

# Out of Copyright

by Charles Sheffield

Troubleshooting. A splendid idea, and one that I agree with totally in principle. Bang! One bullet, and trouble bites the dust. But unfortunately, trouble doesn't know the rules. Trouble won't stay dead.

I looked around the table. My top troubleshooting team was here. I was here. Unfortunately, they were supposed to be headed for Jupiter, and I ought to be down on Earth. In less than twenty-four hours, the draft pick would begin. That wouldn't wait, and if I didn't leave in the next thirty minutes, I would never make it in time. I needed to be in two places at once. I cursed the copyright laws and the single-copy restriction, and went to work.

"You've read the new requirement," I said. "You know the parameters. Ideas, anyone?"

A dead silence. They were facing the problem in their own unique ways. Wolfgang Pauli looked half-asleep, Thomas Edison was drawing little doll-figures on the table's surface, Enrico Fermi seemed to be counting on his fingers, and John von Neumann was staring impatiently at the other three. I was doing none of those things. I knew very well that wherever the solution would come from, it would not be from inside my head. My job was much more straightforward: I had to see that when we had a possible answer, *ithappened*. And I had to see that we got *one* answer, not four.

The silence in the room went on and on. My brain trust was saying nothing, while I watched the digits on my watch flicker by. I had to stay and find a solution; and I had to get to the draft picks. But most of all and hardest of all, I had to remain quiet, to let my team do some thinking.

It was small consolation to know that similar meetings were being held within the offices of the other three combines. Everyone must be finding it equally hard going. I knew the players, and I could imagine the scenes, even though all the troubleshooting teams were different. NETSCO had a group that was intellectually the equal of ours at Romberg AG: Niels Bohr, Theodore von Karman, Norbert Weiner, and Marie Curie. MMG, the great Euro-Mexican combine of Magrit-Marcus Gesellschaft, had focused on engineering power rather than pure scientific understanding and creativity, and, in addition to the Soviet rocket designer Sergey Korolev and the American Nikola Tesla, they had reached farther back (and with more risk) to the great nineteenth-century English engineer Isambard Kingdom Brunel. He had been one of the outstanding successes of the program; I wished he were working with me, but MMG had always refused to look at a trade. MMG's one bow to theory was a strange one, the Indian mathematician Srinivasa Ramanujan, but the unlikely quartet made one hell of a team.

And finally there was BP Megation, whom I thought of as confused. At any rate, I didn't understand their selection logic. They had used billions of dollars to acquire a strangely mixed team: Erwin Schrodinger, David Hilbert, Leo Szilard, and Henry Ford. They were all great talents, and all famous names in their fields, but I wondered how well they could work as a unit.

All the troubleshooting teams were now pondering the same emergency. Our problem was created when the Pan-National Union suddenly announced a change to the Phase B demonstration program. They wanted to modify impact conditions, as their contracts with us permitted them to do. They didn't have to tell us how to do it, either, which was just as well for them since I was sure they didn't know. How do you take a billion tons of mass, already launched to reach a specific target at a certain point of time, and redirect it to a different end point with a different arrival time?

There was no point in asking them why they wanted to change rendezvous conditions. It was their option.

Some of our management saw the action on PNU's part as simple bloody-mindedness, but I couldn't agree. The four multinational combines had each been given contracts to perform the biggest space engineering exercise in human history: small asteroids (only a kilometer or so across-but massing a billion tons each) had to be picked up from their natural orbits and redirected to the Jovian system, where they were to make precise rendezvous with assigned locations of the moon Io. Each combine had to select the asteroid and the method of moving it, but deliver within a tight transfer-energy budget and a tight time schedule.

For that task the PNU would pay each group a total of \$8 billion. That sounds like a fair amount of money, but I knew our accounting figures. To date, with the project still not finished (rendezvous would be in eight more days), Romberg AG had spent \$14.5 billion. We were looking at a probable cost overrun by a factor of two. I was willing to bet that the other three groups were eating very similar losses.

Why?

