A Better Earth

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Thank You

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D and G are hard, as in 'doll' and 'gulf.' J is soft, without a D sound. It is a French 'J', as in 'Jean.'

AE is a long 'A', as in 'name.' In English, the name 'Djaeds' is spelled 'Djades', where a vowel is made long by following it by a consonant and a silent 'e.' 'Gammae', which ends in AE, is pronounced 'Ghah-may.'

Chapter 1

"A bribe, a simple bribe. An extra-legal payment for an extra-legal action." He muttered to himself. That is what Vallen wanted. Suddenly, he remembered he had spoken outloud and had an escort. The young man was sitting with him in the limosine but way to his left and seemed to be asleep. In any case, Vallen had been nearly silent.

He thought about receiving a bribe, not speaking, then a quarry distracted him.

Vallen Dundel was traveling to a subcontractor's factory for an inspection. He was in a country distant from his own and curious. He saw the quarry in the middle of a field.

The land looked flat. The quarry was a big hole in the ground. Its existence told him that rock lay below the dirt rather than sand or gravel and that the dirt was thin enough.

Strong men, he saw, cut large blocks with diamond toothed saws. Special cranes lifted the blocks; they were too heavy for people. No one cut small blocks with a hammer and chisel.

The quarry was efficient. It employed a technology quite different from that of a thousand or two thousand years before — even though the old methods had provided stone for beautiful buildings which had lasted.

Vallen mused. By now, the modern techniques for stone cutting were generations old. The adaptation took place long ago.

But the first time, Vallen knew, the new techniques meant the same number of men could cut more blocks.

For inland cities, transportation was the big cost. Without many stone companies in the market, the people who headed them could get together, restrict production, and keep prices up. No one powerful would have any reason to cut more blocks.

Chapter 2

Filgard Meldon did not plan to become a revolutionary; he tried to raise money from venture capitalists.

As he packed, Fairta leaned against a door frame in the house they lived, on what had once been a farm.

It was just a day trip, but he figured that something might happen. Fairta was middle aged, not too tall, not matronly. She and Filgard had been married for more than two decades.

Fairta said to Filgard, "I have a notion for you to think about as you travel." Filgard grumbled a bit, "I am going to be looking out the window." "Yes," Fairta said, "but some of the time, you will be waiting and have already looked at everything. Then you can think." Filgard nodded. He also knew she would tell him. She prepared everything for him, quite reasonably thinking he was impractical. It no longer bothered her. Most of the time, she led her own life as a violinist.

"Think about the four Galenic temperaments. I don't have any evidence — you might find it — but I do think they fit.

"My temperament, that of making beauty, being optimistic, preferring the here and now, is what Galen called 'Sanguine.' His theory of humors was wrong; but that is neither here nor there. I am concerned about the descriptions his temperaments suggest.

"That first pattern is not practical for a complex society. We don't think of leaders as special." She grinned. "We cause lots of trouble."

Then she went on. "Temperaments are about preference. My preference is Sanguine. That does not mean I cannot see other patterns. Also, of course, there are some people who do well in many different ways. Older people gain skills, too.

"In any case, for a society, a more practical and extensible pattern is the second, the Melancholic. People with that preference work hard and have much common sense. They are conventional.

"Centuries before Galen, Plato and Aristotle talked about temperaments. Aristotle referred to the Melancholic as Proprietary, as people who gain pleasure by acquiring material assets. Plato, for all his idealism, looked at what people did. He called these people Guardians. They guarded the city. He said they also are endowed with common sense, work hard, and are very necessary for survival. All is true.

"If you enjoy moral virtue, if you have what might be considered an intuitive sensibility, then according to Galen, you are Choleric. Aristotle called such a person Ethical, since he or she seeks virtue. That is where these people's pleasure comes. Plato called them Idealists.

"Galen called the fourth type Phlegmatic. They are supposedly calm; at least, they try to appear calm to others. They can learn a great deal easily; it is not necessarily practical immediately.

Fairta stopped and laughed. “Plato would have called you a Rational, because of your reasoning sensibility.

“Some modern people say that there are more than four types, but that those are the biggest. They say that temperaments are expressions of beneficial behaviors. If taken too far, those behaviors become dangerous illnesses. Thus, people who are good diplomats in a tactical sense, make beautiful things, the optimists, the Sanguine as Galen called them — if their beneficial character goes too far, it becomes mania, a disease.

She grinned. Filgard was not wearing his tie, even though he had it hanging out.

“Don’t forget your tie . . .” she said. “Also, you don’t need to pack a suitcase; it is only a day trip.”

“What if something happens?” Filgard asked.

“There are no canals, ponds, or lakes where you are going; besides, if you did fall into one, your hosts would laugh and help you. You are worried and trying to be too much of a perfectionist. All you need to carry is a briefcase with printed copies of your abstract and of the proposed contract.”

“No one needs those; we can exchange email.”

“Yes,” said Fairta, “anyone can be practical; that is not the purpose of this trip. It is symbolic; carrying a briefcase is like your suit.

“And don’t forget to wear your tie.”

The building possessed only a single storey. It was behind barriers, safe from a car or truck attack. Most of the employees, those who had to be there physically, came down a light rail system that had been built in the far right hand lane of a previously wide road. From the airport, it looked like the right hand lane. Going the other way, it would be the left hand lane. The company’s name, Advancement Inc., stood on the barrier wall. It was small, discreet, and meaningless.

Unless you were invited, you would not know that it was the home of a significant venture capital operation.

Filgard was glad the company had paid for his flight. Not only had flying become expensive since the Disaster, much more expensive than it used to be, but he felt pleased they were paying for him now. He was no longer a supplicant. They wanted to smell him, not merely see him on a high resolution audio/video link.

He was happy about the limousine they provided, too. He looked out its window. The grass on the side of the road looked just like his at

home. There were more deciduous trees here, though. He decided that looking out the window of the limousine was no different than looking at a very high resolution audio/video link, except the image went all around. He stared out one window, but they were others. The inside smelled of leather. Filgard decided that was probably artificial. Still, he did not normally sit on leather and enjoy a leather smell. He liked the service.

Filgard did not have to walk from the rail station through the hot, humid air to the barrier, but only through the tunnel from the barrier to the building. The air in the tunnel was not much cooler than the air outside, but it was considerably dryer. Filgard wondered momentarily what low-energy technology was used to remove water from the air.

He moved comfortably and loosely — it was like being in an old time city, he thought, not an old time suburb in which you drove everywhere. He walked; he enjoyed walking. It served as exercise. And he enjoyed dry heat.

Old time cities, those with sky scrapers, were dangerous. That is what he thought. He knew that statistically, most were quite safe. Still, he was fearful. Someone might attack. Even though the new suburbs were much more expensive, being less dense and less energy efficient, they were perceived as safer. He perceived them as safer. You could keep cars and trucks away from buildings. Each commercial building had its own security force and back-up generator. It stored extra fuel, water, and food. It was resilient.

Of course, cities worked well for most people. They were dense and energy efficient and no longer contained high value targets. A belief-based non-state organization could raise money and organize suicide soldiers for an attack, but the payoff had dropped. Few attacked.

The tunnel was not gloomy at all; it was more like a hall in a large building. It felt wide and safe. Natural light came through many windows. Although ceiling strips could provide light, they were off. Filgard looked closely. As he hoped, the windows were triple paned with a vacuum between them. Little heat crept in or out, except for radiation. The tunnel fit energy standards for new construction.

It enjoyed rather good wall paper, too, with repetitive glide and transfer elements.

Filgard came from a university that was close by a town of 250,000 people. Filgard thought of the town as a city. It was large enough for him, but not large enough to become a target. The buildings were older than this suburb. His house was older. All had been retrofitted for energy conservation.

In the past, the university had done nothing notable, except to win sports' tournaments, football, Filgard thought, and maybe other sports, too. It used the victories to raise money from alumni. A fair bit of the

money went back to sports — Filgard thought of competitive sports as an irrelevancy to a university, a way to raise money, as it were, a tax on education. But some of the money came to Filgard.

Leaving the tunnel, Filgard came into a large reception hall, larger than any at his university, except for the one built a generation before in the business school. A young man met him.

"Doctor Meldon, please come with me," he said. As they walked down a short hall, the young man introduced himself. "I am George Trumman. I am your contact here."

During the walk, George Trumman made small talk.

"Filgard D. Meldon, hello," Trumman said. "I do not confuse you with the other Filgard Meldon. He is a convenience store owner. When looking into your background, one of our researchers discovered him first. Not a Professor of Engineering! I wonder what the man thought we were thinking. It took a moment for him to realize that even though you have an unusual name, there can be two people with the same name in the same city. At least, you have different middle initials!"

Like Filgard himself, Trumman was wearing a suit and tie. Filgard thought of that as a uniform telling people who was higher class and who not, at least in his culture. He figured Trumman was better at dressing than he since Trumman did it more often and was more concerned.

Trumman noticed Filgard's momentary lack of attention but said nothing. 'Engineers are all alike,' he thought.

He led Filgard into an office twice the size of Filgard's at the university. Filgard did not comment on that, but finished the conversation, a conversation that Trumman had almost forgot. "Filgard B. Meldon, the convenience store owner, turns out to be a distant relative. I had not known about him. When it became possible, I did searches for Filgard D. Meldon or Filgard David Meldon. That search always brought up me and only me.

"The Filgard comes from the name of a common ancestor several hundred years ago. We are sometimes confused, although the truth is, mostly not. Or people do not tell me. I suspect there are more cases like your researcher, momentarily confused, then understanding. Meldon itself is a common enough name, but not Filgard Meldon. Well," he grinned, "I find it fascinating that the only two Filgard Meldons in the whole world live in the same city."

There was no one else in the office they came to. Filgard began to worry. Trumman did not take long. He said, "Your work is very good. Even though your light waves are hundreds of times larger than molecules, it is clever how you are able to determine the molecules' exact locations, as well as their types. We would like to keep an eye on the project."

Filgard did not say anything; he simply stared.

Trumman shook his head minutely and said, “We cannot fund your project. But it is very good.”

Filgard still did not say anything. Trumman, as if he expected this, said, “You not only have ‘proof of concept’, you have a working device. But we cannot sell it. We would have to spend a fortune to design the liquid helium coolers, the lasers, and the recording elements for everyday use.”

He went on. “You might think, well, we can recoup high private development costs with a high per unit price. But we cannot. That is a problem in a globalized world.”

Trumman had a decanter on his desk. He poured a fair amount into a glass and handed it to Filgard who took it without thinking — and took a big swig of what he realized was very good Scotch whiskey. Trumman curved his lips into a tiny smile. He went on. Filgard still had not said anything.

“As soon as we produce one saleable unit, someone, somewhere — very likely in one of our factories — will produce identical copies without the high initial cost we paid.”

He helped Filgard into a chair and sat down himself.

“That happened with the first CDs and DVDs: people in factories that manufactured them simply bribed a few people, ran extra shifts to stamp out copies identical to the originals, and sold them at whatever the market would bear. As for prevention, the main producers said the action was as dangerous as murder on the high seas — they called it piracy — but they mostly focused on the small and irrelevant. They avoided big action. They did not prevent these actions. I think they were bribed. After all, you can get many people to do just about anything for what comes to a relatively small amount if you are planning on a large return. And bribing people to let a foreign factory run an extra shift? That does not cost much at all.

“It is all a matter of price discrimination: charge more to people who can afford to pay more, less to people who cannot. But we cannot distinguish units of your recorder from one another, not the way an airline can distinguish seat sales by time. Well, no one can tell which CDs and DVDs made by the same factory are pirated or not. It is even more a problem now. We cannot sell one unit more cheaply than the rest.

“So, we can’t fund your project. We here live in a country with laws that are obeyed, more or less. If we were only to manufacture and sell domestically, like a steel mill or car firm a century ago, we could fund it. But we manufacture and sell all over the place. Everyone does. And no one will bribe me or the owners of this company.” For a moment, he looked wistful, as if he wanted to be bribed.

"But there is hope." Trumman took a resolute stance. "Even without high resolution manufacturing, without nano-assemblers, existing droplet sprayers can reproduce many MPLs, many metal-plastic-lubricant designs. They can manufacture parts for a washing machine. I don't know about washing machines, they are simple relatively speaking, but your recorder means that complex mechanical devices can be manufactured much cheaper.

"I suggest you use the recorder you have built at the university. We can suggest what to look at, pay for what gets destroyed, and sell the results. You can give some of the proceeds to the university, some to us, and keep the rest. That way, you can fund more work.

"As I said, your recorder is neat."

Filgard found that the whiskey made him a little woozy and considerably less concerned than he would have been. They were not offering him full funding, but they were offering a little. He would take it.

So Filgard asked simply, "What are you suggesting?"

Trumman was ready, although he seemed a bit startled at how quickly Filgard recovered. "I am sending a file to your wearable," he said. "We can do that in here without any concern for security, although we have encrypted it like everything else we have sent you. Mostly we are suggesting tools to make tools."

He stopped for a moment. Filgard noted that the file had finished downloading. It was short.

Trumman went on. "These devices are intrinsically expensive. Even when the designs are known, as they normally are, the tools are difficult and complex to build. On a world-wide basis, few of each type are needed. That means few are sold. So a company has no motivation to manufacture and sell them at a lower price. We will pay for each tool."

