the mend. She seems to know why he has come, and it takes only half a dozen harsh words from him to get from her the answer he did not really want to hear. Yes, it is true. Yes. Yes. Shadrach listens for a while to her stammering confession, full of circumlocutions and evasions, and then he says, quietly, reproachfully, "You could have told me before this." He is staring straight at her, and now, finally, she returns his stare: now that it is all out in the open between them, now that she has admitted the monstrous truth, she is at last able to meet his eyes again. "You could have told me," he says. "Why didn't you tell me, Nikki?"

"I couldn't. It wasn't possible."

"Wasn't possible? Wasn't possible? Sure it was possible. All you had to do was open your mouth and let words come out. 'Shadrach, I think I ought to warn you that you—'"

"Stop," she says. "It didn't seem that easy to me."

"When was it decided?"

"The day they sent Buckmaster to the organ farm."

"Did you have any part in selecting me?"

"Do you think I could have had

any part in it, Shadrach?"

He says, "One thing I learned a long time ago is that guilty people have a way of answering a troublesome question with another question."

But she does not seem wounded by his thrust, and instantly he regrets having made it. She is a strong woman, quite calm now that she has been unmasked by him, and in an altogether steady voice she says, "Genghis Mao chose you all by himself. I wasn't consulted."

"Very well."

"You might as well believe that."

Shadrach nods. "I believe it."

"And so?"

"When you learned I was the one, did you make any attempt to change his mind?"

"Has anyone ever changed Genghis Mao's mind about anything?"

"You notice how you parry my question with a question of your own?"

This time the jab hurts. She loses some of her newly regained poise. Her eyes slip from his, and she says hollowly, "All right. All right. I didn't try to argue with him, no."

Shadrach is silent a moment. Then he says, "I thought I knew you pretty well, Nikki, but I was wrong."

"What does that mean?"

"I believed you were the sort of person who sees human beings as ends, not means. I didn't think you'd let a—ah—a close friend—be nominated for the junkheap, and not lift a finger to save him, and not even say a word to him about it, no hint of what's been decreed for him. And start to avoid him, even. As if you had written him off as an unperson the moment he was chosen. As if you were afraid that his bad luck might be contagious."

"Why are you lecturing me, Shadrach?"

"Because I hurt," he says. "Because someone I loved sold me out. Because I can't bring myself to hurt you back in any way that's real."

"What would you have wanted me to do?" Nikki asks.

"The right thing."

"Which was?"

"You could have stood up to Genghis Mao. You could have told him you wouldn't participate in your lover's slaughter. You could have let him know that there was a relationship between us, that you weren't capable of—oh, Christ, Nikki, I shouldn't have to be explaining all this to you!"

"I'm sure Genghis Mao was quite aware of the relationship between us."

"And picked me deliberately, by way of testing your loyalty? To find out how you would react if you were made to choose between your lover and your laboratory? One of his little psychological games?"

She shrugs. "That's entirely conceivable."

"Maybe you made the wrong choice, then. Maybe he was trying to measure your fundamental humanity rather than your loyalty to Genghis Mao. And now that he sees how cold-blooded, soulless, unfeeling you are, he may decide that he can't take the chance of having a person like you in charge of—"

"Stop it, Shadrach." She is giving ground under his steady assault, his quiet, measured, remorseless voice; her lips are trembling, she is visibly fighting back tears. "Please," she says. "Stop. Stop. You're getting what you want."

"You think I'm being unkind? You think I've got no call being angry with you?"

"There was nothing I could have done."

"Nothing?"

"Nothing."

"What about threatening to resign?"

"He'd have let me resign, then. I'm not indispensable. Redundancy is—"

"And your successor would have continued with the project, using me as the donor."

"I imagine so."

"Still, even if it changed nothing at all, wouldn't you have felt cleaner putting up some kind of resistance?"

"Perhaps," she says. "But it would have changed nothing at all."

"You could have warned me, at least. I might have fled from Ulan Bator. We might have fled together, if your resignation got you in trouble with Genghis Mao. Wasn't worth destroying your career over me, though, was it?"

"Flee? Where to? He'd be watching us. On Surveillance Vector One, or some other spy gadget. In a day or two he'd decide we had had a long enough holiday, and the Citpols would pick us up and bring us back."

"Maybe."

"Not maybe. And I'd end up in the organ farm. And you'd still become the Avatar donor."

Shadrach considers that scenario. "You're telling me that it wouldn't have mattered whether you had warned me or not?"

"Not to you," Nikki replies. "It would have mattered to me. One way I lose my job and maybe my skin. The other way I get to survive a little longer."

"I still wish you had been the one to tell me."

"Instead of Katya?"

"When did I say Katya was the one?"

Nikki smiles. "You didn't need to, love."

August 19, 2009. A mild summer day in Ulan Bator. Across half the world it is summer now. The time of lovers. Surveillance Vector One shows me the lovers going arm in arm through the streets of Paris, London, San Francisco, Tokyo. The fond gazes, the little kisses, the nudges of hip against hip. Even the ones with organ-rot shuffling along together, slowly dying but still doing the dance of love. Fools! I think I remember how that dance goes, though it's forty or fifty years behind me. Yes, yes, the first meeting, the preliminary tensions and assessments,

the probing and parrying, the spark of contact, the dissolving of barriers, the first embrace, the tender words, the pledges, the sense of conspiracy, two against the world, the assumption that all this will last forever, the discovery that it will not, the falling apart, the falling out, the parting, the healing, the forgetting—oh, yes, the man who is Genghis Mao once danced that dance, long before he was Genghis Mao, he once played that game. Long ago. What purpose does it serve? An anesthetic for the aching ego. A lubricant for the biological necessities. A diversion, a distraction, a foolishness. When I saw it for what it was I renounced it, and no regrets. Look at them strolling together. "Eternal love." As if anything's eternal. But love? *Love?* It's an unstable state, thermodynamic nonsense, two energy-sources, two suns, trying to establish orbits around one another, each one striving to give light and heat to the other. How pretty it sounds, how implausible. Naturally the system breaks down under gravitational stress sooner or later, and one pulls the other to pieces, or they spiral into collision, or they go tumbling away from one another. A waste of energy, a futile spilling of the life-force. Love? Abolish it! If only I could.

January 4, 1989. The text of my doctrine is complete, and when the appropriate moment comes I will reveal it to the world. Today, as I finished the last passages, a name for it came to me: *centripetal depolarization.* Defined as the forging of a consensus of irreconcilables through the illusion of the attainment of everyone's mutually exclusive goals. And it will sweep the world as irresistibly as once did the hordes of old Father Genghis.

Shadrach takes momentary refuge in carpentry. Until now that fashionable cult has been mere amusement for him, a source of relaxation and release rather than the quasi-mystical focus that it is for many of its adherents, but now, frayed and desperate, no longer the calm and detached Shadrach of yore, he surrenders to its full intensity. The world has tightened around him. Ostensibly, all is as it has been, and is not going to change; his routines will continue, his doctoring and his calisthenics and his collecting and his trips to Karakorum; but in these past two days, aware now of the dread subtraction of self that Genghis Mao has covertly ordained for him, Shadrach finds the familiar and comfortable rhythms of life no longer enough to keep him together. Fear and pain have begun to seep into his soul, and the only antidote he knows for that is submission to some force greater than himself, greater even than Genghis Mao, some all-encompassing power. If he can, he will make carpentry the vehicle of that submission. With hammer and nails, then, with chisel and adz, with plane and saw and awl, he seeks, if not salvation, then at least temporary freedom from anguish.

Usually Shadrach attends the

large and majestic carpentry chapel in Karakorum. But there is always a carnival atmosphere in Karakorum, and that tends to trivialize whatever he does there, be it carpentry or dream-death or transtemporalism or mere fornication. Now, in genuine spiritual need, he wants not the fanciest chapel but the one most readily accessible, the one that will enable him most quickly to find surcease from pain, and he goes to a place here in Ulan Bator, down by the Tuula River, in one of those streets of formidable blocky white stucco buildings constructed in the latter days of the Mongolian People's Republic.

It is a starkly functional no-nonsense sort of chapel, lacking in any religious or pseudo-religious iconography. Big bare rooms, sputtering fluorescent lights, the smell of sawdust and lemon oil—it could be an ordinary carpenters' shop, but for the silence and the peculiar concentration with which the men and women at the benches are going about their tasks. Shadrach pays a fee at the entrance—strictly a service charge, covering the cost of tool rental, lumber, and maintenance, never a fee for worship itself—and is shown to a locker where he exchanges his street clothes for clean coveralls. Then he selects a vacant bench. Shining well-oiled tools have been arranged along and around it with an eye for symmetry and neatness that is positively Japanese: chisels of many sizes in a precisely ordered row, an assortment of hammers and mallets, a cluster of gauges, augers, pincers, compasses, bevels, files, try-squares, and rules. The equipment is deliberately varied and copious, to impress upon the worshipper the hieratic nature of the craft, the ancient lineage of its practice, the complexity of its scope.

No one speaks to him. No one looks at him. No one will; those who enter here must remain alone with their tools and their wood. A strange solemnity steals over him as he makes ready to enter the customary initial state of meditation. In the past, having come to the chapel for nothing more than a relaxing couple of hours of cutting and joining, seeing the whole experience as an amusement on the same level as a round of golf or a game of billiards, he has approached this stage of the ceremony in a casual and amiable way, accepting it as part of the tradition, something that one does merely to get into the spirit of the thing, the equivalent of a golfer's ritualized practice swings or a billiards-player's careful chalking of the cue; but this time, as he presses both hands flat against the workbench and bows his head, he feels neither flippant nor stagily ostentatious; he is aware of a numinous presence all about him, and he grows somber and reflective as it enters his soul.

In the meditation one first must consider the tools, their form and divine essence. One must visualize them and name them: this is a tenon saw, this a dovetail saw, this a gimlet, this a bradawl. One then must dwell on their purpose, which

requires one to imagine each tool in action, and this in turn calls for contemplation of certain basic techniques of carpentry and joinery: the making of mortises and tenons, the construction of joists and frames, the fitting of veneers, the setting of braces and struts and wedging. This phase of the meditation is the most prolonged and the most intense. Shadrach has heard that some adherents to the cult devote the entire energy of their worship to it, and never actually take tools and wood into their hands, but carry out a completely satisfying communion in their minds alone. Until today he has never really understood how this could be accomplished, but now, scribing and mitring and butting as he sits with closed eyes, mentally fitting tenon into mortise and tongue into groove, he sees that actual manual labor can be extraneous to this experience if one is able fully to enter into the meditative phase.