Because this was only Phase B of a four-phase project. Phase A had been a system design study, which led to four Phase B awards for a demonstration project. The Phase B effort that the four combines were working on now was a proof-of-capability run for the full European Metamorphosis. The real money came in the future, in Phases C and D. Those would be awarded by the PNU to a single combine, and the award would be based largely on Phase B performance. The next phases called for the delivery of fifty asteroids to impact points on Europa (Phase C), followed by thermal mixing operations on the moon's surface (Phase D). The contract value of C and D would be somewhere up around \$800 billion. That was the fish that all the combines were after, and it was the reason we would all overspend lavishly on this phase.

By the end of the whole program, Europa would have a forty-kilometer-deep water ocean over all its surface. And then the real fun would begin. Some contractor would begin the installation of the fusion plants, and the seeding of the sea-farms with the first prokaryotic bacterial forms.

The stakes were high; and to keep everybody on their toes, PNU did the right thing. They kept throwing in these little zingers, to mimic the thousand and one things that would go wrong in the final project phases.

While I was sitting and fidgeting, my team had gradually come to life. Fermi was pacing up and down the room-always a good sign; and Wolfgang Pauli was jabbing impatiently at the keys of a computer console. John von Neumann hadn't moved, but since he did everything in his head anyway that didn't mean much.

I looked again at my watch. I had to go. "Ideas?" I said again.

Von Neumann made a swift chopping gesture of his hand. "We have to make a choice, Al. It can be done in four or five ways."

The others were nodding. "The problem is only one of efficiency and speed," added Fermi. "I can give you an order-of-magnitude estimate of the effects on the overall program within half an hour."

"Within fifteen minutes." Pauli raised the bidding.

"No need to compete this one." They were going to settle down to a real four-way fight on methods-they always did-but I didn't have the time to sit here and referee. The important point was that they said it could be done. "You don't have to rush it. Whatever you decide, it will have to wait until I get back." I stood up. "Tom?"

Edison shrugged. "How long will you be gone, Al?"

"Two days, maximum. I'll head back right after the draft picks." (That wasn't quite true; when the draft picks were over, I had some other business to attend to that did not include the troubleshooters; but two days should cover everything.)

"Have fun." Edison waved his hand casually. "By the time you get back I'll have the engineering drawings for you."

One thing about working with a team like mine-they may not always be right, but they sure are always cocky.

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"Make room there. Move over!" The guards were pushing ahead to create a narrow corridor through the wedged mass of people. The one in front of me was butting with his helmeted head, not even looking to see whom he was shoving aside. "Move!" he shouted. "Come on now, out of the way."

We were in a hurry. Things had been frantically busy Topside before I left, so I had cut it fine on connections to begin with, then been held up half an hour at reentry. We had broken the speed limits on the atmospheric segment, and there would be PNU fines for that, but still we hadn't managed to make up all the time. Now the first draft pick was only seconds away, and I was supposed to be taking part in it.

A thin woman in a green coat clutched at my arm as we bogged down for a moment in the crush of people. Her face was gray and grim, and she had a placard hanging round her neck. "You could wait longer for the copyright!" She had to shout to make herself heard. "It would cost you nothing-and look at the misery you would prevent. What you're doing is immoral! TEN MORE YEARS"

Her last words were a scream as she called out this year's slogan. TEN MORE YEARS! I shook my arm free as the guard in front of me made sudden headway, and dashed along in his wake. I had nothing to say to the woman; nothing that she would listen to. If it were immoral, what did ten more years have to do with it? Ten more years; if by some miracle they were granted ten more years on the copyrights, what then? I knew the answer. They would try to talk the Pan-National Union into fifteen more years, or perhaps twenty. When you pay somebody off, it only increases their demands. I know, only too well. They are never satisfied with what they get.

Joe Delacorte and I scurried into the main chamber and shuffled sideways to our seats at the last possible moment. All the preliminary nonsense was finished, and the real business was beginning. The tension in the room was terrific. To be honest, a lot of it was being generated by the media. They were all poised to make maximum noise as they shot the selection information all over the System. If it were not for the media, I don't think the PNU would hold live draft picks at all. We'd all hook in with video links and do our business the civilized way.