Filgard looked at the prices on the file and realized that his project could not afford even one. And it would be destroyed in the process of recording it. Filgard could not think of any way to get around that. After localizing the position of each molecule or atom, determining its type, and conveying that information to a computer file, a cutter had to scrape away the very thin, measured layer. That destroyed the original. Then the sensing could continue.

He did not remember anything else that Trumman said. There was nothing meaningful in it. Somehow, he drank more. A little later, he ate a very good lunch that focused on a portion of salmon with an excellent mustard sauce. Salmon are carnivorous. They had become expensive, too. Normally, Filgard hardly ate any. He did not object to the fish at lunch. In a sense, it was just as if the company had funded him. He left that afternoon at the time planned before and flew back home.

He liked the flight's service and its speed. He was in a higher category than his irregular flights before. 'If only I could do this on all travels,' he thought. 'But you have to be rich or have rich sponsors.' The new plan made it much less likely that he would ever become rich. Still, he consoled himself. 'The new plan is not an ending. It is not an ending of my day-to-day reality.' He stopped thinking for a moment. He did not want to think his next thoughts, but they were true. He could imagine that ahead of time. 'It is an ending to my dreams.'

Coming up to his house, his wife, Fairta, studied him shrewdly. She understood immediately. Meanwhile, Filgard looked at his windows. Like those around the tunnel, he could see through them clearly. But the panes were fairly small. They were doubles, with a vacuum between glass. They were small so the two sides would not be crushed together by atmospheric pressure. Obviously, a glass company could put gas between the two panes; that would counter the pressure. The design would help, since a trapped gas does not convect much. But a vacuum was better. In his house, more heat was lost through the frames than through the glass itself. The frames were insulated, but they had to be narrow. Even with insulation, they conducted.

The university had windows that were bigger and originally were considerably better. The new ones — now he realized that 'new' meant two decades old; he had grown older, too, quite unexpectedly; he laughed at himself; he still felt young — the 'new' windows had three panes of glass with aerogel columns as spacers between the outer and central panes. The outer panes were both on the inside and outside of the buildings. The spacers kept the pressure of the air on the outer panes from collapsing against the central. Initially, the aerogels were transparent and you could hardly tell they were there. But now you could see them. The university windows had become uglier than his.

His wife had not been at all certain what would come of the trip. She did not have his optimism. So when she saw him as gloomy but not excessively depressed, she understood. His face, as usual, told her more than he realized.

Filgard told her that the venture capitalists would not buy into company development, but that they would fund operations with the current machine. He repeated what Trumman had said about the world being mostly extra-legal. "That means," he said, "you cannot make a profit from something that will be manufactured world-wide." At that, Fairta grumbled and said, in a voice that told him he should not take her too seriously, "What you are saying is that I will still have to pay attention to money when I buy shoes." He laughed.

Fairta said she did not have to go out that evening — she was a violinist in the university orchestra — and had prepared a meal. It had lamb and chicken as two kinds of meat and squash, potatoes, onions and

beans as vegetables — it was almost a holiday meal; Filgard thought of it as a holiday meal. Fairta had also purchased an excellent, and expensive, bottle of wine. "I expected you to be either exultant or despairing," she said. "I did not expect you to be in the middle. But we are stuck with this wine, unless, of course, you want a cheap bottle. We have that."

"No, no," he said. "The wine goes with the meal. Let's splurge."

Chapter 3

First, Vallen went to wash his hands. He found one of the younger men washing beside him. Vallen recognized the man and said hello. Vallen was slightly bemused to realize that the other was so low on the totem pole, they had never been introduced. Vallen did not know his name. The young man was not wearing a tie. His shirt was open at the neck. Vallen did not know whether that was a generic instance of younger people attacking older or whether it was a peculiarity of the local culture, of saying, 'we are not you.' Vallen suspected the latter. He also noticed that the cloth in the shirt was carefully strengthened so that its open neck looked well. That cost. Vallen liked the effect. He took off his tie occasionally; he would make sure the shirts made for him had the same strengthening. As he left the wash room, the young man put on a jacket. His rebellion did not go too far.

As he was leaving, he said, "You know," — Vallen decided the young man spoke with the same accent as that of major movies — "You know," said the young man, "we could make more profit if we produced more and sold the extra production at a lower price. We would just have to make sure we did not lower all our prices."

"Price discrimination," said Vallen. The young man had halted half way out the door. "But how do we do it? We do not have regional markets, like the first DVDs. We cannot discriminate by time, like airlines." "Well," said the young man, "we can do the same as the first DVD sellers: we cannot copy their governmentally enforced regional markets, although they only concerned themselves with big operations; we don't have that kind of big operation; but we can encourage an extra-legal market. That is where the DVD companies sold."

Vallen nodded. He understood what was going to be offered. Indeed, he expected some sort of beginning like this. At the same time, he thought of price discrimination as good. Good for him, good for the company, good for everyone, except for losers.

It was practical. Few people in extra-legal markets were willing to transfer as much of their resources to his company as those in legal markets. So, extra-legal people should transfer less.

Vallen was confident that the prices of second shift products would be set to maximize profits. He would benefit from higher sales. Another shift would require more workers. They would benefit, too. Only disorganized people who paid more would get hurt. And the unpriced future would pay — pollution is a tax on the future. In places like this, Vallen thought, it is a tax on the present, too. He was glad he did not live here. The rich could afford to pay more and those around here couldn't. Or else those with connections spent their time in buildings with decently filtered air, like this one.

Vallen nodded again. “Intelligent price discrimination is vital for a modern business. There are increasing returns to scale in the production of just about everything. Your produce more, you make more. Only through price discrimination can we pay for initial high costs, including patents and copyrights.” The young man agreed. He nodded vigorously. “Yes,” he said, “yes.”

The young man came out of the bathroom cheerful. Sometime later, after the young man talked briefly with a more senior man, a man who wore both a tie and jacket, that man took Vallen aside. “The problem with price discrimination,” he said, “is that we cannot make it public. Everyone wants to buy as cheaply as possible.” “It is also illegal,” said Vallen. “That, too,” said the old man dismissively. “If we do engage in price discrimination, you will have to be recompensed.” The man’s language was flawless, Vallen noted. ‘Price discrimination’ and ‘recompense’ were long words that just flew off his tongue.

Vallen quoted Adam Smith,

> *It is not from the benevolence of the butcher, the brewer, or the baker that we expect our dinner, but from their regard to their own interest.*

The senior man smiled. They had a deal.

It never occurred to Vallen to repeat a different quotation from Adam Smith; he never thought it relevant; it never came to mind:

> *People of the same trade seldom meet together . . ., but the conversation ends in . . . some contrivance to raise prices.*

Part of the reason was that Vallen did not think of what he was doing as raising prices. On the contrary, he felt he was lowering prices to people who could not afford more. He never considered that over all, he and his company were helping to keep prices higher than they would be in a competitive, free market. They did not sell meat, ale, or bread like the people in the Adam Smith quote. It did not occur to him that at the time Adam Smith wrote, neither a butcher, a brewer, nor a baker enjoyed increasing returns to scale; on the contrary, as more animals were killed, as more grain was grown for brewing or baking, costs rose.

Vallen ran a division which manufactured and sold specialized car parts. All in all, he figured, there was not much risk in permitting a factory to produce more, but there was some; he would have to be compensated.

He would have to make sure nothing ill-written passed him by. He would have to make sure that tax people and noisy investors expected the numbers he provided. It would take work.

It would not do him any good to permit legal prices to fall. That might happen if more people learned of this extra-legal development. At home, only a few managed to get away with paying low prices. Mainly,

they claimed that the products 'fell off a truck' or that they 'bought them wholesale.' Low prices were not widely published.

And of course, agents, especially those employed by competitors and by the government, knew that at home this kind of price discrimination was illegal. It was not simply extra-legal. If it were proved that he was involved, he could go to jail for conspiracy.

He would have to be compensated a fair amount. Well, they could afford it.

The goose was good.

Chapter 4

The morning after coming back from the venture capital company, Advancement Inc., Filgard went into the university. He told people what had happened. He tried to make positive remarks, but everyone could see he was disappointed. Still, everyone said he did well, which Filgard thought was simple politeness. Moreover, they acted as if he had done well. He wondered whether anyone besides himself had hoped.

Later that day, he had to go to a faculty-wide meeting. At first, he thought to himself that it would prevent him from working, but then he saw he would get nothing done anyhow, not that day, so the meeting did not matter.

As far as Filgard remembered, such meetings were rare. Rather than be useful, they were designed to impress on the faculty the plans of the administration. Since administration plans did not change very often, and memos served as ritualistic reminders, there were few meetings. The announcements were routine. He expected to be bored and was surprised when the meeting became exciting.

Among other items, the president of the university spoke of continuing the contract to Efficient Windows Inc. She spoke as if the decision to continue was routine. Doubtless, she thought it was. But one of the physicists spoke up. "Why should we do that?" he asked. "They failed before; what makes you think they have changed?"

Clearly surprised, the president asked, "What do you mean, the windows failed?" The physicist responded, "The aerogel columns on the windows we got from them became visible. Yet they have never said or done anything about it; nor have we."

The president glanced at the windows. There were faint, blue squares visible in them.

"But we installed those windows a long time ago," she said. "Yes," responded the physicist, "eighteen years ago. And after seven years, the aerogel inserts appeared. The aerogel could not handle the relatively small amount of ultra-violet that got through the glass. And neither you nor they have said or done anything, even though they and the university administration said that the windows would remain transparent. They conduct more heat than they did, too."

"The decision was before my tenure," said the president. "Yes," said the physicist. "It looks as if your predecessor or some other senior administration officials were bribed not to say anything." The president hid her surprise at this comment. Why would anyone bother with windows? She thought the fellow was seriously crazy.

"They could have given us an apology. Efficient Windows could have replaced their faulty windows. That would have been sufficient. It would have directed other potential customers to ask about the aerogel.

It would have told them that 'Efficient Windows' does what it says it will do. They could have carried on. As is, we have no evidence whatsoever that new windows will not fail the way the old ones did. Your talk here is about purchasing a potentially faulty product."

"But will anyone notice?" asked the president. "I certainly did." The physicist interrupted the president before she could go on and, Filgard presumed, say that she did not care.

Many professors from the English department and from the business school looked at the windows as if they had never noticed the blue checkers before or had forgot their appearance. But Filgard saw that a good number of physicists, mathematicians, and engineers nodded their heads vigorously. They noticed.

"Remember," said the physicist, "we are installing windows to last more than two decades; we do not want them to be faulty for two-thirds of that time. And my hunch is that we will not replace them until the passage of many more decades than two. People will spend their whole careers in this university with faulty windows. Good people will avoid us."

That last phrase grabbed the president's attention. "What do you mean, good people will not come?" "Well, to my certain knowledge, since they told me," said the physicist, "two good people asked about the windows. We had selected them. I mean the people. We also selected the windows. We wanted the people in our faculty. But after being told that neither you nor the company had said or done anything, they declined. One of them told me, 'That indicates what the administration is like overall. I am better off staying were I am. At least, the people running the place notice mistakes. They would have the law department draw up a tort; it would be good practice for the students.' That is what he said."

An older man in the math department rose up. Filgard did not know him; the man kept to himself or to other mathematicians. At meetings he was silent. But this time he spoke. He said, "Three have told me that faulty windows are the reason they did not come. They would have been interesting.

"You know that, in a sense, it is not relevant where people are located. We can communicate much more easily than a century or two ago. But still, unplanned communications convey many ideas that would not come otherwise — conversations 'by the water cooler,' as they are called. That is why we seek good people. Well, I know you seek them because prizes and awards will help you raise money. Nothing wrong with that. But you threw away prizes and awards.

"It may well be that administrators, business people, English professors, and the like are not sensitive to their physical surroundings. So they do not care. They pay attention to their human surroundings.

They tell the rest of us to get used to physical problems; they urge us to adjust to unnecessary incompetence. But many of us are sensitive, do notice, and do care." He sat down.

The president looked flustered; maybe the physicists and mathematicians were all crazy; regardless, she did not want to be accused of throwing away money. "We will defer the issue," she said. One of the engineers spoke without rising, "That is only one of the issues of efficiency and competence." The president looked even more flustered, but pretended not to notice the interruption. She went on to another topic.

The meeting improved Filgard's spirits. He felt bucked up. The university might never eschew stupidity, inefficiency, and incompetence, but at least a few of the old guard protested. It was good to see that happen.

Then he got back to his project area and Peter Dev, one of his graduate students, made him depressed again. Filgard thought well of the fellow. Peter could explain engineering. Moreover, he not only focused on engineering, he read other books, too.

"It makes sense," Peter said, "that ADVANCEMENT INC. would want to watch what we do. After all, we are one-half of oligarchs', our rulers', biggest practical threat. No one is going to stage a political revolution, at least, not in the rich countries. Rulers need not worry about that." He paused for a moment, looking at Filgard's face. Filgard nodded.

"But they, or at least a few of them, will attend to real dangers. For many, the big threat are von Neumann machines that produce material objects as a side effect of replicating. Rapidly reproducing von Neumann machines mean that what people want costs nothing, at least, that the material objects that people want cost nothing. Were that to happen, the corporations that currently make the objects would go out of business."