He perceives this, but he moves on anyway into the terminal stage of the meditation, which is the entry into the wood, the mother-staff. This too is a highly structured exercise, which one must begin by imagining trees, not merely any trees but specific timber trees of one's own choice, ordinarily pine or spruce or fir for Shadrach, occasionally more exotic woods, according to his whim, ebony, palisander, mahogany, teak. One must *see* the tree; one must imagine it felled; one must carry it onward to be milled and seasoned; one must at last behold the finished board, and contemplate its grain, its texture, its moisture content, its vulnerability to shrinkage and warpage, all its characteristics and special beauties. And then, only then, when one can taste the wood on one's tongue, when one feels the tool hot and eager in one's hand, then does one rise and go to the bin and select one's lumber and begin to work.

Shadrach knows, by the time he has reached this stage, exactly what the form of his worship will be today. He will do no fancy joinery this day, but simple heavy carpentry, simple but pure, a job that strikes to the essence of form: he will construct the centering for a brick arch. It has sprung entire into his mind, the ribs and ties, the braces and struts, the laggings, the wedges; he has calculated the curvature, the span, the height of the crown, the springing line, all in one rush of inner vision, and now he need only cut and fit and hammer, and when he is done he will disassemble everything, carry out the ceremonial burning of the sawdust, and depart, drained and eased of tension.

He works quickly. A kind of wild feverish energy has come over him. He hastens from bin to bench, from bin to bench; his mouth bristles with nails of half a dozen lengths; he does not pause for an instant. Yet there is nothing rushed about his labor. To rush would be folly; the point here is to attain calmness of spirit. The work should be accomplished swiftly but without haste. Serenely Shadrach builds. The work contains its own purpose and has none beyond the

immediate spiritual fulfillment, for one never *uses* anything one constructs in the carpentry chapel, one never takes anything away that one has put together, any more than one would bring in one's own tools. This is not a substitute for the home workshop, after all. The idea here is solely to exercise skill in joining, and thus to experience the fundamental connectivity of the universe; what one actually makes is incidental, a means to a higher end, and must not be allowed to become a goal in itself. Shadrach has never fully understood that part of it before today, either. He has enjoyed the physicality of the work, the hammering and the sweat, and he has enjoyed the esthetic reward, the pleasure of watching something sturdy and attractive take shape under his hands, and he has always felt mildly distressed at the necessary disassembling that follows; because he has never seen the carpentry cult as anything more profound than tennis or golf or bicycle-riding, he has never attained those farther reaches of the spirit which he has heard are available to the communicants here. Now he does attain those reaches, at least their nearer fringes, and, penetrating unexpected realms, he finds his fears and resentments fall away, and he is purified. So it must have been for the Creator, shaping worlds on quiet afternoons, experiencing a total sense of identification with the task, a sense of utter selflessness, of being no more than a conduit for the great shaping force that flows through the universe. No doubt one can just as readily attain the same tranquil place through tennis or golf or bicycle-riding, Shadrach realizes. The means is unimportant; only the state of consciousness toward which one journeys matters. He sees his arch acquiring form; it is not *his* arch but *the* arch, the prototype of all arches, the ideal arch, the arch on which the vault of the heavens rests, and he and the arch have become one, and he, Shadrach Mordecai of Ulan Bator, bears all the weight of the cosmos and feels no burden. Does an arch complain of the load? The arch, if the arch is a proper arch, merely transmits the weight to the earth, and the earth does not complain either, but imparts the thrust of its burden to the stars, which accept it unprotestingly, for there is no burden, there is no weight, there is simply the ebb and flow of substance between the joined members of the one great entity that is the matrix of everything; and when one has perceived that, can it be such a serious matter that one's body, which at the moment houses a pattern of responses that calls itself "Shadrach Mordecai," may soon house instead something calling itself "Genghis Mao"? Such transformations are meaningless. Change does not occur; there are only transfers, not transformations; the only reality is the reality of eternal flux. He is purged of all discord and all dismay.

The arch is done. Shadrach briefly admires its perfection of form; then, calmly, he knocks it apart and carries the pieces to the salvage bin.

Does the arch no longer exist, simply because its components have been dismembered? No. The arch exists, shining as brightly in his mind as when he first conceived it. The arch will always exist. The arch is indestructible. Shadrach restores his tools to their original immaculate order, and gathers his sawdust, and makes the ceremonial pyre of it in the urn in the aisle. When his bench is as clean as he first found it, he kneels, bows his head, and remains that way a minute or two, altogether untroubled, mind blank, a tabula rasa, healed and made whole. Then he goes out.

Images of Mangu are everywhere in the streets, the handsome Mongol face looking down from the facade of every building and staring out from great banners strung from lampposts high above the roadways. At the intersection of three grand boulevards workmen are diligently erecting the armature for what is undoubtedly going to be a vast statue of the dead viceroy. The process of canonization is well-advanced; day by day, departed Mangu is thrust more visibly into the consciousness of the citizens of the world capital, and doubtless everywhere else as well. Mangu dead has taken on a power and a presence never possessed by Mangu alive: he has indeed become a fallen demigod, he is Baldur, Adonis, Osiris, the slaughtered promise of spring, and he is due to rise again.

Shadrach, cool and bouncy, wanders toward the river, whistling some lush romantic melody—a tune out of Rachmaninoff, he suspects. He is being followed, he realizes, by a man who emerged from the carpentry chapel a moment after he did. This does not worry him. For the moment, nothing worries him. He is charmed by everything, the steppe, the hills, the faintly chilly spring air, the idea of being followed. He is charmed even by the silly ubiquity of Mangu, whose bland symmetrical features have been plastered to everything, and sprout from mailboxes, from trashbins, from the low smooth white wall of the promenade that runs along the river; there are Mangu pennants and streamers hanging all around, and everything is done to a background of the Mongol mourning color, which is yellow and lends an oddly bright and festive tone to the display, as though there is shortly to be a parade in Mangu's honor, followed by the viceroy's glorious second coming. Shadrach smiles. He leans his long body over the promenade wall to admire the lovely turbulent flow of the river, quickened by its spring freshets and humming along with rare energy, swirling and dancing. He imagines filaments and tendrils of tributary streams spreading outward from the channel below him, lacing this arid land together, carrying water joyously from the mountains, sweeping it to the river and thence to the sea, a vast arterial system serving the living, throbbing entity that is the earth, and the image pleases the doctor in him. If he listens carefully, he tells himself, he can hear the breathing of the planet, and even the rhythms of its

heart, *lub*-dub, *lub*-dub, *lub*-dub.

The man who has been following him appears now on the promenade and takes up a position just to Shadrach's left. Side by side they watch the river in silence. After a moment Shadrach risks a furtive glance and discovers that the man is Frank Ficifolia, the communications expert, the designer of Surveillance Vector One. Ficifolia is a short, rotund, capable man, perhaps fifty years old, good-natured and talkative, and his uncharacteristic silence now is significant. Upon entering the carpentry chapel Shadrach had had a glimpse of someone he thought might be Ficifolia, but the etiquette of the cult had kept him from taking a second look; his guess is now confirmed. But a different etiquette controls Shadrach here. In the bugged and spy-eyed world of Genghis Mao, one is frequently approached by people who wish to talk without outwardly seeming to be holding a conversation. Many times, Shadrach has carried on long interchanges with someone who is staring in another direction, even with someone whose back is to him. He continues, therefore, to study the rushing flow of the river, offering Ficifolia no greeting, and waiting.

Eventually, Ficifolia says, apropos of nothing and without looking at Shadrach, "I don't understand why you're still hanging around here."

"Pardon me?"

"In Ulan Bator. Waiting for the ax to fall. If I were you I'd go into hiding, Shadrach."

"So you know about—"

"I know, yes. Several people know. What are you going to do?"

"I'm not sure. Stay put for a while, I guess, and think things over. There's a lot I have to evaluate."

"Evaluate? *Evaluate?* Of course you'd say something like that!" Ficifolia, though plainly trying to be unobtrusive, cannot control his emotions; he raises his voice, he gesticulates passionately. "You know, man, you never belonged in this town. You aren't crazy enough to qualify. You're so calm, so reasonable, you always want to think things out, you want to stop and evaluate when they've got the knife to your throat—how did you ever land here, anyway? This is a place for madmen. I mean that seriously, Shadrach. The lunatics are running the asylum, and the head lunatic is the craziest one of all, and you just don't fit in. Can you think of anything crazier than a world full of rotting people governed by a few thousand Antidote-filled bureaucrats and ruled by a ninety-year-old Mongol warlord who's planning to live forever? This is sanity? This is the logical outcome of five hundred years of western imperialism? And the spy-eyes everywhere? The surveillance vectors taping my very words right now and feeding them to God knows what kind of machine where they may not be digested and acted upon for three thousand years? The robot policemen? The organ farms? Anyone who begins to take this world at face value has to be a madman, and that's what we are, all of us, top to bottom, Avogadro, Horthy,

Lindman, Labile, me, the whole crew. Except you. So solemn, so contained, so accepting. Doing your job, doing your job, you and Warhaftig, stitching the new liver into the Khan, never cracking a smile, never saying to each other, This is a crazy way of making a living, never even perceiving the craziness because you're so fundamentally sane—not Warhaftig, he's either a robot or a lunatic, but you, Shadrach, dead-pan, full of weird microelectronic gear and even that doesn't upset you. Don't you ever want to scream and rant? Do you have to accept everything? Do you even accept the idea that Genghis Mao is going to evict you from your own *head?* Do you—" Abruptly Ficifolia checks himself, reining himself in with a little shudder and a quick series of jerking tics of the facial muscles. More calmly, in an entirely different voice, he says, "Really, Shadrach, you're in big trouble. You ought to disappear while you still can."

Shadrach shakes his head. "Hiding's not my style."

"Is dying?"

"Not particularly. But I won't hide. That's not like me. My people are done with hiding. The old Underground Railway days are gone forever."

"*'My people are done with hiding,'*" Ficifolia says, doing his mimicry in a harsh, high-pitched tone. "Jesus. Jesus! Maybe I underestimated you. Maybe you're as crazy as the rest of us here. Genghis Mao has fingered you for doom, has put the old black spot right on you, and you put racial pride ahead of survival. Bravo, Shadrach! Very noble. Very dumb."

"Where could I go? The Khan's spy gadgets will find me anywhere. Gadgets that you helped invent for him."