The excitement now was bogus for other reasons, too. The professionals-I and a few others-would not become interested until the ten rounds were complete. Before that, the choices were just too limited. Only when they were all made, and the video teams were gone, would the four groups get together off-camera and begin the horse trading. *"My ninth round plus my fifth for your second."* *"Maybe, if you'll throw in \$10 million and a tenth-round draft pick for next year..."*

Meanwhile, BP Megation had taken the microphone. "First selection," said their representative. "Robert Oppenheimer."

I looked at Joe, and he shrugged. No surprise. Oppenheimer was the perfect choice-a brilliant scientist,

but also practical, and willing to work with other people. He had died in 1967, so his original copyright had expired within the past twelve months. I knew his family had appealed for a copyright extension and been refused. Now BP Megation had sole single-copy rights for another lifetime. "Trade?" whispered Joe.

I shook my head. We would have to beggar ourselves for next year's draft picks to make BP give up Oppenheimer. Other combine reps had apparently made the same decision. There was the clicking of data entry as the people around me updated portable databases. I did the same thing with a stub of pencil and a folded sheet of yellow paper, putting a check mark alongside his name. Oppenheimer was taken care of, I could forget that one. If by some miracle one of the four teams had overlooked some other top choice I had to be ready to make an instant revision to my own selections.

"First selection, by NETSCO," said another voice. "Peter Joseph William Debye."

It was another natural choice. Debye had been a Nobel prizewinner in physics, a theoretician with an excellent grasp of applied technology. He had died in 1966. Nobel laureates in science, particularly ones with that practical streak, went fast. As soon as their copyrights expired, they would be picked up in the draft the same year.

That doesn't mean it always works out well. The most famous case, of course, was Albert Einstein. When his copyright had expired in 2030, BP Megation had had first choice in the draft pick. They had their doubts, and they must have sweated blood over their decision. The rumor mill said they spent over \$70 million in simulations alone, before they decided to take him as their top choice. The same rumor mill said that the cloned form was now showing amazing ability in chess and music, but no interest at all in physics or mathematics. If that was true, BP Megation had dropped \$2 billion down a black hole: \$1 billion straight to the PNU for acquisition of copyright, and another \$1 billion for the clone process. Theorists were always tricky; you could never tell how they would turn out.

Magrit-Marcus Gesellschaft had now made their first draft pick, and chosen another Nobel laureate, John Cockroft. He also had died in 1967. So far, every selection was completely predictable. The three combines were picking the famous scientists and engineers who had died in 1966 and 1967, and who were now, with the expiration of family retention of copyrights, available for cloning for the first time.

The combines were being logical, but it made for a very dull draft pick. Maybe it was time to change that. I stood up to announce our own first take.

"First selection, by Romberg AG," I said. "Charles Proteus Steinmetz."

My announcement caused a stir in the media. They had presumably never heard of Steinmetz, which was a disgraceful statement of their own ignorance. Even if they hadn't spent most of the past year combing old files and records, as we had, they should have heard of him. He was one of the past century's most colorful and creative scientists, a man who had been physically handicapped (he was a hunchback), but mentally able to do the equivalent of a hundred one-hand push-ups without even breathing hard. Even I had heard of him, and you'd not find many of my colleagues who'd suggest I was interested in science.

The buzzing in the media told me they were consulting their own historical data files, digging farther back in time. Even when they had done all that, they would still not understand the first thing about the true process of clone selection. It's not just a question of knowing who died over seventy-five years ago, and will therefore be out of copyright. That's a trivial exercise, one that any yearbook will solve for you. You also have to evaluate other factors. Do you know where the body is—are you absolutely *sure*? Remember, you can't clone anyone with a cell or two from the original body. You also have to be certain that it's who you think it is. All bodies seventy-five years old tend to look the same. And then, if the body happens to

be really old-say, more than a couple of centuries-there are other peculiar problems that are still not understood at all. When NETSCO pulled its coup a few years ago by cloning Gottfried Wilhelm Leibniz, the other three combines were envious at first. Leibniz was a real universal genius, a seventeenth-century superbrain who was good at everything. NETSCO had developed a better cell-growth technique, and they had also succeeded in locating the body of Leibniz in its undistinguished Hanover grave.