"What do you mean, we are one-half?" Filgard asked. "We are the recording half of the threat," the student said. "The other half is manufacturing, making copies of what we record. That half has only developed part way." He looked at Filgard again, who seemed ready to listen.

"Spray-droplet technology," said Peter, "means we can build metal and plastic devices. So long as parts are separated by sufficient lubrication, we can manufacture separate parts in position. With decent droplets, we can duplicate ball bearings in their housings and do that more cheaply than assembling them. Rapid reproduction is amazing." He repeated himself, "It is amazing, and it means that engineering design becomes very different, even though structural rules stay the same. You can see and test the results of your design quickly. But that is a digression." He focused his eyes on Filgard's face.

"A good way to track what we do is to pay us to record how to manufacture expensive and complex machinery. That tells how good we are. And if you pick machines that are not going to be duplicated widely, even if they become cheap, you can sell manufacturing rights and pay for the cost of keeping track."

He looked at Filgard. "Think of the implications of generalized, rapid reduplication, even what we have now. By duplicating the machines for mining, refining, and granulation, we could cut the cost of inputs dramatically. And if we used high resolution droplet sprayers, we could inexpensively manufacture new sprayers that work at conventional resolutions." He used the word 'resolution' to mean the size of a sprayed droplet of metal, plastic, or lubricant. The droplets were so small that regardless of composition they could easily be melted in flight by a laser and then frozen by the cold of what they hit.

"Even if we cannot do everything an atomic assembler could, even without complete closure, we are ahead. In the end, with spray technology, we may only see a factor of ten increase in efficiency. I expect more, but who knows. Still, that is the same sort of factor that enabled the industrial revolution to threaten and sometimes to destroy the old elites. The people who manage the new dinosaurs have reason to worry."

Filgard said, "They wasted the planet; they had cheap energy," referring to the people who had come in the centuries before him. The graduate student understood. "Yes, yes, they did that; they had that," he replied. "But they also built with fewer inputs than before. Sure, their pricing of fossil energy was screwed. They did not take into account the long term or distant costs of what they did. They did not have to count the cost, so they didn't. That was an important subsidy."

Peter continued to speak. "Many people were not even aware of that subsidy. You know, even for sensible matters, like smoke in the air, people criticised government regulations as costing extra rather than being a recognition of what was already being spent! They did not link private health spending, government action, and someone else dumping smoke into their breath." He shifted back to his main topic. "Still, the old-time industrial revolution engineers also figured out how to do more with less, and much more with the same amount.

"Look at the university's windows." They both turned to stare at the windows with blue checks. "Yes, they are faulty. We all know that. But even though they were built with three levels of glass, with complex aerogels, using vacuum pumps and so on, when you take into account everything, including especially the flow of energy through them and their frames, they are better than single pane windows. And that is even though they failed. Over fewer than ten years, whether it be land to grow wood or some other direct solar converter, or whether you mine

your energy in an oil well or something like that, this kind of triple-paned window ends up consuming less."

Chapter 5

When he reached home after his inspection trip, Vallen found his managers judged him successful. Both the production and sales they saw increased, not much, but a little. In fact, as Vallen knew, production had increased considerably more, but the sales to move the car parts were not the sort that could be reported; and they weren't. Vallen's managers rewarded him with a perk. It cost them nothing, cost the company little, and was not transferable; it was not, as the economists liked to say, fungible. It was a trip on the company yacht, HAPPY TIMES.

Vallen and his wife, Jennifer, walked up the gangway. The ship was fairly large. An engine powered it. It lacked sails and three stories rose above the first. Vallen remembered he should call them decks, not stories or floors. Except for deck, gangway, and a few other words, Vallen thought in landlubber terms. He remembered that starboard was right and port left. On the ship, he mingled with the buyers and sales' people that justified the ship's tax existence.

They planned to go on a cruise out of the bay and into the deep ocean. It would be two days of luxury and networking. Vallen and his wife were good at both. He was very happy he had married the woman. They were not close; it had never occurred to him that they might be close; but she knew how to support a rising corporate manager. It was, he thought, a good arrangement.

The yacht was fine. His cabin was not too big. It had a window, a porthole, Vallen remembered to call it. The porthole was covered with a curtain. The cabin's only bed was double and fit into a wall. Storage lockers fit below it and above it. The locker below, a big drawer, was empty. That above contained life jackets. On the room side of the bed, the only side open, it had a fence that you could raise or lower. The barrier was covered with leather. The crewman who showed him in asked him to please raise it at night. "It will keep you from falling out of bed if we run into big waves," he said. "We do not expect to; none are forecast. But forecasts have been wrong."

The only blemish was outside of Vallen's room. There were no panels on parts of the wall in the hallway. Bare metal showed instead. The old panelling had been removed.

Vallen learned that the fellows who were going to glue in new panels — they were made of wood and had wall paper on them — could not afford to come to work because of higher fuel prices. Or the company that employed them directly could not afford to carry them. Instead of their two buses, the company that organized them had to find a single, more efficient and bigger bus. It had not done so in the hours before sailing.

Vallen figured the workers must be illegal or extra-legal. Either way, his own company would pay less. Less skilled workers, he wondered if in practice they were less skilled, might take a little longer, but they were considerably cheaper than citizens; and the big robot companies did not permit prices to drop sufficiently that humans could be replaced in general.

In any event, his company's president asked Vallen and several other relatively junior 'guests' to do the job. Vallen saw this as a test and enthusiastically accepted the assignment.

The job was not that hard. The panels were glued into place. They and the glue-guns were already on board. Vallen wondered whether the stated reason the subcontractors had not come was true or whether the job had always been intended as a test. Vallen decided the reason was true and the president of the company got to where he was because he could always turn a disaster into an opportunity for the company's backers. It was, Vallen thought, a good-to-know instance of a general lesson.

So Vallen started gluing panels into position. It was a little tricky, since he wanted the straight lines on the wall paper to move across the wall without any jagged jumps. But other than that, it was not difficult. It was not as hard as gluing on rolls of wall paper.

Nonetheless, one of his fellows worked more quickly and less carefully. His lines wiggled. Vallen complained. The man turned and said accusingly, "You sound like an environmentalist. What is your concern for craftsmanship and the future?" Vallen responded simply, but loud enough for others to hear, "We are going to be walking beside these soon and for a long time."

After finishing the wall, Vallen and Jennifer washed up and went to an event in which the food and drink were so good he did not feel unsatisfied although he ate and drank sparingly.

A little later, on his way back to their room, Vallen saw several of the crew use a fancy machine to push a narrow but long pipe into the cracks between panels the man had put up, spray something behind them, and then use multiple suckers to pull whole panels off the metal wall. On the backs of the panels, he saw the glue and the spray, which bubbled like foam. The crew washed off the panels and the walls. They sucked up the liquid with an industrial vacuum cleaner and dried each barren segment of wall with a hot blow dryer.

Vallen never saw his co-worker again. Instead, the swell changed. The yacht had not yet left the bay before. He did not see any people fix the wall, but some did. Vallen decided that crew glued up the panels again, quickly and neatly.

Vallen felt he could relax, albeit carefully.

Chapter 6

At work after the yacht trip, one of Vallen's employees brought him a budget for manufacturing. Brimming with confidence, Vallen said, "I will look at this, but I am sure you did right. Now, produce a budget for sales, presuming we go into a new country with quite different beliefs and marketing practices than those we are accustomed to." The man asked Vallen, "Which country?" Vallen named it. It lacked a huge group of people who could afford legal prices. Vallen expected to sell more parts extra-legally than legally, and more cheaply, too. But the number of those who could buy legally was not too small; that number justified imports and the sales campaign.

The accountant had expected Vallen to speak as he had, but had not expected his new confidence. When he returned to his own office, he commented to a colleague. "Some time since I last saw him, the boss decided he could tackle anything. Maybe he can, too."

His colleague thought it was the yacht. "Usually, that kind of favor implies a test of some sort. I bet Vallen knows he passed with flying colors. He is smart. He is going places."

Vallen figured out that people attributed his added confidence to the yacht trip. He did not tell them otherwise, but he knew the bribe filled him. The yacht trip only helped. His poise signalled others as well as himself that he had done well.

As for the bribe: he liked it. He did not or shortly would not have to depend entirely on one company in one country. Still, he did not dare live more grandly than his overt income permitted. He feared being found out. He did not store his extra income in a local bank either. The tax man might discover him. There were advantages to living in a country that mostly enforced laws, like more personal security, but there were difficulties, too. 'Softly, softly,' he thought. Even so, on his overt income he lived well enough for comfort and for show.

In a sense, Vallen decided, he was helped by his discretion. Rather than spend the money for immediate pleasure or for show, he planned for a more distant future. He was not quite sure what he planned for. All might go well in his conventional life. But he was smart enough to 'expect the unexpected,' as the phrase went. That is what he kept saying to himself.

Rather than just depend on one bank that might fail or might act against him, Vallen chose several accounts in several countries, at different banks. More banks meant more chance that one would feel enough pressure to check him out, or even have incorruptible employees; but he could simply walk away if that happened. He was sure that would not cost more than fifth of the total, or a quarter if he had to bribe officials. He would not like it; he did not expect it; but it was doable.

Later, he would invest in land and buildings. That would be after he had more and learned more. Of course, the extra accounts meant more travel, but Vallen picked places he would visit anyhow. The new accounts meant only that he would conduct inspections more frequently. 'So,' Vallen thought to himself, 'I will gain a reputation as a tough and thorough manager. Not bad.' Vallen figured that without having to write anything down, he could remember five false names and all the ancillary data that went with them. Five pretend lives. He could do it.

Chapter 7

Taffod Dowwen talked himself into receiving a tour. He realized after only a few moments that the plant did not advertise but was ready to give tours. He had not needed to be so persuasive.

The 'energy conversion site' was in an area close to what had been called the Black Forest. The site had not yet received a short name, even thought it had been around for years. It suffered an acronym that no one liked and which did not cross languages. Taffod noted that the acronym did not appear in signs. Then he realized that with the appropriate software, it would not save anyone any time to use it internally in memos. 'Maybe the acronym would vanish!' Taffod raised an eyebrow. 'That would be a benefit of the modern world,' he thought.

At the site, dead trees were cut. There were many in the area. Taffod wondered whether they had been killed by acid rain, by climate change, or by a mixture of causes. At the same time, workers planted fast growing saplings. They would be harvested after the dead trees were gone.

The place provided sustainable energy.

The wood, plus water, went into an on-site refinery. There, the mixture was converted into several substances. Part became a flammable gas, much of which was used to run the refinery; the rest was shipped out. Waste heat generated electricity; most of that left the site. A good portion of the wood (and the hydrogen in the water) ended up as liquid fuel. Taffod used it himself. Like everyone else, he found it convenient to posses energy in liquid form.

Only a small part of the liquid fuel was used on site. Outsiders bought the rest; a few purchased the solid residue, which went as fertilizer.

The refinery interested Taffod only a little. Mostly, he saw metal pipes and containers; he did not know enough chemistry to care what went on inside.

The armored log thrower interested him more. It looked as if the site manager expected that, since the log thrower was the last part of the tour.

Originally it had been a small backhoe, though not the smallest. Rather than have wheels, it rode on tracks like a military tank. In British parlance, it moved around 'on its own flat feet.' The backhoe had a cab, engine, and movable arm mounted on a plate that could turn independently of the treads. It could cross rough ground. Unlike a tank, it could not move fast.

By mounting a second power source on the spinning part, as well as a storage bin, a conveyer belt, a thrower, and the electric motors they used, it could shoot chunks of wood quite a distance. The hoe carried

the thrower; the conveyer belt was flexible, and carried wood from the storage bin up to the thrower. By raising and lowering the hoe and by spinning the cab, the operator could aim.

Except for the windows and the port out of which logs were shot, the whole machine was covered with thick metal plates. They were backed with ceramic and more metal. Outside the original windows, which still remained, were thick sheets of bullet proof glass. The armor was an add-on.

The tour guide showed it all. The door to the storage bin was counter balanced. The guide had no trouble opening it. The bin was huge.

The guide, Henry, told Taffod, "Tossing chunks of wood produces a device that is less lethal than a machine gun, but not less lethal than a microwave denial device or something like that. The latter kills only one in a thousand or so. If logs fall on a crowd, they will kill more. However, logs are visible."

He went on. "Early on, we were attacked as much for show as for anything else. A major goal was to get videos of us killing unarmed protesters — I don't think the protesters thought that, but I am sure their leaders did.

"By throwing logs, visible logs, we indicated that we were ready to hurt, but we were not ready to use guns.

"People ran from the falling logs — the operator intentionally aimed to miss. As far as I know, no one was hurt in the one protest that occurred. This machine made for wonderful video!"

Taffod smiled.

"Of course, it would have been easy for a professional hit man to hide among the protesters and shoot. He would have come to infuriate the guards but could stop the thrower without hurting the driver. We suspected that was part of the plot."

Taffod nodded.

"That is why we attached armor over the backhoe. That was expensive! We could not simply use metal plates we had; a hit man could carry a strong weapon. It could penetrate whatever we had. He could stop the cab from spinning. That would effectively open up the site. The backhoe could not turn quickly or accurately enough on its treads.