"There are ways."

"Disguise myself? Paint my skin white? Wear a blond wig?"

"You could disappear the way Buckmaster did."

Shadrach coughs. "I don't need sick jokes just now, Frank."

"I'm not talking about organ farms. I mean *disappearing.* We disappeared Buckmaster. We could do the same for you."

"Buckmaster isn't dead?"

"Alive and well. We altered the master personnel register the day he was sentenced. Transposed half a dozen binary digits and the records show that Roger Buckmaster went to the organ farms on such-and-such day and was duly carved up. Once it's in the record, it's realer than real. Machine reality is a higher order of reality than reality reality. If Buckmaster shows up on any of the Khan's scanners now, the computer will reject the data as nonsense, because Buckmaster is known to be dead, and dead men by definition aren't found walking around."

"Where is he?"

"That's not important now. What's important is that we saved him, and we can save you."

"*We?* Who's 'we'?"

"That's not important either."

"Should I believe any of this, Frank?"

"No. Of course not. It's all lies. Actually, I'm spying for the Khan,

trying to trap you. Jesus, Shadrach, use your head! Do you think I'm trying to get you into trouble? You *are* in trouble. I'm risking my neck to—"

"All right. Let me think, Frank."

"So think, already."

"You do your hocus-pocus and I disappear. Now I'm without an identity and without a profession. Can I practice medicine if I'm hiding out in some cellar? I was meant to be a doctor. Maybe not Genghis Mao's doctor, but somebody's doctor, Frank. If I'm not working at that, I'm nobody, I'm a waste of skills and talent. In my own eyes I'll be nothing. Is there any point in disappearing into that kind of life? And how long would I have to stay underground? If I'm going to spend the rest of my life locked up in a cellar, I wouldn't be a whole lot worse off letting Genghis Mao use me for Avatar. Better off, maybe."

"You might have to stay out of sight until Genghis Mao dies. But afterward—"

"Afterward? What afterward? Genghis Mao might live another hundred years. I won't."

"He won't either," Ficifolia says, strange undertones of menace in his voice.

Shadrach stares in wonder. He is not sure he believes a syllable of this. Buckmaster alive? Ficifolia a subversive? Conspiratorial plans afoot to do away with the Khan? Questions bubble in him, and he hungers for a thousand answers; but from the corner of his eye he perceives men in gray and blue, two Citpols on patrol. So there will be no answers now. Ficifolia sees them too and nods ever so slightly and says, "Think about it. Do your evaluating, let me know what you want to do."

"All right."

"Have you ever seen the river as high as this?"

"It was an unusually snowy winter," Shadrach says, as the Citpols saunter past.

May 27, 2012. Troublesome dreams last night. Mouth full of cobwebs, fingers growing roots. Premonitions of death. Is the end of Genghis Mao drawing nigh? Morbid, morbid, morbid. To wake and not to be there. The great crash of silence. It pains me. To wake and not to be there. To have gone somewhere else. Or to have gone nowhere at all, the big black hole. The longer one lives, the tighter one grasps life: living becomes a habit that's hard to break. How empty the world would be if I were to leave it. Poof, no more Genghis Mao. Such a vacuum! The winds rushing in from the four corners to fill my place. Tornado. Hurricane.

Oh I love to dwell on death.

Dying can be so instructive. Dying can tell you so very much about your true self. Dying can even be pleasurable, I imagine. Dying as a healing experience, yes, the battered old body gladly giving up the ghost! For some people I imagine it is the sharpest ecstasy they have ever known.

Oh I dread it.

How shall I die, what will the

manner of my going be? I think I fear assassins most of all. To leave the world is one thing, natural and inevitable; to be *sent* from it is altogether other, an affront to the self, an insult to the ego. I will not be able to bear that awareness of dismissal. Or the sense of transition, the moments just before the going, the confrontation with the killer, the contemplation of loss as he moves toward me with his knife or his gun or whatever. Let it be a bomb, if it comes. Let it be instant poison in my soup. But there will be no assassins. I am guarded too well. The mistake was in not protecting Mangu the same way. Still, Mangu wasn't Genghis Mao: his loss was not to him what my loss will be to me. The idea of dying is alien to me. I am too large of spirit, I occupy too great a place in the consciousness of mankind; the subtraction of me from the world is more than the world can accept. Certainly more than I can accept.

But why all this morbidity? Strange, considering how healthy I feel. Tremendous surge of vitality since the aortal transplant. I thrive on surgery. I should get some sort of organ work done every week. Change kidneys the first of every month, new spleen on the fifteenth. Yes. Meanwhile, healthy though I am, death plays games with my soul as I sleep. I think that it is an amusement, a delicious sport, to toy with fantasies of death. We require some tension in our lives to relieve that unbearable *onwardness* of existence. That flow of event, day following day, sunrise, noon, sunset, dark, it can be crushing, it can stultify. And so. The delight of dwelling on the end of all perception, that is, the end of all things. There is joy in thinking about the dismal. Especially though not exclusively as it applies to others. There is a German term, *schadenfreude,* the joy of gloom, the pleasure to be had from the contemplation of the misfortunes of others. This sorry century has been the golden age of schadenfreude. We have known the ecstasy of living at the end of an era, we have shared many blessed moments of decline and collapse. The shelling of the cathedrals in 1914, the English troops dying in the mud, the Soviet massacres, the first great economic disaster, the war that followed it, Auschwitz, Hiroshima, the time of the assassinations, the toppling of the governments, the Virus War, the organ-rot, so much to weep about, though of course always it was others who suffered more than one's self, which makes the weeping sweeter, nine dark decades and I have tasted them all, and why not now achieve a bit of interior distance and turn the principle inward, why not weep for the death of Genghis Mao? There is more pleasure in mourning than in dying. Let me in fantasy savor my own lamentable passing. How much I regret my going! I am my own most grief-stricken mourner. I love these fantasies; I feel so exquisitely sorry for myself. But am I in fact dying? I summon Shadrach. He tells me my morning readings. Everything normal, everything

healthy. I am a phenomenon. I will not go from the world today. Long life to the Khan! Ten thousand years to the Khan!

Béla Horthy seeks him out in a corridor on one of the lower floors of the Grand Tower of the Khan and says, pretending not to be looking at him, "Frank tells me that you intend to stay here."

"For the time being," Shadrach says. "I need to think."

"Thinking is useful, yes. But why do your thinking in Ulan Bator?"

"It's where I live."

"For the time being," says Horthy. He swings around and looks straight at Shadrach—boldly, daringly. His wild hyperthyroid eyes are veiled with concern. He must be one of the conspirators too, Shadrach realizes, and that doesn't seem terribly surprising at all. Horthy says softly, "Run, Shadrach."

"What's the use? They'll catch me."

"Are you sure? They haven't caught Buckmaster yet."

"Aren't you afraid to be saying things like that? When there might be—"

"Scanners in the walls?"

"Yes."

"Everything gets scanned. Everything gets taped. So what? Who can run through all the tapes? The Citpols are drowning in data. Every spy-channel is choked with rivers of conspiracy, most of it insane and imaginary. There's no filtering system to eliminate the useless noise." Horthy winks. "Go. As Buckmaster went."

"Useless," replies Shadrach.

"I don't think so. I advise running. I *strongly* advise running. You know, some people think better when they're on the run."

Horthy smiles. He takes Shadrach's hand for a moment.

As Horthy walks away, Shadrach calls after him, "Hey, are you part of it too?"

"Part of what?" Horthy asks, and laughs.

May 28, 2012. More dark dreams. I went down to Sukhe Bator Square and found they had erected a statue of me in the center of the plaza, a colossus, at least a hundred meters high, made of bronze that was already developing a green patina. My arms outspread in benediction. My face looked awful: wrinkled, cavernous, hideous, the face of a man five hundred years old. And the statue had no legs. It ended at mid-thigh, Genghis Mao on stumps, *but the statue floated in mid-air,* as though the legs had once been there but had been chopped away and the statue had remained at its original height. There was an old workman, sweeping up faded flowers, and I said to him, "Is Genghis Mao dead?" and he said, "Dead and gone, they sent the pieces back to Dalan-Dzadagad, and good riddance." The pieces. They sent the pieces back. I don't like this. There is too much death in my head these days. The game has lost its savor. I must take steps.

After breakfast I decided to make an inspection of the project

laboratories. When preoccupied with death, drop in on those who would help you live forever.

Wise idea. Immediately felt better. First personal visit in months. Should go more often.

Called on Phoenix first, the dainty Sarafrazi woman in charge, marvelous eyes, beautiful face. Terrified of me. Showed me her monkeys, her bubbling vats of chemicals, her pickled brains in belljars. Optimistic forecasts from her, delivered in tense throaty voice. She'll make me young again, so she claims. Am not so sure of that but told her to keep at it. Paralyzed with awe, she was. I thought she was almost going to kneel as I left.

Went from there to Talos. Came in unannounced, but the Lindman woman cool as ice anyway. The report is that she's Shadrach's new lover. Can't understand what he sees in her. Something about her mouth I don't like, spoils her face. Looks like the mouth of some ferocious gnawing creature. She's got a plastic Genghis Mao in her lab, very large, nothing finished below the waist, just framework there, no legs. *No legs.* The Genghis Mao Memorial Statue. "Finish the legs," I told her. She gave me a peculiar look. Told me the legs were the final job, more important now to get the internal engineering done. Knows her own mind, won't take nonsense from me. Even if I am Chairman of the Permanent Revolutionary Committee. I Genghis II Mao IV Khan do command—no. Her robot can wink, smile, wave its arms. Gonchigdorge was with me and said, "It's just like you, sir, a remarkable likeness," but I can't agree. Ingenious but mechanical. I wouldn't want it to succeed me. I will not terminate Project Talos, not yet at any rate, but I don't think it's going to be able to produce what I need.

Went on to Nikki Crowfoot's lab, Avatar. Ah! Yes! Beautiful woman, though tense, depressed, withdrawn, these days. Guilty about Shadrach, I imagine. She ought to be. But she remains a loyal servant of the Khan. Is this a good thing? "When will you be ready to make the transfer?" I asked her. She said, "It's just a matter of months." I felt such a surge of excitement at that that Shadrach phoned from upstairs to find out if I was all right. Told him to mind his own business. But I *am* his own business. Anyway, Avatar gives me hope. Soon I will put on new healthy flesh. Before the first snows come I will speak to the world with Shadrach's lips, I will breathe the air with Shadrach's lungs.