They walked tall for almost a year at NETSCO, until the clone came out of the forcing chambers for indoctrination. He looked nothing like the old portraits of Leibniz, and he could not grasp even the simplest abstract concepts. Oops! said the media. Wrong body.

But it wasn't as simple as that. The next year, MMG duplicated the NETSCO cell-growth technology and tried for Isaac Newton. In this case there was no doubt that they had the correct body, because it had lain undisturbed since 1727 beneath a prominent plaque in London's Westminster Abbey. The results were just as disappointing as they had been for Leibniz.

Now NETSCO and MMG have become very conservative; in my opinion, far too conservative. But since then, nobody has tried for a clone of anyone who died before 1850. The draft picking went on its thoughtful and generally cautious way, and was over in a couple of hours except for the delayed deals.

The same group of protesters was picketing the building when I left. I tried to walk quietly through them, but they must have seen my picture on one of the exterior screens showing the draft-pick process. I was buttonholed by a man in a red jumpsuit and the same thin woman in green, still carrying her placard.

"Could we speak with you for just one moment?" The man in red was very well-spoken and polite.

I hesitated, aware that news cameras were on us. "Very briefly. I'm trying to run a proof-of-concept project, you know."

"I know. Is it going well?" He was a different type from most of the demonstrators, cool and apparently intelligent. And therefore potentially more dangerous.

"I wish I could say yes," I said. "Actually, it's going rather badly. That's why I'm keen to get back out."

"I understand. All I wanted to ask you was why you-and I don't mean you, personally; I mean the combines-why do you find it necessary to use clones? You could do your work without them, couldn't you?"

I hesitated. "Let me put it this way. We could do the work without them in just the same way as we could stumble along somehow if we were denied the use of computer power, or nuclear power. The projects would be possible but they would be enormously more difficult. The clones augment our available brainpower, at the highest levels. So let me ask you: Why should we do without the clones, when they are available and useful?"

"Because of the families. You have no right to subject the families to the misery and upset of seeing their loved ones cloned, without their having any rights in the matter. It's cruel, and unnecessary. Can't you see that?"

"No, I can't. Now, you listen to me for a minute." The cameras were still on me. It was a chance to say something that could never be said often enough. "The family holds copyright for seventy-five years after a person's death. So if you, personally, *remember* your grandparent, you have to be pushing eighty years old-and it's obvious from looking at you that you're under forty. So ask yourself, Why are all you petitioners people who are in their thirties? It's not *you* who's feeling any misery."

“But there are relatives-,” he said.

“Oh yes, the relatives. Are you a relative of somebody who has been cloned?”

“Not yet. But if this sort of thing goes on-”

“Listen to me for one more minute. A long time ago, there were a lot of people around who thought that it was wrong to let books with sex in them be sold to the general public. They petitioned to have the books banned. It wasn't that they claimed to be buying the books themselves, and finding them disgusting; because if they said that was the case, then people would have asked them why they were buying what they didn't like. Nobody was forcing anybody to buy those books. No, what the petitioners wanted was for *other* people to be stopped from buying what the *petitioners* didn't like. And you copyright-extension people are just the same. You are making a case on behalf of the relatives of the ones who are being cloned. But you never seem to ask yourself this: if cloning is so bad, why aren't the *descendants* of the clones the ones doing the complaining? They're not, you know. You never see them around here.”

He shook his head. “Cloning is immoral!”

I sighed. Why bother? Not one word of what I'd said had got through to him. It didn't much matter-I'd really been speaking for the media, anyway-but it was a shame to see bigotry masquerading as public-spirited behavior. I'd seen enough of that already in my life.

I started to move off toward my waiting aircar. The lady in green clutched my arm again. “I'm going to leave instructions in my will that I want to be cremated. You'll never get me!”

*You have my word on that, lady.* But I didn't say it. I headed for the car, feeling an increasing urge to get back to the clean and rational regions of space. There was one good argument against cloning, and only one. It increased the total number of people, and to me that number already felt far too large.

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I had been gone only thirty hours, total; but when I arrived back at Headquarters, I learned that in my absence five new problems had occurred. I scanned the written summary that Pauli had left behind.