"We had to armor the whole backhoe well enough so that only a big military weapon could get through. Nobody was willing to risk that."

Henry turned away from the log thrower. He looked over an open field. Taffod vaguely remembered seeing a picture of it with protesters filling one end. He remembered a plume of logs falling two-thirds of the way across the field, in front of the crowd. 'Yes,' he thought to himself, '. . . good images.' He listened more.

"Essentially, the protesters were against the enhanced trees we plant; their financial backers were against carbon dioxide sequestration unless they could make a great deal of money."

Taffod nodded again. That is what he understood.

"The protesters," Henry said, "feared that genetically modified trees would spread all over. Indeed, if we did not insist on strong safety precautions, they would be right." It was not people at the site that insisted, but people in the regulatory arm of the government. Taffod grimaced to himself, but understood that people in the site supported this government action. Henry went on, "We are safer with these trees than with alien insects catching rides in airplanes and ships. Those insects are not genetically modified, but can come without competitors. They can spread all over the place.

"As for the backers, they feared a drop in profits." Taffod noted he was being told this by a tour guide. The fellow was well briefed. Henry continued. "The financial backers feared that they would lose business to companies who were not forced to bury any of their carbon dioxide. Either they did not believe that the government would identify the right products and tax them; or they expected that certain imports, like windows, would be permitted regardless."

Taffod nodded. 'Interesting,' he thought. 'This is less attractive visually than the log thrower, but more important.'

"European governments," Henry said smiling, "have had a great deal of experience with smuggling." He grinned. "I know this for sure, since some of my ancestors were on the other side." Taffod wondered about the present, but did not say anything.

"I don't think that nowadays there can be much. Certainly, no one is going to smuggle trucks and the like. Doubtless, some items are smuggled," Taffod almost grinned; the man went on, ". . . but we are talking locomotives. They are not going to get smuggled and then operated illegally for twenty or thirty years."

Taffod felt safe in nodding again. He did not know anyone who smuggled locomotives into a law abiding country. He could imagine the buyer and seller of a second hand backhoe agreeing to tell the tax man a lower price than actual. That way, they would avoid some tax. But for new locomotives, a batch of them, in a transaction watched by competitors, in a region where senior people were not bribed much? He doubted illegality.

"Permitted imports are another matter." That comment surprised Taffod. He had not expected Henry to say anything about 'permitted.' He paid attention. 'Maybe,' he thought, 'that was the intention. In that case, we will see that permitted imports are not relevant.'

Henry explained. "That triple paned window with an outer layer of glass and plastic, so an errant ball does not break it — that is a good

idea. Except, we do not have many kids. We do have a few. But even the poorest ones play in parks; they seldom play where they can break windows. We can put in windows without plastic."

Taffod nodded again. 'That fits,' he thought. Henry went on, "I can see the argument: a window with an outer layer of plastic with glass on top of it, so it does not scratch easily — a window with plastic costs more. An extra tax on it will make it cost even more. That is true.

"But if you think of the extra tax as a payment for not burying carbon dioxide from making plastic, then the extra cost vanishes. Without the tax, you are receiving a subsidy.

"The only argument left is that triple paned windows reduce heat flow. There is no argument about that. They do reduce heat flow. Fortunately, you mostly don't need to worry about errant balls breaking all glass windows. And when you insulate your roof, you don't need to worry about winter ice, either. Most of the time, you do not have to be afraid it will gather itself, melt, slip off, and break a window. So we could have windows without plastic.

"But that is neither here nor there. Any kind of window is permitted for imports, yet the only kind I can buy contains plastic and has no carbon dioxide sequestered."

Chapter 8

The venture capital company provided Filgard's group with a large, complex machine that could make a special kind of paper. It barely fit into the recorder's cavity. The machine took a long time to cool.

And then, after it was recorded, which meant it was totally destroyed, the spray-droplet duplicate refused to start. Just in case the problem had to do with the spray-droplet machine and not with the recorder, a second duplicate from the same recording was constructed by a machine from a different manufacturer. That duplicate refused to start, too.

Filgard had talked about the difference between theory and practice; he had warned his students and everyone else that even though his simple recordings duplicated right, more complex duplicates might fail.

Still, this was the first time he had been responsible for so costly a failure. The destroyed machine cost more than his annual budget. It was humbling.

Fortunately, his group could record, and in the process also destroy, both non-working duplicates, the failures. They compared the two new recordings; they were identical. Filgard's group compared one of the new recordings with the original. It too, was the same; that is to say, Filgard was precise in his language, all three recordings were identical. So the problem was not in either of the spray-droplet machines or in the recording; it was in Filgard's recorder.

Peter found what looked to be the problem, a complex interaction between two otherwise good subsystems. They modified the recorder and then made a different record. Filgard had high hopes. Indeed, the next duplicate started. But then it broke.

After two more expensive iterations and some of the hardest work Filgard had ever done, a duplicate worked and kept working, exactly like its original.

Then they tried recording a different machine, one used in truck manufacture. It also was large and complex. Its duplicate appeared to succeed. Everyone cheered. That evening Filgard and his wife celebrated. The next morning, Filgard saw that several of his graduate students had celebrated even longer than he. But he did not say anything. At that point, he and they learned that when installed in a truck, the duplicate's output caused another part, completely unrelated, to jam. Something was wrong.

It took three expensive iterations to create a version of the recorder that produced recordings whose duplicates' outputs did not cause trouble.

The next type of machine produced duplicates that failed in yet another way. It took four iterations before that machine could be du-

plicated properly. Then every different machine that was copied made records whose duplicates did well. The spray-droplet manufacturers produced good, working copies.

Just to be on the safe side, ADVANCEMENT INC., the venture capital company, funded another recording of an instance of the original paper making machine. They wanted to find out whether Filgard was creating a machine-specific recorder or a more general one. Filgard found that his recorder was too complex for him to imagine all the interrelations. Each part was fine; but then, they always had been. The interrelations caused the trouble. So he worried before and during the test. Fortunately, the new record succeeded. A duplicate worked fine. The test cost a fortune, but Filgard decided it was in a good cause.

The venture capital company sold licenses for spray droplet manufacturing. First it made money which replaced what it had spent; then it made a profit, then it made a huge profit. The companies buying the licenses found their costs dropped. They made a bigger profit, too, even charging less. The companies which purchased the duplicates were happy; they paid less. Even the final customers felt they gained, since they, too, paid less — not much less, but a little. Hardly anyone noticed that most prices stayed high.

One of the features of the 'Meldon Recorder', as the venture capital company insisted on calling it, was that it worked a great deal faster than similar machines. Filgard did not think much of that. He used a bunch of old tricks. They mostly centered around having fewer illuminators than parallel recorders. Of course, he had to make sure that the recorders worked in step with the illuminators. No one else had been able to do that, but Filgard did not consider that a problem. On the other hand, he did recognize his cutter design. That had been hard. Not only had it to cut and to cut quickly without much raising the temperature — to avoid excessive thermal jiggling, the temperature had to stay near absolute zero; and to be practical, the recorder had to be fast — but the cutter had to last.

Filgard began to figure out how to make his recorder's cavity bigger, the cooling faster, and the machine itself more transportable.

Chapter 9

All was going well. Vallen knew he had made two important jumps in his career, one that he could not talk about, to receive bribes, and the other that he could mention, his trip on the company yacht. His wife, Jennifer, did not look older, although she was. She lived a nearly independent life from him. They did not quarrel. Their two children, a boy and a girl, Jeffrey and Janice, were two years apart and entering adolescence. Neither embarrassed him in public nor fought him.

So Vallen planned a barbecue. It would be his first in years. He had an outdoor barbecue stove, but had not used it for a very long time. If it rained, he and his guests would go inside, but that would be unlikely. Where he lived, plans could be made a long time ahead.

Jennifer was good at picking guests. She mostly chose subordinates, a few seniors. She also chose a few who were not in the company at all. Their role was to serve as entertaining outsiders, as misfits.

To be safe, Vallen planned to hold a barbecue for his family first. He wanted to see what could go wrong. He was not expecting his son, Jeffrey, to tell him that the stove was now illegal!

"It cooks perfectly well," he said. He was not quite sure of that, since he had not used it for so long; but it had worked fine the last time and he could not see anything wrong with it.

"That is not the issue," Jeffrey replied. "I was told at school that the problem demonstrates scaling. No single stove is dangerous. Each works fine. But when you have too many together, too often used, then you have trouble. Each puts a little smoke into the air. In an empty or near-empty world, that would blow away; no one would care. But here, we have too many in one place. Even though we often have wind, concentrations build up. That is the problem."

"So, what do we do?" asked Vallen. "We buy a modern barbecue, one with an electric blower to move the smoke through an electrically heated catalytic converter," said his son.

"I know what you mean," said Vallen. "I have seen advertisements. There are only two or three companies that make that kind of barbecue. There must be a price leader and price followers. I bet they do oligopolistic pricing. That is what I would do. That would keep prices even higher than all the extras. We live in a country where a local government can afford to send aircraft and sensors overhead to discover who is doing what. They can enforce the rule. And nobody in power cares about the high prices."

"Well, we don't care about the prices either, do we?" asked Jeffrey. "No, not at all," said Vallen. "It is just that this whole notion pisses me off." Both his wife and his son were struck by Vallen's language. Usually, he spoke in much more elevated words. He was unhappy. Jen-

nifer moved to placate him. “We cannot live in a rural area. There are no jobs. This place is not bad, not at all. Just expensive. And, as you said, we can afford it. We will have to buy a modern barbecue. That is all.”

Vallen used his regular, legal income for the purchase. As far as he was concerned, it was not a big deal. Still, he saw again that more resources for him meant his freedom increased. This purchase cut his resources a bit. He did not like it.

‘Well,’ he thought to himself. ‘Very likely, the scaling issue is real. The catalytic converters are a needful limitation on what we can do. I should not be too upset about oligopolistic pricing. That will happen in any industry so long as there are few manufacturers or few sellers or one or the other are controlled. In any industry with increasing returns to scale and no regulation, there will be just a few or there will be just one. It will be the one which grows bigger sooner than the rest. Each item it produces costs less. So it will put competitors out of business. That means just about every modern manufacturing industry. It exactly fits what we were taught in school.’

Vallen considered more. ‘Of course, in successful companies, no one will support change. That restraint will turn those companies into losers when technologies change rapidly. But I think the rates of technical change are slowing. Everyone complains, but I think that is because the changes they have to make are unpleasant, like buying a more expensive barbecue. People do not complain about changes they like.’

Vallen could not think of any ruling group that imposed only limitations that were needed by everyone. Rulers would, if they were smart, impose limitations that were necessary. He knew there had been rulers, like those who had ruled in the Lebanon when cedars still grew, who were not smart enough. They didn’t preserve the cedars. The rulers vanished.

But in addition to needful limitations, rulers, whether of businesses or countries, always imposed limitations that helped them, like higher prices. As a university student, Vallen had conceived the possibility of the opposite, but he had not seen any like that in contemporary practice.

He felt that by becoming disillusioned, he had grown up.

The test barbecue went off well. The prime ribs tasted great. He even got to sit down for a moment. Forestalling his son, who looked to be preparing to say something, Vallen explained his understanding of innovation. He said it was important. Because of innovation he kept making a profit and this kept him being employed.

Vallen did not believe his words; he spent more time thinking of people than of technology; but it was a good story. And to some extent he believed. He certainly believed when he spoke.

Vallen thought that the leading man determined it all. That meant that a person who looked like a leading man received good pay. Neither Vallen nor any one else in his world thought to support the people his engineers depended on. They had a movie view of innovation. Vallen saw the hero, whom he persistently called the scientist, as critical. That belief was false, but Vallen did not deal much with engineers and people like them. He did not understand that he had been fooled by entertainment.

Vallen also thought but did not tell his son that technical progress led to income disparities. 'Let Jeffrey discover that for himself,' he thought. 'He will learn that many organizations and cultures fail to adopt a more efficient method. Those which do adopt one, those in control which do, get more. At least, they get more in a competitive market.

'Indeed,' he thought, 'with technological advance, an economy might help only some.' He considered again a proud stone cutter, who worked with hammer and chisel, and a programmer who worked with symbols.

He said to himself, 'The unemployed poor lack income from ownership. Tax transfers are small; welfare, that is what those transfers are called. Nobody likes them. The unemployed poor simply lose. Of course, the unemployed rich differ. No one refers to their not working as unemployment. A few stone cutters ended up owning quarries; a few programmers gained from stocks. But they aren't many compared to the total population of the planet.'

He talked to himself quite a bit. Well, it was useful. And he certainly could not talk with others. Those that understood would either be above him or below him or be competitors.

He kept thinking. 'The new technology only requires that it pay for itself. It is society that determines how benefits get spread around. And if society is mostly extra-legal, like most societies on this planet, no one can force the spread of benefits.'

Vallen knew the argument for taxes on people like himself — to him, an increment of benefit mattered less than such an increment mattered to a poor man or woman. He already had enough. But he did not see taxes levied fairly. More importantly, he was not going to be a sucker. He did not like that idea at all. He was not going to give someone else a free ride. He paid a tax lawyer and sought bribes.