Entering the Project Avatar laboratory unannounced in mid-afternoon, Shadrach is confronted immediately by Manfred Eis, Nikki Crowfoot's chief assistant, who emerges out of a maze of equipment and strides purposefully toward him like Thor on the warpath, halting with a crispness just short of a heel-click.

"We are very busy now," Eis announces, making a challenge out of it.

"I'm glad to hear it."

"You have come because—?"

"A routine inspection visit," Shadrach answers mildly. "To check on progress. I haven't been here for a while."

In fact it is several weeks since he was last in the Avatar lab, not since just before Mangu's death, and the rhythm of his schedule has usually brought him to each project at least once a month. But Eis hardly makes him feel welcome now. He is a cold-mannered, humorless man at best, a cliché-Teuton, stiff and square-jawed and square-shouldered and very Nordic, with frosty blue eyes, pearly teeth, long yellow hair, everything but the dueling scar. Shadrach is accustomed to Dr. Eis' Aryan brusqueness, but today there is something new in his manner, something gratuitously hostile, almost patronizing, vaguely contemptuous, that Shadrach finds disturbing because he suspects it has to do with his own suddenly significant personal involvement in the destinies of Project Avatar.

Eis is *pleased* that Shadrach has been chosen. Eis is *gratified.* Eis thinks it altogether *proper* that Shadrach should be the one. That's it. Perhaps it was Eis who actually sold Genghis Mao on the idea of selecting Shadrach. No, no, an underling like Eis would never have had access to the Chairman; but still, Eis must have rejoiced, seems still to be rejoicing right now. Shadrach does not like being gloated over. He wonders if it is possible to find some appropriate experimental use for Eis' fine Nordic body.

Nevertheless, Shadrach is nominally in charge here, and Eis must give ground. Busy though the lab is, he will have to let Shadrach make his inspection. The place really is busy, too, frantic, all sorts of experiments with all sorts of animals under way, while electronic gear is hauled from room to room by sweating, cursing technicians, and men and women in lab smocks run around wild-eyed, brandishing sheafs of print-outs—a real circus, altogether manic and comic, mad scientists at work, desperately striving to square the circle before the onrushing deadline arrives.

It makes Shadrach queasy to realize that *he* is the circle they must square. He is the patsy, the sucker, the victim, whose life is eventually going to be swallowed by all this equipment, and the manic tone of the current Avatar operations is entirely the result of the need to convert everything, fast, from Mangu-parameters to Shadrach-parameters. Probably a dozen people here know as much about his body, his brain-wave patterns and his neural circuitry and his serotonin levels, as he does himself. Quite likely he has been under covert scrutiny for days. (Do they steal nail-parings? Hair-clippings?) Shadrach wonders how many of these technicians know of the host substitution. He imagines that they all do, that they are eyeing him with secret fascination even as they rush to and fro—that they are sizing him up, comparing the authentic actual Shadrach Mordecai to the clusters of abstract and synthetic Shadrach-simulation pulsations that they have been working with. But maybe not. Apparently only a few of the Avatar people knew that Mangu was going to be the body-donor in the first place, and most likely even fewer have been allowed to learn the identity of Mangu's replacement.

Nikki, at any rate, is not caught up in the general manic mood. Summoned by Eis, she greets Shadrach quite calmly. The project, she tells him, is making steady progress. Her gaze is steady, her voice is centered and composed. "Progress," in this laboratory, can only mean the daily process of bringing Shadrach closer to destruction, and certainly she is aware that he will put that interpretation on it; but it seems that she has decided not to feel guilty or act evasive any longer. They have already had their showdown; she has admitted that she was willing to betray her lover for the sake of Genghis Mao; now life continues—for however long—and she has her job to do. All this passes between them within the space of ninety seconds, and none of it is communicated in words, only in tone of voice and expression of eyes. Shadrach is relieved. He does not enjoy making people feel guilty; it makes him feel obscurely guilty himself.

"I should look at the equipment," Shadrach says.

"Come."

She takes him on a guided tour. She demonstrates for him the zoo of metempsychosized animals, the latest triumphs of electronic transmigration: here is a dog with the soul of a raccoon, diligently dip-

ping its dinner in a pan of water, and here is an eagle with a coded peacock-construct in its skull to make it strut and preen and spread its wings, and here they have slipped the essential sheepness of a sheep into a young lioness, who sits placidly munching fodder, to the probable detriment of her digestive system. All these reborn beasts have a trapped, bewildered look, as though they are being gnawed from within by some insatiable parasite, and Shadrach asks Nikki if this is going to be a characteristic of human avatars as well, if the expunged soul of the body-donor will not linger as a miasma to complicate the life of his supplanter.

"We don't think so," Nikki says, "Remember, all the animals I've shown you have undergone implant codings across species lines, in fact across generic lines. A peacock is *never* going to be comfortable in an eagle's body, or a sheep in a lion's. Eventually the animal gets the hang of operating its new body, but it'll always tend to keep reverting to the old reflex patterns."

"Then why bother with trans-generic switches? What's the point, other than showing off how clever you are?"

"The point is that the disparities between the implanted entity and the host are so gross that we can instantly confirm the success of the implant. If we put a spaniel's mind into another spaniel's body, if we put a chimp into a chimp, a goat into a goat, how do we know if we've accomplished anything? The goat can't tell us. The spaniel can't tell us."

Shadrach frowns. "Surely the electrical pattern of one spaniel's brain is different from another's, and that can readily be detected. If brain-wave patterns aren't unique to the individual, what's your whole project all about?"

"Of course the patterns are unique," Crowfoot says. "But we need confirmation on gross behavioral level. We *have* done intra-species coding and implants, plenty of them, but the behavioral differences after the implant are too subtle to prove very much when we put one chimp into another, say, and the brain-wave changes that we can detect are, for all we know, just artifacts of our own meddling. Whereas if we code a sheep and feed her into a lioness, and the lioness is thereupon transformed into a grazing animal, we have very dramatic confirmation that we've achieved something. Yes?"

"But it would be very much more dramatic, naturally, if the minds you were switching around were human ones. And much easier to confirm that a switch has actually been induced."

"Naturally."

"Only you haven't done any of that."

"Not yet," Nikki says. "Next week, I think, we'll tackle our first human implant."

Shadrach feels a faint chill. He has managed an admirable impersonality thus far on this tour, he has carried on this conversation exactly as though his interest in Project Avatar is a purely professional one; but it is not that easy

to escape an awareness of the ultimate consequences of all this painstaking research, now that he and Crowfoot have begun talking of moving human minds from one body to another. He is unable to ignore the final goal of Avatar, the transmigration of tiger into gazelle: Genghis Mao is the tiger, and he himself the hapless gazelle. What becomes of the gazelle, when the tiger invades? Shadrach examines, briefly, one avenue of escape that he has not previously considered: if they can move sheep-mind to lioness-body and Genghis Mao-mind to Shadrach-body, they can just as easily move Shadrach-mind to some other body, and leave him to proceed from there. But the fantasy fades in the instant of its birth. He does not want to move to another body. He wants to keep his own. How like a dream this is, he thinks. Except that there is no awakening from it.

"How long will you do experiments in human implants," Shadrach asks, "before you'll be ready to—to—"

"To transplant the Chairman?"

"Yes."

Shrugging, Nikki says, "That's hard to answer. It depends on the problems we encounter in the early human transplants. If there are unexpectedly difficult problems of psychological adaptation, if transplant leads to psychotic freak-outs or cerebral breakdown or identity bleed-throughs or anything like that, it might be months or even years before we dare shift Genghis Mao to a new body. Our animal experiments haven't indicated that such things are going to happen, but human minds are more complex than spaniel minds, and we have to allow for the possibility that complex minds will react in complicated ways to something as traumatic as a shift of bodies. So we'll proceed cautiously. Unless, of course, the imminent bodily death of Genghis Mao makes an emergency mind-transplant necessary, in which case, I suppose, we'll just have to plunge ahead and see what happens. We're not eager to do that, of course."

"Of course," Shadrach echoes dryly.

"We'd much rather be orderly about it. A period of experimentation with human subjects, and then, if all goes smoothly there, we'd like to do two or three preliminary Genghis Mao transplants before we—"

"What?"

"Yes. Insert the Genghis Mao construct into several temporary host bodies, simply to find out how the Chairman reacts when transplanted, what adaptations may be required in order to—"

"And what will you do with all these extra Genghis Maos?" Shadrach asks. "It's beautiful redundancy, I know, to keep a stockpile of them around. But if they all start giving orders at once—"

"Oh, no," Crowfoot says. "We don't intend to let the Genghis Mao material remain in any of the experimental subjects. That sort of redundancy is absolutely not wanted here. We'd expunge each subject once we were done testing him. We'd do a complete mindpick

after we've run our tests."

"Ah. Yes. Assuming the subject will let you."

"What do you mean?"

"Remember, you won't be dealing with a helpless flunky, once you've done your transplant. You'll be dealing with Genghis Mao wearing a new body. You'll be up against the dominant spirit of the age. You might have problems."

"I doubt it," Nikki says breezily. "We'll take precautions. Come this way, will you?"

She leads him forward, to a vast computer bank, a wall of gray-green metal studded with incomprehensible apparatus. In here, she tells him, the coded essence of Genghis Mao is stored, everything that has been recorded so far, a nearly complete digital persona-construct that is capable of responding to stimuli precisely as the living Genghis Mao would, to a probability of seven or eight decimal places. Nikki offers to demonstrate the construct's Genghis Mao-ness with a few quick simulation runs, but Shadrach, suddenly disheartened, shows little interest; she marches him on to some of the other Avatar wonders, to which he reacts with no greater enthusiasm, and, as though at last noticing that Shadrach has ceased to pretend to be delighted by her technological miracles, she ushers him into her private office and locks the door.

They stand facing each other, less than a meter apart, and he feels sudden surprising excitement, physical, intense. The intensity astounds him. He had thought all desire for her had gone from him forever, once he discovered how she had betrayed him. But no. Still there, strong as ever. The lure of her sleek tawny body, the memory of her fragrance, the glitter of her huge piercing dark eyes. His Indian princess, Pocahontas, Sacajawea. Even now he is drawn to her, even now. He ceases to see the ingenious woman of science whose ingenuity has altogether undone him; he sees only the woman, beautiful, passionate, irresistible. He feels the pull of her body and he is sure she feels the pull of his.