First, one of the thirty-two booster engines set deep in the surface of the asteroid did not respond to telemetry requests for a status report. We had to assume it was defective, and eliminate it from the final firing pattern. Second, a big solar flare was on the way. There was nothing we could do about that, but it did mean we would have to recompute the strength of the magnetic and electric fields close to Io. They would change with the strength of the Jovian magnetosphere, and that was important because the troubleshooting team in my absence had agreed on their preferred solution to the problem of adjusting impact point and arrival time. It called for strong coupling between the asteroid and the 5-million-amp flux tube of current between Io and its parent planet, Jupiter, to modify the final collision trajectory.

Third, we had lost the image data stream from one of our observing satellites, in synchronous orbit with Io. Fourth, our billion-ton asteroid had been struck by a larger-than-usual micrometeorite. This one must have massed a couple of kilograms, and it had been moving fast. It had struck off-axis from the center of mass, and the whole asteroid was now showing a tendency to rotate slowly away from our preferred orientation. Fifth, and finally, a new volcano had become very active down on the surface of Io. It was spouting sulfur up for a couple of hundred kilometers, and obscuring the view of the final-impact landmark.

After I had read Pauli's terse analysis of all the problems-nobody I ever met or heard of could summarize

as clearly and briefly as he did-I switched on my communications set and asked him the only question that mattered: "Can you handle them all?"

There was a delay of almost two minutes. The troubleshooters were heading out to join the rest of our project team for their on-the-spot analyses in the Jovian system; already the light-travel time was significant. If I didn't follow in the next day or two, radio-signal delay would make conversation impossible. At the moment, Jupiter was forty-five light-minutes from Earth.

"We can, Al," said Pauli's image at last. "Unless others come up in the next few hours, we can. From here until impact, we'll be working in an environment with increasing uncertainties."

"The PNU people planned it that way. Go ahead-but send me full transcripts." I left the system switched on, and went off to the next room to study the notes I had taken of the five problem areas. As I had done with every glitch that had come up since the Phase B demonstration project began I placed the problem into one of two basic categories: act of nature, or failure of man-made element. For the most recent five difficulties, the volcano on Io and the solar flare belonged to the left-hand column: Category One clearly natural and unpredictable events. The absence of booster-engine telemetry and the loss of satellite-image data were Category Two, failures of our system. They went in the right-hand column. I hesitated for a long time over the fifth event, the impact of the meteorite; finally, and with some misgivings, I assigned it also as a Category One event.

As soon as possible, I would like to follow the engineering teams out toward Jupiter for the final hours of the demonstration. However, I had two more duties to perform before I could leave. Using a coded link to Romberg AG HQ in synchronous Earth orbit, I queried the status of all the clone tanks. No anomalies were reported. By the time we returned from the final stages of Phase B, another three finished clones would be ready to move to the indoctrination facility. I needed to be there when it happened.

Next, I had to review and approve acquisition of single-use copyright for all the draft picks we had negotiated down on Earth. To give an idea of the importance of these choices, we were looking at an expenditure of \$20 billion for those selections over the next twelve months. It raised the unavoidable question, Had we made the best choices?

At this stage of the game, *every* combine began to have second thoughts about the wisdom of their picks. All the old failures came crowding into your mind. I already mentioned NETSCO and their problem with Einstein but we had had our full share at Romberg AG: Gregor Mendel, the originator of the genetic ideas that stood behind all the cloning efforts, had proved useless; so had Ernest Lawrence, inventor of the cyclotron, our second pick for 1958. We had (by blind luck!) traded him along with \$40 million for Wolfgang Pauli. Even so, we had made a bad error of judgment, and the fact that others made the same mistake was no consolation. As for Marconi even though he looked like the old pictures of him, and was obviously highly intelligent the clone who emerged turned out to be so indolent and casual about everything that he ruined any project he worked on. I had placed him in a cushy and undemanding position and allowed him to fiddle about with his own interests, which were mainly sports and good-looking women. (As Pauli acidly remarked, "And you say that *we're* the smart ones, doing all the work?")