He wanted more, but he had not got it yet.

The bigger barbecue succeeded, although Vallen did not get a chance to sit. He decided he worked harder than at his office, but that he was at a level where he should give more barbecues, many more. It was good politics.

Chapter 10

Someone came to speak at the university. It was advertised as a talk about 'the current situation on the planet and what we can do.' Filgard did not know anything about it. Many speakers visited. He paid no attention.

But his graduate student Peter Dev went to the speech. It was Eltis Akthorn who spoke, a stranger. Afterwards, Peter spoke glowingly of her and of the speech. He spoke to everyone. Peter even said that Eltis mentioned their project! Filgard heard.

Peter kept talking about Eltis — Filgard noticed that Peter referred to her by her first name — so Filgard looked at a picture. She was young and beautiful. 'Hah!' Filgard thought to himself. 'He is attracted to her as much as to her message.' Filgard could not imagine living with her. He felt old. Still, Peter had said that she had spoken about the recorder. Filgard decided he could scan the text of her speech; it could not be more than six or seven thousand words and most likely, he could skip major parts of it. Maybe he would find something useful, although probably it was not worth reading. Why anyone would go to such an event, he could not imagine, although they did.

After an introduction and a poor section 'to tell them what I am going to tell them', Akthorn started with a short description of the damage being done to the planet: how human actions were moving gigatons of earth, over-cutting forests, over fishing, mining soil faster than it was recreated, mining energy, and causing yet more climate change.

Filgard thought that people should know already about these actions, but on the one hand, most acted as if they didn't, and on the other hand, would nod when they heard.

'So . . .', he thought, 'maybe most act rationally. After all, there is very little anyone can do as an individual, in a family, or in a small group. At the same time, by employing a known theme, Akthorn can introduce her ideas gently.'

Filgard thought to himself a bit longer. 'There are three things an individual can do without needing to be part of a large group: as a scientist, he or she can discover; as an engineer, he or she can invent new technologies to repair the planet; as a politician, priest, or regular person, he or she can explain the situation.'

He laughed to himself, 'the three Rs,' he thought, 'research, repair, and reveal. They are better than doing nothing.' As an engineer, he was an inventor, repairing the planet. (He did not think of the costs of innovation and the involvement of others.) Akthorn was revealing the situation. Maybe she was planning to become a politician.

Next, Akthorn said that the choice is to go forwards or backwards. 'This is right!' thought Filgard. 'Just what I have been saying.' He laughed again at himself. 'Because I agree, I think she is right.'

Moreover, Akthorn spoke of technology. She did not hope for changes in human character. She said, "Fundamentally, I do believe, as has been said for millennia, that 'Man is Fallen', where the word man has the old-fashioned, inclusive meaning of women, too."

She must have paused in her speech, because the next sentence started a new paragraph. "I am not saying that there cannot be changes in human character; indeed, there have been." She did not say anything critical; instead she said, "What I am saying is that a political movement should not depend on such hopes." There was no pause in the text, but there had to be in the spoken speech. She said, "Like an army or business, a political movement must go with what we have." 'But,' thought Filgard, 'she has not yet talked about her political movement; the speech does not make sense.'

"What we have are existing technologies."

Akthorn repeated herself: "We can go forward or we can go backward. Those are the only two choices. We cannot stay where we are because we cannot continue to damage much longer a finite ball, this Earth."

She spoke of the 'Meldon Recorder' as a great invention. Filgard had to agree with Peter, he liked that. Akthorn said that in combination with spray-droplet devices, another existing technology, the two could enable humans to live well and longer. That is what Peter had said. Filgard thought it was true, not simply because the 'Meldon Recorder' was named after him and he liked the praise for his portion of the technology, but because the claim was objectively true. He still had not learned anything.

Akthorn also spoke of yet another invention, a cheap but fast propulsion system for vehicles in space, a mini-magnetospheric plasma device. "This does not work," she said, "without a big vacuum, plenty of nothingness." She provided a few more details, "Even though it can provide more thrust than an ion engine, it cannot push hard enough in the normal course of events to escape a large gravitating body."

Filgard had to look up the invention. He had not heard about it. It existed. Indeed, 'mini-magnetospheric plasma propulsion' had first been described in the 20th century. Still, no one had developed it. Akthorn blithely ignored possible technical failings. Filgard wondered how much it would cost to get one to work.

But, as Akthorn said, it enabled the use of space resources on human terms. "It means that with existing technologies, we can manufacture inexpensive light-to-microwave-to-electricity systems from nickel-

iron planetoids. But all this is opposed by many who would personally lose, although others favor long term safety."

Filgard decided she sounded familiar. "The alternative is to go backwards," She detailed examples, "Food and fuel will cost more. Ocean transport will still be cheap," she said, "but it is expensive to grow food in a desert. Old farmlands will become new deserts, either because people have extracted fossil water from aquifers or because of continuing climate changes. That is what going backwards means."

She talked about poorer heath. "No one will pay drug manufacturers to develop new antibiotics to defeat bugs that have grown resistant to the old. Neither the money nor the capability will be there." Filgard wondered about that. He thought there would be a little money. The necessary changes were small and the new techniques dramatic. But it was not his field and he did not know the answer. He did not think that very many in the audience knew either. He figured that even though they too did not know, they would agree with Eltis.

She said there would be a few who were not much hurt at all by going backwards, ". . . not immediately," she said. "The powerful will not be; others will be hurt." However, by going backwards, the powerful would lose, too. She said, "Nonetheless, they will not know how much they lost. After all, inventions will not be made and few dream about what no one knows."

She asked the audience to press for the future.

So far, Filgard noted with a little irritation, that was the only action she had asked of her audience.

It might be rational for an individual or a person in a small group to do nothing, or to engage in one of the 'the three Rs', to research, repair, or reveal. Still, Akthorn spoke politics. Yet so far, it was more a report, an analysis, than anything else. He wondered whether administrators, politicians, and the friendly rich would see the implications, or would they just pass them by?

It was obvious to him that knowledge would benefit all, that research should be funded, especially long term and apparently useless research. He also saw that governmental restrictions on knowledge transfer, like patents and copyrights, should be reduced. They should not be treated as if it were the divine right of owners to restrict knowledge. Such understanding was not necessarily obvious to those who had the power and the interest. In the past, patents had been promoted as a way to overcome restrictions, but nowadays they lasted too long. So did copyrights. Copyrights lasted a very long time.

Either way, going forwards or going backwards, Akthorn said, the planetary human population had to reduce. In going backwards, this would be more painful than in going forwards. "Countries," she said, "with a low total fertility the past quarter or half century, and with

little immigration, are already experiencing the difficulties of decreased population. Yet this is a benign form of the catastrophe! It will be harder if they go backwards and easier to go forwards. Going forwards provides hope." As far as Filgard was concerned, this was another commonplace report.

Finally, she spoke of the farther future. She said, "We have not learned enough from the Disaster. Our success in running a planet, our success in this spaceship Earth, does not require new inventions. But they would help. They do not yet exist, but might if funded." Akthorn said that invention was helped by an encompassing project, at least so long as the proposed project did not require anything impossible.

As a good project, she suggested interstellar travel and colony. The inventions would be difficult, she said, but could be and would be made. Filgard agreed; for a politically acceptable expedition, as far as he knew, the necessary inventions were not scientifically impossible, but were hard, very hard.

In particular, Akthorn said, interstellar travel required a duplicator that works with individual atoms and a way to copy living organisms and have them live again. "We need atomic duplicators," she said, "because a future colony will have to build things from scratch once it gets to a distant planet. An interstellar spaceship will not be able to carry anything big. And we need to be able to copy living organisms because we will not have the space to carry them live. The information recording them will have to be compressed."

"Such a duplicator would help this planet, too. It would cut the costs of production, especially of computers that are made of small parts. It means that what we humans need could be produced off planet and brought down in computer controlled aeroshells. We could survive well on this spaceship of ours."

Filgard noted the speech's structure:

- current situation dangerous
- existing solutions
- fight with existing evils
- result of fight unforeseeable
- distant hope

Akthorn ended with a 'told you what I was going to tell you' section. As far as Filgard remembered, the speech did not quite follow Aristotle, but came close. He agreed with its contents.

As for the structure, it came across as 'warning, solution, danger, hope', bad, good, bad, good. Filgard thought that Akthorn made a fair statement; but as far as he was concerned, it was not very useful.

Still, Peter's attraction stuck by him. He showed a video of the session to his wife, Fairta, and offered her a transcript although, as he

expected, she did not bother with it. She said, “Eltis is attractive. I bet she would make Peter a good wife. Let’s host her next time she comes.”

Chapter 11

Not much time passed before Eltis Akthorn came again. As Fairta planned, they hosted her. Eltis came in for a late dinner; she would stay the night and speak the next day.

At dinner Eltis asked Fairta how she occupied herself, "besides cooking this wonderful meal."

Fairta explained that, among other things, she was a violinist. She played in the university orchestra and spent hours practicing. Filgard said, "The time is almost too much, although I am usually at work, so I don't know how much time she spends."

"I do not practice enough!" was the retort. "I like playing, but I have other things. I have you!" she said to Filgard.

"To be very good," Fairta said, "I would have to be more dedicated. I am not. Also, I would have to be a bit more talented. Still, music is a good hobby."

Her eyes lit up. She smiled. "I am a good writer, too. Both of you only pay attention to the content of what you say." She directed her attention to Eltis. "I listened to your speech. I listen to how words' sound. You don't. That is a flaw. The contents are fine."

Looking at Filgard, she said, "I know that engineering has not been around since the birth of language. I mean as a profession. Engineering has been around for a long time.

"Engineering as a profession lacks the long history of traditional subjects. You would have a hard time sounding well at the same time you write precisely about building a complex device. But Eltis is doing something different; she is explaining how things are and what to do. She needs to pay attention to her rhythm. I have some ideas." She looked at Eltis. "We can try them out on Peter tomorrow. Besides knowing many non-engineering topics, he is an engineer's engineer. If I ask the right questions, he will be honest. He will tell us what we need to learn."

Then she shifted. "On another topic," she continued like an imp, "not engineering, not violins, not sound — but it will intrigue you, both of you."

"What is this?" asked Filgard.

"It is an extension of what I suggested to you before you went on that trip to try to raise venture capital, an extension of the notion of Galen's temperaments," she said.

"Over a generation ago, the anthropologist Alan Page Fiske talked about four social structures. They come from the way people perceive, although I don't know whether Fiske said this. How people perceive is, I think, wired into how the brain works. A half century before Fiske,

a fellow named Louis Guttman claimed that all forms of measurement belong to one of four types of scale, four types of measurement: categorical, ordinal, interval, or ratio, or are conflated into one of those four.

"Guttman was talking about measurements. Fiske extended that to social structure. My claim is that people perceive those four patterns. For everything else, the details are different. There are, or were, huge numbers of different cultures on this planet. People act differently from one another.

"Fiske claimed that his four patterns fit different primary mathematical structures. (He may have proved the discovery, so the claim does not depend on his say so; but I don't know.)"

She stopped for a moment, to let them consider that only four patterns supported everything, then she continued. "It is easy to understand the four patterns, categorical, ordinal, interval, or ratio:

- "One animal is a cat and another one is a dog — a cat fits a different category than a dog.
- "In an army, a captain is superior to a lieutenant but you cannot say by how much he is superior (and indeed, the 'how-muchness' is irrelevant). Soldiers follow orders; ranking is 'ordinal.'
- "You cannot meaningfully say that one Fahrenheit or Celsius temperature is twice another. That is because those temperature scales have an arbitrary zero; they are 'interval scales.' However, you can add ten Fahrenheit degrees to a Fahrenheit temperature. You can subtract twenty Celsius from a Celsius temperature.
- "Finally, you can say that this stone weights twice as much as that stone. Weighing requires an ratio scale.

"Fiske claims that from these four patterns, we can construct all the types of human social pattern that we see: that from the categorical, we get all the ethnic and religious conflicts, us or them, we get nationalism, as well as sharing, the goodness of being in a family. From the ordered, we get corporations and empires, as well as being a child taken care of by parents. From the interval, we get voting and civil rights. From the ratio, we get complex societies and free markets.

"My notion is that the four Galenic temperaments reflect preferences for one or the other pattern.

"My temperament is optimistic; I prefer the present time and want to make beauty. Galen called my temperament Sanguine. It fits the first pattern, the categorical. Maybe a third of the world is like me.

"That pattern is not practical for a complex society. I am talking about a pattern of perception, of society that I prefer. That does not mean I cannot see other patterns, it is about what I prefer." Then she

repeated herself. Her statement was new to Eltis: "Some people do well in many different ways and older people gain skills, too."

Fairta continued. "In any case, for a society, a more practical and extensible pattern is the second, the hierarchical. My hunch is that the people who do well in that kind of social system are the Melancholic." Again, she said much of what she said earlier to Filgard but this time to Eltis.

"Such people work hard. They have common sense and are conventional. They want to perceive the more and the less. In a society, a hierarchical format fails when you need to make rapid changes; but when you don't, in a changeless world, the pattern works fine. Somewhere between a third and a half of everyone fits this temperament. It is the biggest."