It ought not to be such a surprise. Here they are, man and woman; they have been lovers for many months; they are alone, the door is locked. Why should desire not come over them, despite everything? But still, this sudden shifting of gears into the erotic mode amazes him. Somehow sex, unexpectedly obtruding itself against this background of betrayal, depression, impending doom, seems irrelevant and inappropriate, bizarre and unwelcome.

He pretends he feels nothing. He makes no move.

"How are you managing, Shadrach?" she asks, tenderly, after a moment. "Is it very bad?"

"I'm holding on."

"Are you frightened?"

"A little. More angry than frightened, I guess."

"Do you hate me?"

"I don't hate anyone. I'm not a hater."

"I still love you, you know."

"Quit it, Nikki."

"I do. That's what's been ripping me apart for weeks."

The force of Crowfoot's concern for him is like a tangible presence in the small office.

"I don't want to hear about it," he says.

"You do hate me."

"No. I'm just not interested in your remorse."

"Or my love?"

"Such that it is."

"Such that it is."

"I don't know," he says. "I don't want my head messed up any more than it already has been."

"What will you do, Shadrach?"

"What do you mean, what will I do?"

"You aren't going to stay in Ulan Bator."

"Everybody's been telling me to run."

"Yes."

"It wouldn't do any good."

"You could save yourself," Crowfoot tells him.

He shakes his head. "I wouldn't get away. The whole planet's bugged, Nikki. Watch Surveillance Vector One for fifteen minutes and you'll realize that. You know that already. You've told me yourself that escape's impossible. There's a tracer on everyone. Anyway, it would spoil your project again if I disappeared."

"Oh, Shadrach!"

"I mean, I'm the key man, right?"

"Don't be an idiot."

"You'd have to find another host for Genghis Mao. Then you'd have to recalibrate all over again. You would have to—"

"Stop it. Please."

"All right," he says. "At any rate, it's futile to try to escape from the Khan."

"You won't even try?"

"I won't even try."

Crowfoot regards him levelly for a long silent moment. Then she says, "I should feel relieved about that, I suppose."

"Why?"

"If you won't take responsibility for saving yourself, then I don't have to take responsibility for—for—"

"For what's going to happen to me if I stay here?"

"Yes."

"That's right. You don't need to feel any guilt at all. I've had fair warning, and nevertheless I freely choose to stay and face the music. You're absolved, Nikki. Your hands are washed of my blood."

"Are you being sarcastic, Shadrach?"

"Not particularly."

"I can never tell when you're being sarcastic."

"Not this time," he says.

They stare at each other strangely again. He still feels that mysterious sexual tension, that grotesque and inappropriate lust. Then he thinks of Eis and his colleagues running around on the other side of the locked office door, busy with their computers and their chimps, doing simulated transfers of the persona of Genghis Mao into the body hull of Shadrach Mordecai, and his ardor cools a little. But only a little.

Nikki laughs.

"What's funny?" he asks.

"Do you remember," she says, "that time we spoke about the con-

cept of you and Genghis Mao being one life-system, one self-corrective information-processing unit? That was before any of this happened. Mangu was still alive, I think. I talked about how the chisel and the mallet and the stone are aspects of the sculptor, or, more precisely, that the sculptor and his tools and materials together make up a single thinking-and-acting entity, a single *person,* and how you and Genghis Mao—"

"Yes. I remember."

"It's going to be even truer now, won't it? In the most literal sense. That seems awfully ironic to me. Your nervous system and his, entwined, interlocked, indistinguishable. When we spoke then you said no, it wasn't a true analogy, that Genghis Mao can send data to you but you can't send it to him, so that there's a limitation on the information flow, a discrete boundary. That'll change, now. It'll be impossible to tell where one of you leaves off and the other begins. But even then, I wanted to tell you that you weren't really grasping the idea—that the marble can't design a sculpture but is nevertheless part of the total sculpture-making system, and that you can't feed metabolic data into Genghis Mao but are nevertheless part of the total Genghis Mao system; there *is* an interaction, there *is* a feedback relationship that links you to him and he to you, there is—" She has been talking very rapidly, a torrential flow of words. Now she halts and in an altogether different voice says, "Oh, Shadrach, why don't you want to hide?"

"I told you. It's useless. I keep telling people that, but they don't seem to want to believe me."

He thinks about himself as part of the total Genghis Mao system. He considers the analogies. No doubt of it, his sensors and implants link him to the Khan in a very special way. But he is no more—and no less—important to the total Genghis Mao system than Michelangelo's lump of marble was to the total statue-making system. Michelangelo, if he felt that a given lump of marble was no longer necessary to the needs of the total system, would casually discard it and introduce another into the system.

Nikki is trembling.

"If you won't try to save yourself," she says, "then nobody else can do anything for you."

After he and Genghis Mao come to share one body, they will truly be an integrated information-processing unit. Of course, such a unit needs only one biocomputer, one brain, one mind, one self. And that self will not be the self of Shadrach Mordecai.

He says, "I know that. We've already discussed that. I take full responsibility."

"Don't you *care?*"

"Maybe not. Not any longer. I don't know."

"Shadrach—"

She starts to reach toward him, a tentative gesture, perhaps sexual, perhaps merely some sort of reflexive grab at a sinking man. He pulls back. There is a wall between them, an impermeable barrier of words and fears and doubts and

hesitations and guilts. He does not mind that. He takes refuge behind that wall. But still there is that sexual pull between them, that taut hot line of erotic tension, spanning the barrier, drilling through it, eroding it, breaching it. And then the barrier is gone. He loves her, he hates her, he wants her, he loathes her. He makes a tentative gesture toward her and halts. They are like two adolescents, absurdly unsure of themselves, feinting foolishly, making silly false starts and finicky nervous withdrawals. He smiles tensely. So does she. She is obviously as conscious as he is of the minute shifts of balance that are rapidly occuring within them and between them. It is as though they are voyagers aboard an ocean liner that is struggling through turbulent, stormy waters, and they are trapped together in a tiny cabin with a massive metal safe that slides wildly about, careening across the floor with every convulsion of the waves, crashing into the walls as they jump about, threatening to crush them if they do not succeed in scampering out of its way as it bears down on them. There is something undeniably comic about their predicament, but the peril is real, too, and not at all funny. How much longer can they hold out? The safe is so heavy, the sea so rough, the cabin so small, and they are getting weary—

And suddenly they come together, embracing, grappling, mouth seeking mouth, fingers digging furiously into flesh. He is terrified by the power of the blind, irrational force that has been unleashed in him, that he has unleashed in himself. "No," he mutters, even as he claws at her clothes, even as he pushes himself against her. "No," she whimpers, seemingly equally appalled. But neither of them resists. They stumble about ridiculously, sway, topple to the floor.

Later he is stunned, dazed, hardly believing what has just passed between them. They look at each other. He blinks; so does she. There are thin faint smiles of embarrassment.

Shakily he rises, adjusts his clothes, coughs self-consciously, stoops to offer Nikki a helping hand. She shakes him off gently and gets to her feet unaided, and they stand facing each other. He has nothing to say. It is a sticky moment, but she rescues them from it by taking his hand, by giving him a warm loving smile, by pulling him toward her for a quick chaste kiss, lips lightly brushing lips, a kiss that simultaneously acknowledges the intensity of what has just taken place and brings down a curtain on it. It is time for him to go.

"Save yourself," she whispers. "No one can do it for you. Save yourself."

"I need to think about things some more."

"Go, then. Do your thinking. I love you, Shadrach."

He knows what he is supposed to reply to that, but the words are impossible. He squeezes her fingers instead. And swiftly leaves.

TO BE CONTINUED

the money machine

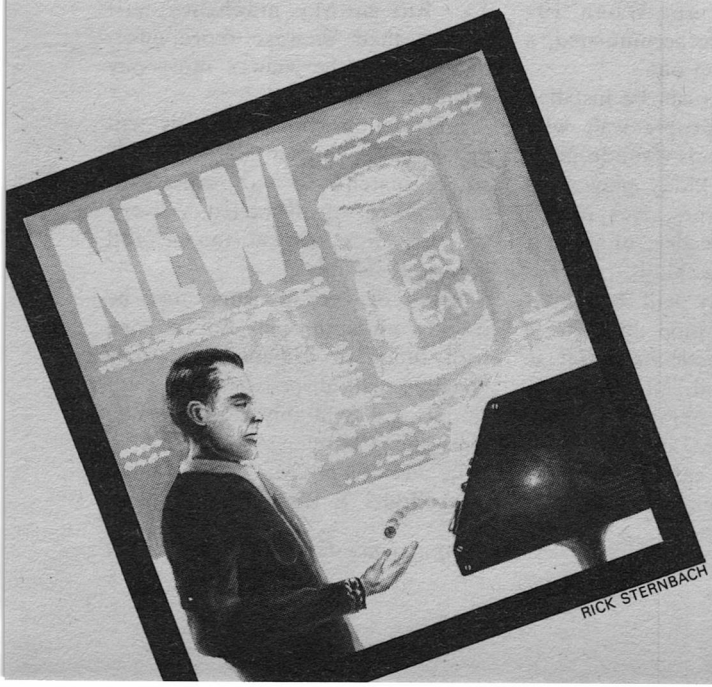
Greed makes the world go 'round.

Pat Underhill

Here is an invention which, I modestly claim, will end unemployment, eradicate illiteracy, bypass bureaucracy, and help liberate this continent's most oppressed minority—children. All this, and more—yet it costs no more than a coffee machine.

There are vending machines which dispense almost everything imaginable: drinks, candy, ice cream, sandwiches, fruit, soap, launderings, games, kiddy rides, massages, weight measurements, fortune tellings, tickets, newspapers, car washes, pens, stamps, photos, cigarettes, condoms, tampons, ice, phone calls, music, and porno flicks. So why not—*MONEY*?!!

Of course there already are change machines and slot machines. But what I have in mind is



a machine which gives money out but takes something else in. *What* goes in?

For a starter how about advertising? Thousands of companies spend millions of dollars on direct mailing. Many cater to kids and other poor people. Each ad costs 20¢ or more for postage, printing and addressing. And there is no assurance that it will even be glanced at on its way to the waste basket. For a fraction of this cost a money machine reaches an *attentive* audience.

The Model A (for advertising) consists essentially of a magnetic tape player, a film strip projector, and a dime dispenser. It plays a series of ads, interspersed with questions. The questions are multiple choice. If the patron pushes the correct button, points are scored and lights light up. When 10¢ worth of points are accumulated, a dime comes tinkling out.