It's not the evaluation of a person's past record that's difficult, because we are talking about famous people who have done a great deal; written masses of books, articles, and papers; and been thoroughly evaluated by their own contemporaries. Even with all that, a big question still remains: Will the things that made the original man or woman great still be there in the cloned form? In other words, *Just what is it that is inherited?*

That's a very hard question to answer. The theory of evolution was proposed 170 years ago, but we're

still fighting the old Nature-versus-Nurture battle. Is a human genius decided mainly by heredity, or by the way the person was raised? One old argument against cloning for genius was based on the importance of Nurture. It goes as follows: an individual is the product of both heredity (which is all you get in the clone) and environment. Since it is impossible to reproduce someone's environment, complete with parents, grandparents, friends, and teachers, you can't raise a clone that will be exactly like the original individual.

I'll buy that logic. We can't make ourselves an intellectually exact copy of anyone.

However, the argument was also used to prove that cloning for superior intellectual performance would be impossible. But of course, it actually proves nothing of the sort. If you take two peas from the same pod, and put one of them in deep soil next to a high wall, and the other in shallow soil out in the open, they *must* do different things if both are to thrive. The one next to the wall has to make sure it gets enough sunshine, which it can do by maximizing leaf area; the one in shallow soil has to get enough moisture, which it does through putting out more roots. The *superior* strain of peas is the one whose genetic composition allows it to adapt to whatever environment it is presented with.

People are not peas, but in one respect they are not very different from them: some have superior genetic composition to others. That's all you can ask for. If you clone someone from a century ago, the last thing you want is someone who is *identical* to the original. They would be stuck in a twentieth-century mind-set. What is needed is someone who can adapt to and thrive in *today's* environment-whether that is now the human equivalent of shade, or of shallow soil. The success of the original clone-template tells us a very important thing, that we are dealing with a superior physical brain. What that brain thinks in the year 2040 *should* be different from what it would have thought in the year 1940-otherwise the clone would be quite useless. And the criteria for "useless" change with time, too.

All these facts and a hundred others were running around inside my head as I reviewed the list for this year. Finally I made a note to suggest that J. B. S. Haldane, whom we had looked at and rejected three years ago on the grounds of unmanageability, ought to be looked at again and acquired if possible. History shows that he had wild views on politics and society, but there was no question at all about the quality of his mind. I thought I had learned a lot about interfacing with difficult scientific personalities in the past few years.

When I was satisfied with my final list, I transmitted everything to Joe Delacorte, who was still down on Earth, and headed for the transition room. A personal shipment pod ought to be waiting for me there. I hoped I would get a good one. At the very least, I'd be in it for the next eight days. Last time I went out to the Jovian system, the pod internal lighting and external antenna failed after three days. Have you ever sat in the dark for seventy-two hours, a hundred million miles from the nearest human, unable to send or receive messages? I didn't know if anyone realized I was in trouble. All I could do was sit tight-and I mean tight; pods are *small* -and stare out at the stars.

This time the pod was in good working order. I was able to participate in every problem that hit the project over the next four days. There were plenty of them, all small, and all significant. One of the fuel-supply ships lost a main ion drive. The supply ship was not much more than a vast bag of volatiles and a small engine, and it had almost no brain at all in its computer, not even enough to figure out an optimal use of its drives. We had to chase after and corral it as though we were pursuing a great lumbering elephant. Then three members of the impact-monitoring team came down with food poisoning-salmonella, which was almost certainly their own fault. You can say anything you like about throwing away spoiled food, but you can't get a sloppy crew to take much notice.

Then, for variety, we lost a sensor through sheer bad program design. In turning one of our imaging systems from star sensing to Io-Jupiter sensing we tracked it right across the solar disk and burned out all the photocells. According to the engineers, that's the sort of blunder you don't make after



kindergarten-but somebody did it.

Engineering errors are easy to correct. It was much trickier when one of the final-approach-coordination groups, a team of two men and one woman chose the day before the Io rendezvous to have a violent sexual argument. They were millions of kilometers away from anyone, so there was not much we could do except talk to them. We did that, hoped they wouldn't kill each other, and made plans to do without their inputs if we had to.