"We are not in a changeless world," said Eltis. "No, we are not," said Fairta, "but that is neither here nor there. I am trying to link four preferred modes, which are four mathematical forms, with four possible temperaments."

"OK, I understand," said Eltis. "Please go on."

"The third pattern fits the Choleric. It is like a Fahrenheit or Celsius temperature scale. You can add similars for the physics. For the social, it is where you get the same in return for what you put out, like a dinner invitation. Well, not in this case; we are hosting you. But often. Or you enjoy doing the same as another, like vote. This temperament has fewer than one in ten people in it.

"The fourth pattern is yours," she looked at Eltis and then at Filgard, "both of yours.

"That temperament is the Phlegmatic. You, and people like you, love discovering things, love making things. So does everyone else, but to a lesser extent. You love being consistent. That is the social side. Fewer than one in ten, perhaps fewer than one in twenty match this pattern."

"The portions do not add up to 100 percent," said Filgard. "No, they don't," said Fairta. "Maybe there is something else, maybe not; maybe the measurements are wrong. This is all vague." She stopped but Filgard did not say anything more.

"I am being Phlegmatic now, although I have an easier time with and prefer the Sanguine."

"What do you mean," asked Eltis, "you prefer the Sanguine?"

"I can talk as you do, abstractly, be consistent, and all that. I am adaptable, but it is not me."

"You make more sense to me now than when you talk about other things," said Filgard. Fairta looked smug and at the same time happy. "That is because you don't pay much attention; you don't value other

things much, although you will agree that two fried eggs on toast is a necessity for breakfast. That is the sort of thing I especially notice. You get involved in something else.

"In any case," she addressed both of them again, "much progress in science and engineering comes from changing the default perceptual pattern. (You will notice I am using your language: 'default perceptual pattern.')

"For many centuries, people said 'it is cold outside.' Cold was a category distinct from hot. Then people came to say 'it is colder today than yesterday.' This is an ordinal scale. After the invention of the thermometer, it because possible to say 'it is 10 Fahrenheit degrees colder today than yesterday', making use of an interval scale. Finally, after Kelvin and Boltzmann, an engineer could say 'the thermal energy content of this piece of iron is 0.6% less than it was yesterday', making use of a ratio scale."

Fairta smiled again. "As for me: I prefer a categorical scale. I like something to be true or false. I play a piece of music right, or I play it wrong. It is hot out or cold out.

"In horseshoes, the closer shoe wins. I notice that it wins. It was thrown right." She spoke an aside to Eltis, "The game of horseshoes is similar to quoits; it is, or was, common in America."

Then she spoke directly to the two of them. "In horseshoes, you do have to measure. You, that is to say, all Phlegmatics, would notice that. But I don't. For me, the salient question is whether you won or lost.

"Traditional logic presumes a statement is either true or false. I guess this is why I prefer it over the more modern kinds, the fuzzy logics. The metaphor for my kind of logic comes from early experience with a cup. Either your proposition is contained, like water in a cup, and is true, or it is outside, spilled, and is false. The categories are inside, true, or outside, false. There is no third option."

Both Eltis and Filgard started. They ducked their head. Each independently thought of drops on the edge of a cup. But neither said anything.

Fairta stopped for a moment, then went on. "It just occurred to me: do people with a Choleric temperament create the rituals that the others of us follow, at least sometimes? Someone has to have created the rituals. They are one of the ways that lead to numinous experiences. Obviously, especially in pre-agricultural societies, rituals are emergent. But someone had to do the job. Me, I don't care, although I can contribute to what others have created. Geniuses can compose music; I can play it. The Melancholic can make sure that cathedrals do not fall down ... But who cares enough about people, and at the same time, does not care about the lack of falsification implicit in sacred

postulates?" Her eyes glinted. ". . . at least, the lack of falsification for sacred beliefs you believe in."

She let everything go for a moment, then returned to her subject. "Who likes actions being the same, whether a group of people all do the same together or one person repeats over time? The Choleric, that's who. Rituals all involve swaying together or singing together — or different people repeating the same activity at different times — well, maybe not *all*. My point is that these features of a ritual do link people together. They help people feel a 'time out of time,' feel the eternal."

She made sure she had the attention of both of them. "In your terms, the evidence for ancient temperaments is faint. Sure, some people fit them. But do enough fit them for those categories to be useful?"

She laughed, "People often categorize others. You know the old joke, 'there are two kinds of people, those who categorize others and those who don't.' Everyone understands, although some prefer not to put people into categories."

Fairta went on. "My evidence linking Fiske's social structures and Galen's temperaments is essentially zilch." She grinned. "I think they fit because they feel right, but that does not help you at all.

"Why," asked Filgard, "if they are true, have we forgot the temperaments? Their truths must be determined before we can even consider a link to Fiske's social structures."

"Maybe," Fairta said, "the new institutions of the latter 19th century required people to focus on another category."

"Yes," said Filgard, "new types of corporation and new types of university became common in the 19th and 20th centuries. They needed to recognize people with analytical skills, whether they be cognitive, utilitarian, or both. That would be a good reason to ignore past concepts then. But what about the present? Why don't we know?"

Fairta liked that. Filgard had always known more than simple engineering. "Maybe, the notions were truly false and best forgot," she said. "Or maybe the concepts are becoming important again." She smiled.

"Anyhow, the claims will intrigue you. You will mull them over as you fall asleep. I am sure of that. I know that you both think of yourself as different from each other, one more a teacher, a builder of objects, the other more an organizer, a builder of political parties."

"I'm an organizer," said Filgard. "Compared to Eltis . . . ? It is true, I am not into politics."

Fairta's eyes danced. "You are both very similar. You both focus on producing, you both organize what you need, you both consider the long term. And . . . you both prefer to forget our guest room, even though you agree it is important." She looked towards Eltis, "Let me point you to it."

The next morning, after a breakfast of fried eggs and toast, an 'English breakfast' even though they were not in England, Fairta said to Eltis, "Abstraction is not right. It is not the right concept." During the night, she had been mulling things over, too.

"What is this about abstraction?" asked Eltis.

"It is often said," Fairta explained, "that Melancholic and Phlegmatic people are better at abstraction than Sanguine or Choleric people. Yesterday, I said, 'I can talk abstractly.' As a practical matter, I think the notion is irrelevant."

She was sitting with a cup of coffee. Eltis drank tea. "Some of what I do with music seems abstract to those who do not play the violin or piano. But to me the notions are concrete. To me, a chord is something I do on a piano with my hands. Specifically, I think of a major chord in C. I think it has to do with practice."

Eltis caught on immediately, but spoke to make sure she was right, "You are talking about concrete words. You are saying that people like you prefer what you can point to or pantomime. You are suggesting that people like me prefer the abstract."

"Yes," said Fairta, "except that I don't think the distinction between concrete and abstract is useful. Everyone learns to conceive of abstractions. Everyone talks about heaven and hell, love and hate. You cannot point to those notions. They are definitely abstract. You can only point to people in love or full of hatred, people going to heaven or going to hell."

Eltis nodded her head. "I see what you are saying."

"Suppose," said Fairta, "that what you think of as an abstraction is the base for an example. Then, the issue is what examples come to mind. What are the referents?

"Some categories have fewer intrinsic referents than others. When I think of birch, I actually think of white birches with a paper-like bark. That is a type of birch. There are birches whose bark is not white. But as far as I know, there are fewer types of birch than there are hells. But a discriminator that depends on fewer and more? That is no good. No two people will agree on the boundary.

"Maybe the distinction should be between words as direct signals of an entity and of indirect signals, metaphors. But some think of hell as a metaphor, and others think of it as a definite place." She stopped for a second, but Eltis did not say anything, so she continued.

"Most people," said Fairta, "treat what are called 'abstract words' as 'exemplar words.' They handle them as words that carry examples. They may not be conscious of the distinction they are making. Phlegmatics like you make sure the definitions are consistent and complete. Everyone else, more than ninety percent of the population, treats them

as they do other kinds of word. You would say 'vaguely;' I would say, 'relevantly to the conversation.' That is key.

"To be more precise," Fairta nearly laughed; she understood Eltis well, "two groups will care for consistent and complete definitions: one group are people with your temperament; you care naturally. The other group consists of people who are forced by law or logic. Everyone else goes for examples. That is what is relevant most of the time.

"Those people who are forced by law or logic — they will hate the pressure. That means they will dislike law and logic." She grinned at Eltis. "They are not like you are all. You like logic. And you like sensible laws, those that preserve personal autonomy.

"As for an example, when you talk about 'hell', I see people burning in a fire. That is what the word brings to mind. The meaning of the word is abstract; no one can point to hell. But I can talk about it.

"I know that some hells involve cold, people frozen in ice, not burning. That does not matter. As far as I am concerned, the image brought up by the word is just an example. The notion is familiar. That means that even if it is abstract, I can use it readily. That is what counts for the vast majority of people.

"My point . . . "

"You have a point?" asked Eltis, interrupting and smiling.

"Yes," said Fairta. "My point concerns what you suggest." Eltis looked startled. "It is," said Fairta, "that it would be useful to spend time in school on concepts like 'faintly suggestive evidence' and 'strongly suggestive evidence.' You could show examples and kids could work with them. Then the concepts would become familiar.

"'Practice, practice, practice.' That is the answer to the old joke, 'How do you get to Carnegie Hall?' The critical point is that those who go to Carnegie Hall not only are talented but they enjoy practicing more than the rest of us. They are willing to practice longer.

"People will learn when they are forced; they learn poorly — we frequently force school kids; they learn, but not very well. As a practical matter, most will not learn about differing degrees of evidence very well. Who cares? That does not mean the concepts are useless. They are useful. That is why the concepts and examples should be in school."

Eltis looked thoughtful. "What about saber-toothed tigers?" she asked. She was trying to think of an entity that could be pointed to before language. It was not the immediate issue, but she had been thinking. "They were important; they killed many people when our species was young."

"What about cars?" said Fairta, who was accustomed to back references. "They are also dangerous. It takes a while for kids to learn to avoid walking unexpectedly into roads. The word 'car' is a general one;

the word 'saber-toothed tiger' is specific. I could talk about the danger of specific types of car, a type you could point to. Our ancestors did the same. They pointed at saber-toothed tigers. Dangers exist now just as they did then.

"Obviously, many things were and are important as entities to which you can point. Saber-toothed tigers were only one of them. The foods you eat are others. What I am saying is that heaven and hell, love and hate, are also important. As far as we know, people have always discussed them. They have always have been important. Nonetheless, the concepts are abstract. You cannot point to heaven. You cannot pantomime love, yet everyone talks about it."

"Yes," said Eltis. She paused and looked quite fierce. If Fairta had not known that face was just a thinking expression, she would have been scared. "Yes," Eltis repeated. "Everyone talks about love, even though it is an abstract notion. That is true. . . . I have got to reorganize my life." "You mean, your thinking life," said Fairta. "Yes," said Eltis a third time, after only a momentary frown. "My thinking life."

She had not said anything about school.

Peter listened to Eltis practice. The speeches were better. He said so. He never realized that Fairta was putting him together with Eltis.

Chapter 12

As for 'needful limitations' in a society: Vallen thought about them one weekend as he was getting ready to go to the beach. He was still bothered by the barbecue. Buying it stuck in his mind.

More people living together meant he, as one of them, had to have his impact limited. The more opportunities to act, the more people, the more energy each had, the worse it got. A straightforward analysis made limitations evident, at least once someone discovered them. The theory of conflict and cooperation was quite practical. The impact of the barbecues' smoke, the total losses, did not become relevant until many people lived together.

Vallen liked the theory's notions; he had learned something after kindergarten. You could decide what a society should do. You added up the total of losses and gains. (Vallen did not think about the difficulties of measurement.)

A society had to adopt a stable course. It could not be negative forever. It would collapse. A total might go negative after a period in which society was unstable in a positive and desired direction. Vallen thought all that. Costs and profits depended on the number of people, their impacts, and their locations. In this case, the solution was to control barbecues in a built up area. That made sense. Cities needed sewers. Controlling barbecues was similar.

Vallen wondered whether he got ahead in his work because of his study of game theory. That is what the theory of conflict and cooperation was called. Most people below him did not think of it everyday. They did not live the concepts. They were not looking for 'stable strategies.'

They did not make multivariate analyses either. They depended strictly on their human connections and on confidence. They acted as if the whole world could be understood as human action, not just parts of it. They treated the inhuman world as if it were the human world.

Vallen was not like the other kind of person, an engineer or scientist who focused entirely on the non-human world. He did not look only on those parts of the human world that could be predicted in an inhuman way, like electrons or like the rate of suicide in west European countries in the late 19th century. Indeed, he did not like the non-human world. He had had enough of it in school.

He packed several more towels. His family always needed them.

He had to admit, however, rates of warranty return, rates of sale, rates of profit — they were all predicted more or less correctly by non-human means. He had to understand those predictions so he could set expectations.

He selected strategies that would succeed even when events went against him. He thought of them as coming from his studies, but they were rather conventional: make backups; always expect the unexpected; but don't expect too many of them. Fly during the good years.

As a practical matter, Vallen was in a division that produced specialized car parts. What if their sales went down? Well, then he could switch to other specialized parts. If the whole economy went down, then he would not be doing worse than others, so it wouldn't matter. But if it was just him . . .