Money machines can be installed in places where people wait with time on their hands—laundromats, bus stations, and kiddy play areas at shopping centers. But also I foresee whole arcades of money machines of various kinds.

The rate of pay will be determined by competition but, for a trial, suppose a machine is set so that a persistent kid can obtain 50¢ an hour and a persistent adult $1.00. Machines for kids would be lower and have easier questions. The machines catering to the youngest kids might pay off directly in eatables—oranges, apples or—perish the thought—lollipops.

The Model A won't appeal much to steadily-employed adults. But when I'm broke, I'd rather earn $1.00 or even 50¢ an hour in the booth of a convenient money machine, than suffer the red tape and invasion of privacy necessary to beg assistance from a welfare agency.

Sponsors will likely include not only product advertisers but anyone with a message to spread or a trip to lay—the Salvation Army, churches, Red Cross first aid instruction along with appeals for donations, Highway Department safety messages, and large corporations who wish to start image-building early—the same outfits who presently clutter up radio and TV. But money machines will present their message more effectively, since the viewer must pay attention to get pay.

Information content of ads will probably be higher than on TV since, instead of subliminal indoctrination of distracted viewers, the ads must appeal to the full conscious faculties.

Some of the sponsors may be frankly philanthropic. For anyone with funds to dispense, a money machine will dispense them more simply and equitably than can any alms-giving bureaucracy.

In addition to Model A, I envision Model E (for exercise) spon-

sored by some Foundation for Physical Fitness. After an arcade patron tires of watching ads and pushing buttons, she steps to a coin-dispensing bicycling or rowing machine. As an ecological bonus the Model Es propel generators which recharge batteries and power the arcade.

For gamblers there is Model G—a money machine/slot machine cross-breed, which delivers a jackpot—or nothing.

Future, more sophisticated money machines will include the Model T (for teaching)—a programmed learning machine that offers extra incentive. Model Ts can be sponsored not only by educational foundations but by large companies who sell products requiring technical expertise for their use. Honda Motors might set up a Model T to teach motorcycle maintenance, not only so they will have more budding mechanics to choose from in their hiring, but so that potential customers will not feel intimidated by mechanical intricacies. Likewise Sony and electronic theory, and Intel and micro-computer programming. Payoffs will be graduated, with the more advanced lessons and courses paying more; this, plus boredom, will discourage anyone from endlessly repeating the simpler lessons.

Further in the future are money machines which input something other than information, and which pay more. For example, there is Model C (for cottage industry). Insert 10 pseudosilver dollars and out come a batch of unassembled printed circuit-board kits. Assemble them. Feed them back in. The machine tests them. If they all pass, out roll 15 pseudosilver dollars. Any cards which don't pass are returned to the assembler for rework—accompanied by a Bronx cheer. Model C won't pay as well as similar work in a factory; there is longer turn-around-time and the labor of stocking. But, also, there's no need to hassle with personnel departments whenever someone needs a few sheckles.

Unfortunately, the money machine, like many of the great inventions of history, will probably arouse opposition. In my nightmares I see an angry mob of unemployed teachers, idle welfare administrators, unwanted personnel managers and deserted parents, armed with sledge hammers and crowbars, storming an arcade of defenseless money machines. But maybe public opposition can be avoided by early introduction of the Model S—which makes use of the capabilities of school teachers and welfare administrators.

Since I don't have the resources to develop this idea myself, I'm telling it to anyone who can. But kindly remember to include in your product line a Model B—which uses and pays well for the talents of struggling freelance writers and inventors—such as I! ■

Analogish / Jeff Rovin

Like most free-lancers, I've earned a fair share of rejection slips. These are odious strictures issued by publishers, and they range in timbre from terse and impersonal to terse and sympathetic. But there are always the frustrating standouts, those rare critiques which inspire an author to abandon his craft completely for a job at *McDonald's.* For me, the most recent of these hailed from a science fiction paperback house, the editor of which had decided that my outlines were good, but "too Analogish."

This evaluation left me somewhat nonplused. Seldom have I been told that my work is unacceptable while at the same time being thrust into the company of Isaac Asimov, Arthur C. Clarke, and Robert A. Heinlein! Yet, this is precisely what happened. And, in trying to revise the synopses, I found myself unable to disassociate science fiction from Analog, a publication which has molded my attitude toward the field since I was fifteen. So I decided to ply my skills elsewhere: in Analog, for example. But the rejection did have one positive effect. The label "Analogish" nagged at me, for I had never thought of the magazine as an *adjective.* Yet so it is.

In terms of science fiction literature, *Analogish* suggests the work of authors such as those I mentioned above. But how does it apply to other of the science fiction arts, such as motion pictures? As a film critic, I was intrigued with the promise of a sub-genre aborning, and set to work on some definitions. These, in turn, led to a plan which I'm going to ask that you help me implement in the months to come.

First, however, some history and a few observations.

Consider the remarks of a well-known filmmaker concerning his newest motion picture. "It will involve something so visual and so trippy," he boasted, "that it's going

to be the all-time visual extravaganza." Obviously, the young artist knows something that Alfred Hitchcock and William Wyler do not. For half a century, these directors have been honing their work to a thoughtful and engrossing edge, when all they really need have done was to make it "trippy."

Nonsense? Of course it is. Which is why these parameters should be stricken from the lexicon of the science fiction filmmaker. You'll not find them on the lips of those in sister fields. Ask a scientist to define his work, and he'll tell you it's to explain the world in which we live. Pose the same question to a responsible science fiction author, and he'll discuss how he is preparing for tomorrow's science by flexing the imagination. But science or science fiction, the two share an obvious kinship: each must be rooted in logic to be effective. They must be *Analogish.*

Let's return, then, to the science fiction filmmaker. Rationally, one would expect him to employ the sight, sound, and structure that are unique to film in roughly the same conceptual manner as the science fiction novelist. Unfortunately, this isn't the case. Directors are notorious for using the field to create cinematic rainbows—movies which appeal to the eye but are naggingly translucent—or as a soapbox for sophomoric intellectual presentations. Seldom do they honor the requisite of *any* good science fiction narrative, which is to present the audience with a plausible confrontation between man and technology. The food for thought.

Clearly, there is a discrepancy of purpose between the printed word and the motion picture screen. And it stems from a mutual ignorance on the part of the public, the producers, and the directors.

Purpose is one of those words brandished loosely by commentators, and it is best that we define the term. A writer and filmmaker, both, work under the same general restrictions: they have to fashion consistently bankable commodities or their patrons, the publishers and producers, won't give them any more electric trains to play with. Apart from the dictates of personal aesthetics, then, their common purpose is to create a commercial property. Here is where the two fields diverge. The same audience which would make a science fiction novel a great financial success, a sale of some fifty or sixty thousand copies, would cause theaters to yank a science fiction film in favor of the latest kung fu programmer. The filmmaker cannot afford the author's luxury of wooing solely the devotees of the genre. His audience must number in the millions. And the millions—three generations of movie-goers—have learned to think of science fiction in terms of monsters and special effects.

It all began shortly after the invention of the motion picture camera. Filmmakers were thrilled with the challenge of creating illusions, but none of them enjoyed greater success than George Melies. The Frenchman made over five hundred short movies between 1900 and 1913, most of them special effects

productions. Accordingly, he needed plots which would tolerate this kind of imagery, and turned to fantasy and science fiction. Among his most inventive efforts were *A Trip to the Moon* (1903), based on Wells and Verne, *The Impossible Voyage* (1904), about a journey to the sun, and *Conquest of the Pole* (1912). In terms of science fiction, the films were charmingly naive. The swimsuited chorus girls who launch Melies on his lunar voyage are proof-positive that we are not dealing with hard science. However, we must give Melies credit for even imagining that space flight might some day be practical!

First and foremost, however, Melies was a screen magician, and aspired to be nothing more. And his films, being bizarre escapist entertainment, were run ragged by American distributors. Indeed, our own motion picture industry—hugely moral, in those fledgling days as now—went so far as to remove his name from the credits and replace it with their own. In this way, a theater would have to book the pirate's home-grown tripe if it wanted to play Melies' wonder films.

With the coming of World War I, the Frenchman's studio was commandeered for munitions research. Raw film stock was difficult to come by, since it was made with many of the same chemicals as explosives, and the movie wizard simply hadn't the money to start anew. He sold his films and equipment to junk dealers in order to survive, while American filmmakers watched him drown and forged ahead with the product he had pioneered. They began concocting incredible visual displays with such pseudo-science films as *The Lost World* (1925) and *The Invisible Man* (1933). These pictures were enormously popular, but it was only when the rash of generally poor follow-up films made money that producers realized the audience cared little for logic or quality. They were responding to the screen trickery.

With *Frankenstein* (1931), the monster, the triumph and victim of technology, became a science fiction film staple. This picture proved so popular that the bankers responsible for decisions in Hollywood ordered science fiction filmmakers to highlight monsters and special effects in their films. Thus, of the $2,000,000 which George Pal lavished on *War of the Worlds* (1953), $1,600,000 went to the technicians who leveled Los Angeles, while $400,000 was spent to hire actors, writers, a director and other incidentals. Consider this impropriety in a more alarming perspective: a modest film budget, even in the fifties, was considerably more than a half million dollars. Simply put, these films were little other than vehicles for special effects. And, not surprisingly, this preoccupation led to the eventual exclusion of plot and characterization from science fiction films. Only on rare occasion did a producer or director see the genre's unique entertainment value and order his staff to *work* for their money. Thus, films like *The Thing* (1951), *Invasion of the Body Snatchers* (1956), and *2001: A*

Space Odyssey (1968) managed to slip through with the rest of the dross.

In fact, *2001* is somewhat of a miracle. Not only did Stanley Kubrick succeed in melding exquisite visuals with theme and sophistication, but he actually had the gall to ask his audience to *think*. And there were those of us who did. But there were others, a mass of people rapt in the throes of turning on and dropping out, who were immune to thought. *They* made *2001: A Space Odyssey* a hit, flocking to see the light show at the end of the space tunnel, as an astronaut went spinning through the famous 'psychedelic' star gate. And so we're back where we started. The public responded to flashing lights, futuristic transports, and costumes shot with metal fibers; as a result, filmmakers continued to peddle vigorous and colorful pap like *The Omega Man* (1969), starring Chuck Heston as the right hand of God, and *Silent Running* (1972), with Bruce Dern as the Almighty's green thumb.

Does this mean that the public won't buy good science fiction? No. They've bought it before.