Finally, one day before impact, an unplanned and anomalous firing of a rocket on the asteroid's forward surface caused a significant change of velocity of the whole body.

I ought to explain that I did little or nothing to solve any of these problems. I was too slow, too ignorant, and not creative enough. While I was still struggling to comprehend what the problem parameters were, my trouble-shooters were swarming all over it. They threw proposals and counterproposals at each other so fast that I could hardly note them, still less contribute to them. For example, in the case of the anomalous rocket firing that I mentioned, compensation for the unwanted thrust called for an elaborate balancing act of lateral and radial engines, rolling and nudging the asteroid back into its correct approach path. The team had mapped out the methods in minutes, written the necessary optimization programs in less than half an hour, and implemented their solution before I understood the geometry of what was going on.

So what did I do while all this was happening? I continued to make my two columns: act of nature, or failure of man-made element. The list was growing steadily, and I was spending a lot of time looking at it.

We were coming down to the final few hours now, and all the combines were working flat out to solve their own problems. In an engineering project of this size, many thousands of things could go wrong. We were working in extreme physical conditions, hundreds of millions of kilometers away from Earth and our standard test environments. In the intense charged-particle field near Io, cables broke at loads well below their rated capacities, hard-vacuum welds showed air-bleed effects, and lateral jets were fired and failed to produce the predicted attitude adjustments. And on top of all this, the pressure, isolation, and bizarre surroundings were too much for some of the workers. We had human failure to add to engineering failure. The test was tougher than anyone had realized-even PNU, who was supposed to make the demonstration project just this side of impossible.

I was watching the performance of the other three combines only a little less intently than I was watching our own. At five hours from contact time, NETSCO apparently suffered a communications loss with their asteroid-control system. Instead of heading for Io impact, the asteroid veered away, spiraling in toward the bulk of Jupiter itself.

BP Megation lost it at impact minus three hours, when a vast explosion on one of their asteroid forward boosters threw the kilometer-long body into a rapid tumble. Within an hour, by some miracle of improvisation, their engineering team had found a method of stabilizing the wobbling mass. But by then it was too late to return to nominal impact time and place. Their asteroid skimmed into the surface of Io an hour early, sending up a long, tear-shaped mass of ejecta from the moon's turbulent surface.

That left just two of us, MMG and Romberg AG. We both had our hands full. The Jovian system is filled with electrical, magnetic, and gravitational energies bigger than anything in the Solar System except the Sun itself. The two remaining combines were trying to steer their asteroid into a pinpoint landing through a great storm of interference that made every control command and every piece of incoming telemetry suspect. In the final hour I didn't even follow the exchanges between my troubleshooters. Oh, I could *hear* them easily enough. What I couldn't do was comprehend them, enough to know what was happening.

Pauli would toss a scrap of comment at von Neumann, and, while I was trying to understand that, von Neumann would have done an assessment, keyed in for a databank status report, gabbled a couple of questions to Fermi and an instruction to Edison, and at the same time be absorbing scribbled notes and diagrams from those two. I don't know if what they were doing was *potentially* intelligible to me or not; all I know is that they were going about fifty times too fast for me to follow. And it didn't much matter what I understood-they were getting the job done. I was still trying to divide all problems into my Category One-Category Two columns, but it got harder and harder.

In the final hour I didn't look or listen to what my own team was doing. We had one band of telemetry trained on the MMG project, and more and more that's where my attention was focused. I assumed they were having the same kind of communications trouble as we were-that crackling discharge field around Io made everything difficult. But their team was handling it. They were swinging smoothly into impact.

And then, with only ten minutes to go, the final small adjustment was made. It should have been a tiny nudge from the radial jets; enough to fine-tune the impact position a few hundred meters, and no more. Instead, there was a joyous roar of a radial jet at full, uncontrolled thrust. The MMG asteroid did nothing unusual for a few seconds (a billion tons is a lot of inertia), then began to drift lazily sideways, away from its nominal trajectory.

The jet was still firing. And that should have been impossible, because the first thing that the MMG team would do was send a Power-Off signal to the engine.