If he knew a need to switch and knew what he wanted, he could switch quickly. That is why he insisted on daily sales reports and why he kept learning more about various trades. It was vital insurance.

It was a good reason for Vallen to keep his eyes peeled. Another product might be useful. He never thought that in a different, more senior job, he would end up supporting Filgard Meldon.

His two kids got into the back seat, his wife, the front. He thought of his two children as 'kids' even though they were getting older; and he thought of everyone by their roles. He grunted. It was not an unpleasant noise. He was telling everyone he knew they were there. But at home, he often was not social. He kept on thinking.

'As for corruption,' Vallen thought, 'rulers could make it more difficult. That went without saying.' It would cost more, but he knew that two cops or other investigators could patrol together. Or more than two, since the payments for corruption could be very high. That is why Vallen split up his fortune. He might lose — he did not expect to, but he might lose. An anti-corruption drive might hurt him. He wanted to be resilient, like the planet should be, but wasn't, at least, not in any duration relevant to humans.

Vallen knew there were a whole bunch of techniques for controlling corruption, standardly written up. 'Fortunately,' he thought, 'mostly the powers engage in evasion or excuses. They do not try to prevent corruption, even when it harms themselves. Nor does anyone else.'

Vallen figured that evading or excusing the practice was crazy for rulers — he remembered that Ferdinand de Marcos, a dictator in the Philippines, had not evaded or excused; he wanted the money for himself.

The issue was what a society's components would do. Most of the world did not have governments as strong as his. There were too many corrupt people. Or maybe the governments were corrupt. Vallen considered that dangerous. When governmental organizations were corrupt, rulers would not be able to enforce needful limitations, no matter how smart.

Vallen wanted to survive; he wanted his children to survive and to live well. He wanted the same for his wife and friends. Incapable rulers could be more dangerous than letting the powerful charge high prices.

But Vallen went along with higher-ups' craziness. It helped him personally. As far as he was concerned, these men, they were mostly men, did not know they were evading or excusing the issue and hurting themselves in the process. They were skilled fools.

Or maybe, he thought differently than before, they were like him: skilled, knowledgeable, and excellent actors. Maybe they were corrupt and that is how they ruled. They hired people who were corrupt, who took bribes, as he did. Either way, he enjoyed a bigger chance to become rich.

'If they plan for a long enough time, if they think ahead far enough, the rulers of a country can do well for their society, too.' Vallen kept thinking of those in Japan who kept the country forested. He could not remember who did it or when. Still it helped Japan. He also remembered that they, too, presumed an unbounded Earth, a flat Earth; that is to say, when they had the opportunity, they had trees cut down elsewhere. They exported deforestation; they would hurt the other countries first. Eventually that practice would hurt everyone on Earth. It was a ball; it was not flat. But in the meantime, a time that might last many lives, a few benefited.

The whole family arrived at the beach. Vallen had not been aware of the drive at all.

Chapter 13

Eltis Akthorn came again. This time she planned to focus on traditional social and political technologies, but with a difference. She stayed with the Meldons.

Fairta partly rewrote Eltis' speech. Together the two invented and introduced the four 'Ps' and the five 'Rs.'

These lists, they were lists, would not work in many other languages, or they would not work as well. The leading sounds would not be the same. But as Fairta said, "You are not writing an engineering treatise that you know is going to be translated into another language. You are speaking in English to an audience of English speakers." Eltis had to agree.

Fairta knew the substance of what Eltis should talk about: "You need to talk about degrees of evidence and determining them. Most people like me will not like what you have to say. They won't know what you mean. You need to introduce appropriate examples very early on.

"You can take an old example, one that led to legislative action and is not controversial any more: thinning of bird's eggs. That was seen in the 1950s. In the United States, the national bird, the Bald Eagle, was going extinct. You cannot look at just one nest. Even a stretch of several years is no good. A single nest may bias you one way or another. It is not like you are eaten or left untouched by a saber-toothed tiger.

"So you need to talk about degrees of evidence and how to determine them. Evidence tells you what is real. Then, you can say that after gathering evidence, our representatives must be responsible for considering reliably, with rigor and reason, the reality of their decisions."

Eltis practiced her new speech. "Those are the five 'Rs.' They are memorable: *responsibility*, *reliability*, *rigor*, *reason*, and *reality*.

"That does not say anything about evidence," she said to Fairta.

"You are wrong," Fairta said. "It does. It talks about *reality*. You can only approach reality through evidence. Otherwise, it is easy to be confused. But you are right, it is not direct."

"That evidence tells you reality, that makes sense," said Eltis. "Unfortunately, I have not figured out how to fit all this together into a speech. Let me keep trying with what we have got."

She went on, "Political decisions must always *protect*, *preserve*, *prepare*, and *provide* for us."

In English, each topic started with a 'pr' sound. Eltis wondered what the sounds would be in other languages. She hoped her speech would be translated. At that point, the alliteration might fail. She continued.

"Politicians must protect us against inhuman enemies, like snow storms, typhoons, and climate change."

She was aware of following Fairta, at least in part, going from 'snow storm', which everyone in her immediate audience would have experienced, to 'climate change', which might be somewhat vague. She wondered about that part of her audience that was not immediate. Many would not have experienced snow storms. She did not know how to talk to them.

Eltis went on. "Politicians must also protect us against human enemies, especially as the technologies of destruction become more efficient. When many people among your enemies believe in a 'plausible promise,' in a cause that excludes you, you are in danger. Warfare becomes or can become more asymmetrical. Defense requires more thought."

She stopped for a second. For many listeners, the notion of a 'plausible promise' would be new. On the one hand, maybe she should not mention it; she did not want to confuse people too much. On the other hand, a plausible promise convinced people. However plausible, the promise might be false. Certainly, that is what people thought of their enemy's beliefs. Fairta was right, more emphasis should be placed on evidence. It was not simply that people had made judgements for centuries, but they had to learn to judge everything; or they would not know whether they believed a true or false promise.

She did not know what to say. So she said simply, "Defense is *protect*, the most fundamental action."

She stopped longer and finally said at normal speed, "That last sentence is good. As for more of my speech . . ."

She spoke again at her slower, speech speed. "Most politicians will be conservative. That includes many who appear radical. In the United States in the 1930s, President Roosevelt was like that. Many thought of him as radical, but he acted to preserve American society.

"As we humans gain more power over nature, we are going to have more impact. That means that to preserve us, our governments will need new tools. The old mechanisms, like the old notions of what you can do with real estate, they will have to go."

Fairta spoke up, "You are not conservative, not in the political sense. You are acting to conserve humans. You will do that even when it costs current society. You think, as I do, that our current society cannot be protected and preserved, that attempts to do so will fail."

Eltis listened as Fairta said, "What you are doing, and what politicians must do, is prepare us."

Fairta went on, "In particular, they must prepare us for the long term. I do not handle the long term well. No one does; not anyone like me who thinks short term. On the other hand, many who think long term, like Filgard, fail in the short term. They are stupid. Only a few

do both well. A politician succeeds in multiple short terms. If he or she fails just once, he or she fails. A politician is like a person descending a chain; if any link breaks, the politician falls.

"But politicians have to prepare us for the long term. That is their duty.

"I have to say, my preference truly is short term. But that does not mean it is impossible for me to think otherwise. As I grow older, it gets easier. And in any case, I never was extreme.

"My point," said Fairta, "is that the four 'Ps' of politics can be remembered by English speakers. They are *protect*, *preserve*, *prepare*, and *provide*."

Fairta returned to a point she had made on an earlier visit. "School children need examples for determining the quality of evidence, weakly suggestive, strongly suggestive, that sort of thing. That fits into the 'reality' part of the 'five Rs,' *responsibility*, *reliability*, *rigor*, *reason*, and *reality*."

"How am I going to do that?" asked Eltis, speaking more to herself than to Fairta. Then she said to Fairta, "You mentioned the idea of exemplars in that dinner where you got us thinking about traditional temperaments. Or maybe it was the next morning. You were saying that most people think in terms of examples, or at least that is how people think when the object designated cannot be pointed to or pantomimed. You said you thought of white birches, to which you can point, when anyone mentioned birch trees.

"You suggested that children learn examples of differing degrees of evidence just as they learn examples of the notions of heaven and hell."

"Right," said Fairta. "Schools should teach examples for thinking about degrees of evidence. Obviously, people have thought about those degrees for generations. Children learn them. I am talking about making the examples formal, fully spelling out the criteria."

"But it is not only evidence that needs formal examples," said Eltis. "The other of the five 'Rs' and four 'Ps' all need them."

"Yes, that is true," said Fairta. "You need many examples."

She went on. "You can show failures in each of the five 'Rs' and four 'Ps' through history. Failures tend to be more memorable than successes. They make dandy illustrations.

"Thus, in the 1770s," said Fairta, "the English government did not consider reliably the reality of the asymmetrical war that George Washington led against them. They did not investigate with *rigor* and *reason* why they were winning battles and losing the war. They were not *responsible*. They did not apply the five 'Rs.'

"Each of those notions, *rigor*, *reason*, *reality*, *reliability* and *responsibility*, is worth an essay. That way children can be forced a little, as I was."

"Maybe kids should not be forced at all," said Eltis. "After all, as both you and I know, they won't learn much except to hate you and the concepts."

"That is true," said Fairta. "But how do you guide kids so they want to learn these particular items? The whole point of an education is that children don't have to go down false trails. I don't know how you could meet the challenge."

"You are not that kind of teacher," said Eltis. "I don't think it is a temperament issue; I don't think any of those things you talked about have anything to do with this. I think there is a sequence that you don't know but that some professionals do — not those who think of themselves as higher in a hierarchy than they and who force children, and not those who figure that children are as good as they and let them happily walk over cliffs, but others."

"Hmm . . .," said Fairta, "you used the word 'think' three times in your last statement. You are not certain of your conclusion. By the way, it is a temperament issue. The largest group of teachers are like the largest group of people, Guardians. They are full of sense and hard work; but they also think of themselves as higher in a hierarchy than children. The next largest group are like me, who know that children are as good as we are. But I will let the claim go. I hope there is another method.

"Back to history: Napoleon's government failed to protect most French against his rule or against the notions of the eventual winners. That failure came at a time when bourgeois businesses were burgeoning."

Eltis did not say anything about Fairta's comments regarding uncertainty, although she kept it in mind. Instead, she laughed. "You are being carried away by alliteration: 'bourgeois businesses burgeoning.' But I am taking your point. The Napoleonic government did not protect people. It did not preserve itself.

"Presumably you are going to say that persons' incomes must be seized, that is what taxes are, after all, a seizure of others' income — or you can say that they are a necessary fee — to pay for a public education that prepares children for adult work. The character of work changes when bourgeois businesses boom. Traditional learning, as peasants, fails."

"Yes," said Fairta, grinning, ". . . 'bourgeois businesses booming' prepares them to pay the fees necessary for emergencies and for their retirement . . . that prepares them to provide.

"The four 'Ps' . . . *protect*, *preserve*, *prepare*, and *provide*."

Eltis thought for a moment. "None of these criteria, the five 'Rs' or the four 'Ps', determine particular directions or beliefs," she said.

"Yes and no," said Fairta. "On the one hand," she shook her left hand, "they do specify what a responsible government must do. They do determine. Powerful people can be irresponsible for quite a long time — far longer than anyone lasts in government, even hereditary rulers. So this criterion does constrain individuals.

"That is why the Japanese government, in coming out against deforestation, acted responsibly in the Eighteenth Century. Its actions took and lasted generations. So yes, these criteria do specify particular beliefs, or maybe a better word is habits. When you use the word belief, the vision that comes to my mind is that of a fundamentalist preacher arguing with a quantum physicist."

"When I hear the word 'habit'," said Eltis, "I think of a woman in a Catholic religious order, wearing old fashioned clothes, a 'habit.' But I take your point. The criteria tell people to act in certain customary ways."

"On the other hand," Fairta shook her right hand, "so long as beliefs are not falsifiable — and here I am using the word 'belief' intentionally — and so long as beliefs' applications serve the society, anyone can believe anything. Thus, the Earth has people with Buddhist, Moslem, and Christian beliefs all at once; and none of them will contradict those who consider those beliefs all too limited."

Eltis frowned. "What if your belief system is too limited?"

"Well then, it won't work," said Fairta. "There are some people in every religion who think too small. For success, a system must be able to handle different kinds of people and different situations. That is why the great religions survived the collapse of old civilizations. They were big enough. Some of these old religions may even survive our civilization. No, the criteria do not point to one or other religion."

Eltis worked to incorporate Fairta's ideas into her talk. She started talking about a 'Melior Movement', where 'melior' was the old Latin term meaning 'better.'

Regarding evidence, Eltis said the goal is to improve on what people had done for ever and ever, which is to make judgements, to decide reality when it is not obvious.

She reminded everyone that courts traditionally operated to put the accused in one or other category, innocence or guilt, 'beyond a reasonable doubt.' That meant people added up degrees of evidence, slightly, faintly and strongly suggestive. At the same time, Eltis said, a good many actions are truly binary or are categorized that way.