As one might expect, there have been no more than a handful of world class, provocative science fiction films which *did not* showcase technical trickery. Pictures such as *Breaking the Sound Barrier* (1952) and *Man in the White Suit* (1952). The fact that they were not promoted as science fiction worked in their favor: audiences did not want or expect special effects, and consequently had a great time with two classic films. For this same reason, it is quite possible that most genre buffs have never seen or even heard of them. They are never shown at science fiction fan conventions, where such tatty efforts as *Battle for the Planet of the Apes* and *Marooned* are screened with alarming regularity. They haven't been reviewed in the Scientifilm World section of *Perry Rhodan,* nor are they a part of the *Creature Features* repertoire. Which says, in its own mute way, that these are quality motion pictures whose assets give the genre class, rather than vice versa.

Breaking the Sound Barrier, directed by David Lean (*Bridge on the River Kwai, Lawrence of Arabia*), portrayed the men behind the Mach One technology and showed how it both eroded and enriched their lives. *Man in the White Suit* was a dark comedy in which a scientist (Alec Guinness) invents a fabric that will not dirty or wear. The only thing subject to destruction is the poor scientist who, in his gleeful quest for discovery, has made himself both the devil and saint of a stunned textile industry. Both films are superb examinations of the effect that science has on society. What's more, they're entertaining!

Intellectual snobbery, you say? Alright, then. Let's examine quality science fiction in terms of a more 'popular' film. *Day the Earth Stood Still* (1951) achieved a similar impact due to the skills of director Robert Wise (*West Side Story, The Hindenburg*). Wise realized that no matter what the genre, he had to

make a good picture before he could make a good western, war, or science fiction picture. He did this by using the confrontation between man and science as the basis for a story, and not as an excuse for "trippy" special effects.

All of which brings us to the future of science fiction films. Are we doomed to see the robust but witless likes of a dozen such efforts as *Rollerball* or *Space: 1999* to every *Dr. Strangelove* or *Star Trek?* Hopefully not. A genre that stimulates the imagination cannot be allowed to stagnate. Thus, I suggest we channel our outrage into a constructive program and, in so doing, see the field clear from this deluge of cinematic drek.

Last year, Analog sponsored a science fiction film course which was produced in many of this nation's four hundred planetaria. We published a seventy-page booklet (available for $1.00 from this magazine) which outlined the plots, casts, and merits of the thirty-two finest science fiction films ever made. Presented in special planetarium programs, the film course enjoyed tremendous popularity. However, just as there are tens of thousands of science fiction film fans who went to *see* these films, there are many people who would also like to *make* movies. Some are experimenting with Super 8mm film at the junior high school level; others of them are trying to master the intricacies of visual composition and storytelling with 16mm productions in college or semi-professionally. Thus, the next logical step in bringing good science fiction to the screen is to bring together this wealth of talent in local amateur science fiction filmmaking contests. Perhaps these might be tied into school or local planetarium activities, and submissions presented at a suitable hall or movie theater, gatherings to which the public and press are invited. Remember, award credentials are extremely valuable in helping young filmmakers gain entrance to film school, or perhaps land a position with a professional moviemaking outfit. Most important, however, is that *your* combined efforts just might change the course of science fiction film history. We're not suggesting that you try to produce *2001: Part II* your first time out. Besides, it's already been done by a pair of amateur filmmakers in Duncanville, Texas. We *are* asking that you bring the will and enthusiasm to a field desperately in need of new talent and ideas.

Please drop us a line if you'd like suggestions on how to organize a science fiction filmmaking contest. Wherever possible, we will be happy to refer you to existing competitions in your area. And be sure to keep us informed of your progress, so that we can pass the information on to our readers. In the meantime, I'd like to recommend a more expedient plan to show Hollywood what you think of their science fiction film product. Save your ticket money and televiewing hours, invest them in a telescope, and turn it to the sky. You'll find the show to be far more interesting. And the special effects? They're the *greatest!*

BRASS TACKS

Reader response to G. Harry Stine's article, "Detesters, Phasers and Dean Drives" in the June issue was not only heavy, but spread across a full spectrum of opinions. We don't have the space for all of the letters received; here's a sampling.

The Editor

Dear Editor:

. . . . Mr. Stine's remark that "The last word has yet to be written" is prophetic. Let me fulfill part of the prediction. I am astonished by the number of would-be inventors of reactionless drives and their physicist critics, who have displayed sheer ignorance of the information in their physics texts. After having pointed out to many esteemed physicists that *electromagnetism is excepted from Newton's Third Law of action vs. reaction,* and that therefore electromagnetic reactionless drives are possible, they have "assured" me that exceptions "do not exist" and that my insight is "based on a misconception." Yet, my information is derived from explicit statements in physics texts, many of which point out my statement. Let the reader check the following references: *Fundamental Physics,* Jay Orear, 1966, p. 41; *Physics,* K.R. Atkins, 1967, p. 387; *University Physics,* Sears and Zemansky, 4th Ed., p. 16. An example of an exception would be a charge moving perpendicular to a current-carrying wire. The wire exerts a force on the charge but not vice versa! . . . After this incident, I learned the lesson that if a physicist "assures" me that something is "impossible," I cannot take him at face value, whatever his credentials.

A.H. KLOTZ

39 Simon Street
Babylon, N.Y. 11702

Dear Mr. Bova:

. . . . In 1960, I was assigned to Air Force Office of Scientific Research in Washington, DC. Upon reading John Campbell's editorial comments on the Dean Drive, I contacted Mr. Dean and was invited to see a demonstration of his machine.

Mr. Dean put his device through a number of demonstrations, two of which were particularly noteworthy. In one, the device was placed on a set of bathroom scales. With the device shut off, it weighed a certain amount, as shown on the scales. When it was turned on, and the speed increased, the weight as shown on the scales decreased, and at sufficient speed was reduced nearly to zero. The second was a version of Stine's "pendulum test." The device was placed on a pendu-

lum consisting of a square aluminum plate which was suspended from the ceiling by chains, one from each corner. The device was connected by a rigid rod to a sled which rested on the floor, and upon which were placed several weights. In operation, the device pulled the sled across the floor towards itself. However, the pendulum continued to hang vertically, instead of swinging towards the load it was pulling. To say the least, these demonstrations were impressive.

Mr. Dean's offer was straightforward and businesslike. He held a patent; if the Air Force made successful use of his device, he expected to be paid royalties and wanted a contract to that effect; he would provide full assistance to the Air Force in making use of his device. In particular, he did not follow the practice of many inventors of alleged miraculous devices, who want a large sum of money before they will reveal the "secret." He provided me with copies of some papers he had written describing his device, and of the consulting engineer's report which computed the thrust to be obtained from a full-scale device.

An AFOSR contractor to whom I had described my experiences took the trouble to dissect a bathroom scale, and found that the mechanism had the effect of a "negative peak reading" device. That is, if you vibrated the platform of the bathroom scale, it gave a constant reading equal to the negative peaks of the vibration. Result: scratch one "impressive" demonstration for the Dean Drive.

I reviewed the consulting engineer's report, and found that he had committed a gross error in solving the equations of motion of the device, under the assumption of purely Newtonian mechanics. Specifically, he had solved the equations using Laplace Transforms, and had failed to take into account initial conditions, thus giving an erroneous constant term in the final solution, which, therefore, appeared to contain a net thrust. This didn't particularly bother me. If Newtonian mechanics were valid, the Dean Drive couldn't work; if it worked we were going to have to scrap Newtonian mechanics. Therefore, an analysis which started out with Newtonian mechanics, if properly done, would have to show no net thrust in the final results. The engineer simply blundered.

I obtained some funds from a sympathetic two-star general, and let a contract to an engineering firm headed by Jacob Rabinow, who had formerly worked for the Bureau of Standards and the Army's Harry Diamond Laboratories. He held an impressive list of patents, including the original patent on the magnetic clutch. Under the contract, he was to analyze the performance of the Dean Drive, using a model which Mr. Dean offered to lend to AFOSR for the purpose.

Rabinow's analysis was very thorough, and in particular included the "pendulum test." Rabinow found that the device worked as it did by taking advantage of the friction of the sled on the floor. The sled was pulled forward in

short sharp jerks, and in the interim between these jerks, the device pushed backwards against the static friction of the unmoving sled. When the sled was placed on a lubricated sheet, it simply oscillated back and forth, without any net motion towards the device suspended on the pendulum. In short, Rabinow replicated all the behavior the Dean Drive had exhibited, and showed that it could all be explained by Newtonian mechanics and nonlinear friction.

On the basis of this report, I dropped all further activities with regard to Mr. Dean, and shortly thereafter was routinely reassigned to another duty station. I remain convinced that Mr. Dean was sincere in his belief he had hit upon something worthwhile. He was not a con artist. . . . Finally, Mr. Dean's patent makes no mention of a space drive. The only applications listed there are industrial and commercial tasks which the device could, in fact, perform. May the Dean Drive, and Mr. Dean, Rest In Peace.

JOSEPH P. MARTINO
University of Dayton
Dayton, Ohio 45469

Dear Ben:

Stine's Phaser probably has a 3° phase shift due to a slight difference in compliance between the coupling arms from the driving force to each mass. Dean's 45° phase shift came from a much larger difference in compliance, such as from one mass being driven rigidly by a steel connecting rod and the other mass being driven by a plastic rod or a hollow steel tube. This can be easily modeled mathematically using springs and dashpots as I've outlined in the accompanying letter to Harry Stine. The jerk team of the Davis mechanics is not required (jerk is a time rate of change in acceleration). Note that the system is strongly frequency dependent near phases of 45° and that a 45° phase may occur at more than a single frequency.

The above model uses a linear system; it would be interesting to explore the properties of a nonlinear system where stress and strain were not linearly related. Such materials do not exist.

GARY R. OLHOEFT, PHD
956 S. Miller St.
Lakewood, Colo. 80226

Dear Mr. Bova:

. . . I'd like to make Mr. Stine an offer which he cannot refuse (if you'll pardon the cliché). It occurs to me that We (Fans of Science Fiction/Science Fact) have been given the privilege and honor (indeed the Obligation) to rally to the Cause, and effect a solution to the problem posed by Mr. Stine. To this end, . . . I am willing to organize and serve as *temporary* chairperson for a "Society for the Propagation of Unidirectional Thrust" devices (acronym SPOUT). The Society I propose shall be a nonprofit organization. The net proceeds of the Membership Dues shall be distributed to reputable persons or organizations (such as Mr. Stine, et al) who can demonstrate the need for assistance in

their research of a bona fide Unidirectional Thrust device. The Society shall also serve as a clearing-house for information on the subject as it becomes available. For further information, write to me at the below address.