The time for impact came when the MMG asteroid was still a clear fifty kilometers out of position, and accelerating away. I saw the final collision, and the payload scraped along the surface of Io in a long, jagged scar that looked nothing at all like the neat, punched hole that we were supposed to achieve.

And we did achieve it, a few seconds later. Our asteroid came in exactly where and when it was supposed to, driving in exactly vertical to the surface. The plume of ejecta had hardly begun to rise from Io's red-and-yellow surface before von Neumann was pulling a bottle of bourbon from underneath the communications console.

I didn't object-I only wished I were there physically to share it, instead of being stuck in my own pod, short of rendezvous with our main ship. I looked at my final list, still somewhat incomplete. Was there a pattern to it? Ten minutes of analysis didn't show one. No one had tried anything-this time. Someday, and it might be tomorrow, somebody on another combine would have a bright idea; and then it would be a whole new ball game.

While I was still pondering my list, my control console began to buzz insistently. I switched it on expecting contact with my own trouble-shooting team. Instead, I saw the despondent face of Brunel, MMG's own team leader-the man above all others that I would have liked to work on my side.

He nodded at me when my picture appeared on his screen. He was smoking one of his powerful black cigars, stuck in the side of his mouth. The expression on his face was as impenetrable as ever. He never let his feelings show there. "I assume you saw it, did you?" he said around the cigar. "We're out of it. I just called to congratulate you-again."

"Yeah, I saw it. Tough luck. At least you came second."

"Which, as you know very well, is no better than coming last." He sighed and shook his head. "We still have no idea what happened. Looks like either a programming error, or a valve sticking open. We probably won't know for weeks. And I'm not sure I care."

I maintained a sympathetic silence.

“I sometimes think we should just give up, Al,” he said. “I can beat those other turkeys, but I can't compete with you. That's six in a row that you've won. It's wearing me out. You've no idea how much frustration there is in that.”

I had never known Brunel to reveal so much of his feelings before.

“I think I do understand your problems,” I said.

And I did. I knew exactly how he felt—more than he would believe. To suffer through a whole, endless sequence of minor, niggling mishaps was heartbreaking. No single trouble was ever big enough for a trouble-shooting team to stop, isolate it, and be able to say, there's dirty work going on here. But their cumulative effect was another matter. One day it was a morass of shipments missing their correct flights, another time a couple of minus signs dropped into computer programs, or a key worker struck down for a few days by a random virus, permits misfiled, manifests mislaid, or licenses wrongly dated.

I knew all those mishaps personally. I should, because I invented most of them. I think of it as the death of a thousand cuts. No one can endure all that and still hope to win a Phase B study.

“How would you like to work on the European Metamorph?” I asked. “I think you'd love it.”

He looked very thoughtful, and for the first time, I believe I could actually read his expression. “Leave MMG, you mean?” he said. “Maybe. I don't know what I want anymore. Let me think about it. I'd like to work with you, Al—you're a genius.”

Brunel was wrong about that, of course. I'm certainly no genius. All I can do is what I've always done—handle people, take care of unpleasant details (quietly!), and make sure things get done that need doing. And of course, do what I do best: make sure that some things that need doing *don't* get done.

There *are* geniuses in the world, real geniuses. Not me, though. The man who decided to clone me, secretly—*there* I'd suggest you have a genius.

*"Say, don't you remember, they called me Al..."*

Of course, I don't remember. That song was written in the 1930s, and I didn't die until 1947, but no clone remembers anything of the forefather life. The fact that we tend to be knowledgeable about our originals' period is an expression of interest in those individuals, not memories from them. I know the Chicago of the Depression years intimately, as well as I know today; but it is all learned knowledge. I have no actual recollection of events. I don't *remember*.

So even if you don't remember, call me Al anyway. Everyone did.

### **About the Author**

Charles Sheffield (1935- ) is a mathematician and physicist who has written numerous short stories, technical papers, and books. His fiction, which is mostly hard science fiction, has won major awards. He is Chief Scientist and Board Member of Earth Satellite Corporation, a Past-President of the Science Fiction Writers of America, and a Fellow and Past-President of the American Astronautical Society. His most recent novel, *Transvergence*, appeared in 1999 from Pocket Books