By the way, do you know if Mr. Stine has considered the possibility of using a piezo-electric crystal, operating in the Mhz range (one-half cycle at less than critical action time, the other half at greater than critical action time)? I remember that the Starship 'Enterprise' used some sort of crystal in its propulsion unit. Could it be that we'd be merely rediscovering an already known principle?

In closing, I'd like to say that I enjoy your magazine very much, and I especially enjoy the Science Fact articles. Keep up the good work.

RAYMOND T. HECKERT
Rte #3, Box 12
Antigo, Wisc. 54409

Dear Ben:

So you're bringing that hoary old fraud, the Dean Drive, back to life? The first time around I was one of the innocent little bunny rabbits out here in readerland, and was filled with proper indignation against all those stuffy ol' signtists and their derisive snorts. Now, as one of the SOS's, and with some pertinent experience under my belt, I'd like to offer a few comments.

Have you personally inspected the patent for this thing? I have. It is quite straightforward and easily understood. There is nothing to indicate that it is capable of exerting a new force in any direction. (I should say impulse.) It can propel itself along the tape by grasping it at the right times during each cycle, but the tape, of course, has to be attached to something. I have yet to see this little detail mentioned. As I recall, some mention was made in the patent of antigravity. How that ever got by the patent examiner is the biggest part of the mystery.

Mr. Stine, too, is obviously not a true believer. His open-minded approach at the time is worthy of praise, though similar work was being done for other purposes at about the same time. One item that concerned the Navy was whether the rate at which a load was applied to a steel rod had a fundamental effect on its deformation behavior. Mr. Stine was concerned with something similar, but I don't see that it's important and will simply mention it. The second item was mechanical impedance, which relates the movement of a point on an object to a simple harmonic force applied to that point. The relationship involves both an amplitude and a phase angle. In the early 60's, the hardware did not exist to do a decent job of defining mechanical impedance. A few years later, though, my group spent a couple of years playing around with some pretty good equipment until we decided it was not a useful tool for our purposes. With this background, I'd like to make two points: 1) Mechanical impedance is mathematically the same as electrical impedance, and alternating current can be handled quite well

without using third derivatives; 2) Mr. Stine could have gotten any phase angle he wanted between plus or minus 90° simply by changing his motor speed. He might have been able to pick up some interesting resonance effects, too.

If memory serves me, I've seen two big newspaper ads in the last ten years where some poor boob had rediscovered the vibration generator and thinks he has an antigravity machine. I don't really think you're doing anyone a favor with this business.

KEN CORNELIUS
11818 Smoke Tree Road
Potomac, Maryland 20854

Dear Mr. Bova:

. . . . Some years ago, I read William O. Davis' article in the May 1962 Analog entitled "The Fourth Law of Motion." . . . Moreover I gave a mathematics exam in May 1965 which based one problem on the Davis "law."

Now, as then, I am quite dubious about these ideas. As a scientist of the pencil-and-paper breed, I cannot improve on the pendulum test for suggested space drives, but, from my background in physics, I can comment on the basic notions of Davis mechanics. . . .

First General Proposition: Most supposedly heretical observations in Stine's article are well-known phenomena of advanced mechanics which involve no violations of traditional concepts. . . .

Item 1: All thoughtful physicists, including Newton, have recognized that Newton's three laws of motion apply in their full generality only to ideal "particles," and operate in only an approximate sense for solid bodies. The response to external forces by any solid body involves the interactions between the particles of that body. Sometimes a body, with high accuracy, exhibits the response of a single particle, but an elaborate theory of current importance treats the behavior of more complicated bodies. Thus Davis' speculations about more general response are no news to any knowledgeable scientist, but the existing theory for such phenomena involves no contradiction with Newton's laws.

Item 2: A solid body can behave like a particle when its various parts can react to one another faster than the external forces can act upon the body. A good measure for the rapidity of this internal communication is the speed of sound within the given body. The speed of sound in steel is about 5000 meters per second. Thus a piece of steel apparatus with dimensions of about one meter will begin to exhibit behavior unlike the response of an ideal particle when the frequency of the external force on this apparatus begins to approach an appreciable fraction of 5000 cycles per second. Hence the anomalous observations by Stine at 1500 rpm. are no surprise from the standpoint of this remark. Such observations *may* have no fundamental importance whatever.

Item 3: Any elementary physics student should be aware that stress is not always proportional to strain. Hooke's law, for example, becomes

invalid when the force (the *stress* for a linear elongation) becomes too large. The mathematical theory of continuum mechanics explores the immense variety of such possible relationships; phenomena involving time delays form an important part of this subject. However none of this work contradicts Newton's laws of motion. Davis, Stine, and company are curiously unaware of these developments.

Second General Proposition: Davis mechanics predicts some anomalous results which defy common experience. The defenders of this theory should provide some explanation for these discrepancies to win a more extensive hearing for their ideas. The mathematical simplicity of the analysis suggests a certain reluctance by the defenders to pursue a critical test of their hypotheses.

Item 4: A linear oscillator in Davis mechanics satisfies a differential equation of the form:

$$O = kx + L\,dx/dt + m\,d^2x/dt^2 + n\,d^3x/dt^3.$$

Here k is the spring constant, L is the damping coefficient, m is the particle mass, and n is the "fourth law" coefficient. An analogous equation with slightly different symbols makes an appearance in Stine's article. However, a system with this theoretical description will exhibit spontaneous oscillations of increasing amplitude either when $n<O$ or when $O<L/k<n/m$. People observe no such spontaneous oscillations. Davis and Stine assume a positive value for the coefficient n, but exhibit no realization of the fact that their theory, together with normal experience, implies a fundamental limitation on human ability to design systems with low friction. If one rejects such a limitation, then one eliminates their theory.

Item 5: Consider a constant magnetic field with magnitude B and direction *e;* introduce a charged particle with charge q and mass m. Such a particle, in Davis mechanics, satisfies a differential equation of form

$$0 = qB(e \times v) + m\,dv/dt + n\,d^2v/dt^2$$

where *v* denotes the velocity of the particle. The velocity may be split into two components, one parallel to the magnetic field, the other perpendicular to this field. If the coefficient n for the "fourth law" is negative then the particle motion in the field direction is unstable: that is, such a particle, almost at rest, will undergo spontaneous acceleration along a field line. Clearly, such motion has not been observed, but of course the coefficient n has been assumed positive. However, the particle, in the plane perpendicular to the field lines, will exhibit motion in ever-widening circles, *even for positive* n. Charged particles in a cyclotron execute many, many circles during their acceleration; and show no signs of such behavior. The proponents of the fourth law of motion must explain this apparent contradiction with all past experience of cyclotron operators.

Third General Proposition: Hypothesizing new unknown forces to evade all such objections is not cricket. The object of science is to propose a small number of laws

which explain a large number of phenomena. Anyone who needs a new concept for each new situation is making a presumptively weak case for his ideas. A proper defense of Davis mechanics must involve an explicitly stated set of ideas. I offer advance apologies for my suspicious mind, but I am trying to avoid an inconclusive exchange of generalities.

Final remark: I do not know who told Stine "that it was nearly impossible to get anything published that contradicted Einstein in the slightest degree." The past literature on basic physics contains various challenges to Einstein's ideas; Professor Robert Dicke of Princeton University has published several papers on an alternative theory. Moreover, the *Physical Review* is not the only journal in the world which accepts papers on theoretical physics. An hour in any university library would suggest other outlets for such work. Certainly a manuscript can alienate editors by making immoderate claims, but otherwise the author might achieve publication by approaching other journals.

JOHN S. LEW
IBM, Research Division
Box 218
Yorktown Heights, N.Y. 10598

Dear Mr. Bova:

The data for the prototype Dean drive (85 pounds of thrust using a ¼-inch electric drill which would not exceed a half horsepower) suggests a very simple crucial experiment.

A thrust producing device can be mounted on a rotating arm and the torque used to drive a generator. The power output is the thrust times the peripheral velocity. The distinctive feature of an inertial drive such as the Dean drive is that unlike a propeller which acts on the surrounding medium the thrust does not decrease as the velocity increases and unlike a rocket the kinetic energy of the working fluid is not part of the input. To avoid a perpetual motion machine the peripheral velocity at which the output exceeds the input must be unattainable. Theoretically the speed of light would be such a barrier, practically the centrifugal stress in the rotating arm would be a limit.

As the break-even velocity is given by:

$$V \text{ (feet/second)} = \frac{550 \text{ Power (horsepower)}}{\text{Thrust (pounds)}}$$

the quoted Dean data gives a velocity so low that there would be no difficulty in setting up the crucial test. If the Dean drive (or any of the proposed inertial drives) gives any appreciable thrust while moving in a circle the energy crisis is over because we have a perpetual motion machine of the first kind.

I am curious how a group of qualified investigators overlooked this obvious energy consequence of an inertial drive.

WILLIAM SQUIRE
449 Hillview Drive
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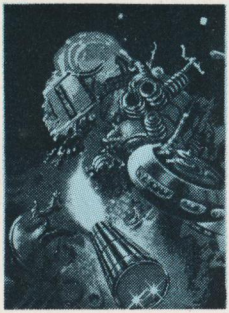

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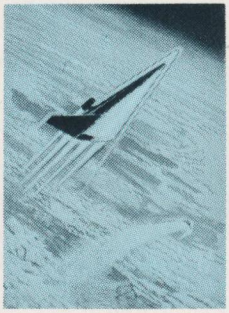

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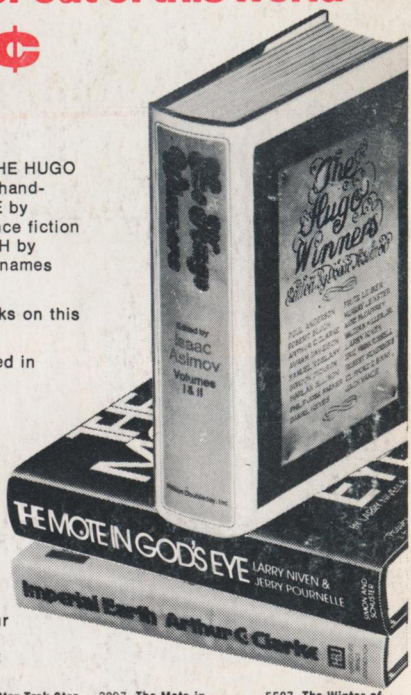

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