As for the five 'Rs': she spoke of them as what people in government should do. "Responsibility and reliability as determined by reality with reason and rigor." She also said that most of the time, most people

would not care or know what their government was doing. But occasionally, they would judge their government. The five 'Rs' were no more than an aid.

Likewise, the four 'Ps', to protect, preserve, prepare, and provide: for most people, they would be another occasional aid.

People in government could remember, Eltis decided they ought to remember, the four 'Ps' and five 'Rs.' They would justify themselves according to them. So long as people judged the evidence for those claims and decided whether they agreed or disagreed with politicians' and civil servants' values, society possessed a more or less accountable and lasting system.

Eltis could see why Filgard married Fairta. Even though she was different, the woman had ideas and knew how to express them so that someone like Filgard or Eltis herself paid attention.

Several months later, Fairta fell sick.

Chapter 14

The fellow acted somewhat subservient when Vallen arrived. He knew Vallen had not traveled half way around the world to praise him. Vallen thought the contractor showed considerable spunk. Clearly, he thought Vallen was going to take away just about everything he had built up.

"Our production people," Vallen said, "reject sixteen percent of the air intakes you send us. Those castings do have to guide the incoming air exactly. They must be exact to five microns."

Vallen knew that for generations, expensive machinery had enjoyed twice that precision, to two and a half microns, to one ten-thousandths of an inch. Casting to that precision was new . . . not too new . . . Selling widely, that is to say, cheaply — that was somewhat new.

"We are selling a product that boosts acceleration in cars," Vallen said. The man knew that, but Vallen repeated it anyhow. "The extra acceleration is not much but is enough to notice. And we do it without increasing the fuel needed, without increasing liters per hundred kilometers traveled, or as Americans like to say, without reducing miles per gallon.

At this stage, Vallen was remorseless. "The air intake is only one part of what is a fairly complex device. The air must be filtered before it goes to the intake . . ." Vallen did not say, but he implied that he could not afford higher costs or complexity. "The device is not part of the car as it comes out of the factory. It is not necessary or wanted by enough people. That is why we sell it. So long as the part is not too expensive . . . and it works . . . we succeed.

"We do not have to order from you," he said. "You have competitors. It is not as if just a few companies do precision casting."

Then Vallen changed his tone and his expression. "We could regularly order more from you, rather than do it when necessary. We would return those that do not fit. Before assembly, we test each part. But I am not certain how long you would last with a permanent fifteen or twenty percent return rate. It is a good deal cheaper to do it right the first time.

"After assembly, we test the whole. That is why we have a good reputation technically. What we sell, works."

He grinned, "You are thinking almost entirely of people. You are just like me, most of the time. However, I have discovered that I have to think of machines, too. So do you. That is the key."

The man asked, "What do you mean?" This is what Vallen wanted. He did not want to shift to another supplier if he could help it.

Vallen was on the road, or in his case, in the air, even more. A competitor swallowed the main company that assembled various parts. It's new management felt strong enough to raise its price. One part was the device for which he needed the well-cast air intake. The company that cast it had not been bought.

Vallen did not think the higher price would help him. Besides, he could handle six smaller organizations at once. They could assemble the parts. After picking them, they would make little or no extra work. In total, they would produce as much. He felt sorry for the people in the big company. They faced huge lay offs within four years.

For each of his new contractors, the general manager had to be like Vallen, a person who mostly liked and thought of people, but who could understand technology. He had to be able to think long term and strategically, too.

The factory bosses had to work hard. They got parts from suppliers that Vallen listed, had them assembled, and shipped them. They should not want to look too far ahead; most of their problems would be short term. As a practical matter, they would be hierarchical.

The research people had to think technically, long range as well as short. Their leader had to think both technically and about people. He would connect to the general manager and to the accountants. He would speak to outsiders.

Vallen knew how hard it was to find anyone with those capabilities. Very seldom could you promote a technical person away from his laboratory and expect him to be a good interface to people. Few people thought technically. In a large enough organization, you could find people and train them. But Vallen was looking at smaller companies.

Regardless of difficulty, Vallen figured that even though the largest of his new companies would be only a quarter the size of the previous, it should have a research department. At least two more should employ research people, too. With ideas more and more restricted, and public research receiving less and less support, only by funding the work themselves, and sharing it with allies, could any company succeed.

He laughed to himself. Patents were a way to turn help into harm. Except that he gained income from several, none of which he had invented or sponsored. But he had seen, early enough, that they could be used to move resources from others to their owners; and he purchased shares in companies that owned them, so he became an owner.

He enjoyed patents as a help to him. Nonetheless, their current existence was another disillusionment. He knew that in countries which enforced law, patents restricted. It was not simply that they forced up prices; with the help of governments, they prevented competition.

Vallen remembered as a youth being told that patents 'promoted innovation.' He remembered reading that in the mid-19th Century,

Scientific American printed new patents as a way to spread knowledge. No longer.

Determining whether a company had a research department was easy. Determining whether the fellow in charge of it was good or not, that was harder. Vallen's people could exclude companies whose head of research failed to publish reasonably good papers when young. That excluded the incompetent and a few of the competent who had not been smart enough to make sure their papers got into the data bases his people investigated. They could look at recordings, too, and exclude those who badly handled contemporary public relations. He chuckled. Outside of the companies themselves, only his people might care enough to look.

Of those left, Vallen had to meet them face-to-face and ask technical questions as well as 'human interest' questions. It was the only way for him to determine what they were like.

Well, he had to meet the general manager, too, and the factory bosses. From Vallen's point of view, factory managers were the simplest. Likely, they would never have got to the positions they held unless they were smart and hard working. Incompetent relatives would be pushed elsewhere.

In a large company, the head of research would be higher in an organizational chart, but not in any so small. Vallen figured the factory managers would treat him as one of the boys. Or her. A woman who knew how to be 'one of the boys' . . . she could go far.

For each potential contractor, Vallen decided to have a general meeting and then individual meetings with the general manager and the head of research. He expected to visit ten or a dozen companies to find the six he wanted.

As he flew to another city, Vallen realized that all he did involved contracts, whether written or unwritten. He wondered if others thought the same way. He doubted it. They thought more in terms of unwritten, human connections. Except he was from far away, from a different culture. Specifying connections both human and inhuman, which his written contracts did — that was helpful.

Vallen remembered reading about big, modern companies in the previous century. They manufactured in-house. In the 1930s, an economist, Coase, wrote about the rise of corporations. As he pointed out, corporations allocated resources hierarchically rather than in a market. He had argued that when the cost of contracts was higher than organizational costs, corporations expanded in-house production.

Partly, it was an increase in the size of entities and in the progress of financial intermediaries. The companies that Vallen hired could afford fancy machinery, even though they were in a location that previously

had been distant to bankers. Partly, it was new technologies. It was easier to discover costs than it was a century before.

Ironically, the new technologies enabled closer monitoring, too. Corporations could expand in-house production. Except it would not work. People were too different. Only certain things, like prices and quantities, could be safely defined. 'Maybe,' Vallen thought, 'my contracts are enough.'

Vallen was happy. He liked travel. He knew he was unusual this way. He was not a good family man. It enabled him to do at what he was best, which was to sniff people out. Many others were unhappy, even when they did not travel. That showed itself by them growing tired after six or eight hours. They took week ends off, too.

Several of his older superiors said they grew tired after fewer than eight hours — they were surprised they had grown so weak and predicted that Vallen would, too, "but not for another twenty years."

Chapter 15

Fairta had an unusual name. That is how Filgard came to know her. Their leading initials were the same. As Fairta said, "They intertwined." Filgard knew enough to avoid saying that any pair of letters could intertwine. He figured that instead of being literal, she meant they two were intertwined. That was true.

Even though she knew her desires were different than his, she understood him well, better than he thought. Mostly, she thought, her understanding came from accidents of upbringing. Her parents had discussed people's characters traditionally; and Fairta decided that even if the reasoning was wrong, the descriptions were right.

Thus, she understood that Filgard focused on work or on an idea. She appreciated his need for autonomy and his presumption that she wanted it, too. At other times, he loved to talk in detail or, as others termed it, expound. She could see that because of his focus, it would sometimes appear that he did not pay much attention to her. That was not true; she knew that. She also knew that she had to disrupt his focus every so often. She was good at that.

When Fairta looked peaked, Filgard noticed. When he suggested she receive a thorough examination from the university doctors, she agreed readily. That was not usual at all. And when she came out of the doctors' office, appearing worse than when she went in, Filgard became very worried.

Fairta was quick to explain. "The local doctors," she said, "do not give me a chance. They say I will be dead within six months, if my treatment is good, a year if there is a miracle." She looked at him. "I feel tired, but not bad," she said. "I don't want ever to feel bad. Do you think they can predict the future as well as they pretend?"

"I don't know," Filgard said. "In any case, let's get another opinion. We do not have to depend just on these people. Maybe they are wrong."

Fairta had already accepted her death; but Filgard had not.

It took longer to set up the second examination than Filgard expected. It was in another city. And the results were less immediate. Filgard felt frustrated. Eventually, they came. They were the same. The university doctors were not wrong. The second team said that Fairta had less than six months to live. Nothing could be done.

Both Fairta and Filgard believed that the two groups of doctors were as good at their art as anyone. There was not anything that could be done. Magic would not help, only pain killers.

Neither would bargain with the imaginary, although Filgard decided he wanted to.

Fairta became weaker. She spent more time in bed. They moved the bed into the living room on the ground floor; she could not climb the

stairs. Filgard talked with her more than he had ever before. Sometimes, especially just before her end, he talked more at her than with her.

He sat on an armless chair facing the head of the bed, holding her hand. He realized that his life could carry on; but that the meaning of it would change. He was pleased with his students; he was pleased with his recorder. Nonetheless, as he asked Fairta without expecting an answer, "What good are they, what good is it, in my day by day world?" He paused, and answered himself but speaking aloud, "So, the result is to make trucks a little less expensive. That is not bad; that is not evil. But it is not much.

"You and I will never have children, not children of your body; only children of our minds. But what of our successors in a half century or a century or more? What of other sentient beings?" Momentarily, Filgard imagined beings with tentacles. He did not limit his notion of 'us' to a particular breed of human, or to all humans, or to humans and other possible sentients on the planet, like dolphins and whales; he included all sentient or all potentially sentient beings.

He held Fairta's hand. She was lying comfortably in bed. She was not saying anything. Filgard continued. It was as if he were talking but it was not; he was thinking outloud. "Some say we are here as a test or preliminary. I don't think so. I think we are complex, sentient systems.

"Of course, if you think we are here as a test, then our purpose already exists; it is to pass the test, like children in a school. Hmph!," he smiled. "I give tests." He creased his forehead. "I mark them, too." He laughed again. "I must be a god . . ."

He stopped after that, then spoke again. "If you don't think, if you are non-thinking, if you don't think we need a reason to live, then you just do. You just live. I bet the less aware animals are like that. But if you do think consciously, then you either have to invent a purpose yourself or put the job onto others. Mostly, people put the task onto others, their culture or religion. They are modest."

He did not think about the need for linguistic communications. Smart creatures who did not talk, chimpanzees, for example, could not ask others their purpose. But any individual could have a numinous experience. A chimpanzee could experience the emotions of love, fear, dependence, fascination, unworthiness, majesty and connection.

Fairta was listening, although she could not move at all. She thought of chimpanzees who could not talk. They were like her; she could not talk now. But they had no language. None could talk. She wondered whether they had temperaments. Two temperaments, the Sanguine and the Choleric, did not require linguistic communication. She thought the two others did, the Melancholic and the Phlegmatic. She was not going to find out; she was not even going to be able to discuss the question.

Filgard thought only of entities who could talk and were about as intelligent as he. "It is reasonable to be modest," he said. Fairta was not responding at all. He did not know that she had forgot what he was talking about. She liked to hear him. Eventually, his subject would make sense again.

Filgard knew people with serenity; he knew people with ideas he would never think on his own; but he did not know anyone who could come up with a new, previously unthought purpose. That was his topic. He would not come up with a purpose himself. He would have to pick an existing one.

"Stewardship. That is the only purpose I can think of," Filgard said. Fairta heard Filgard and suddenly remembered everything. "In a sense, that is what I am, a steward. I help keep education going. My recorder is new in only the most trivial sense, that of never having been built before. Regardless what the university patent lawyers claim, none of the ideas are new. The device required hard work and intelligence; but it did not require genius."

Filgard stopped speaking for a moment. He was a steward, an intelligent steward. But the question he ought to ask was whether the culture in which he was a steward was good.

Filgard was not quite sure where that question came from. Like the idea of stewardship, it did not come from him. Certainly, he believed that his culture was better than many others. He preferred it over the alternatives he knew. Well, he was in it. 'Maybe,' he thought, 'that is the reason.' But his culture had objective advantages, too. It was not only that he knew it.

For one, it taught reality, or parts of it taught reality. That is what a steward was, he thought, a basically conservative person who keeps to the past, who makes sure that things are as they were. Teaching reality was a good habit of the past. He was silent now. He figured he should speak again outloud.

First he said, "I teach reality." Then he realized that without the context, the statement was meaningless. What would Fairta think? He went back; he said, "One of the advantages of this culture is that parts of it seek the truth, more than just the habitual or accidental truth that you learn very young, more than just the minimal truth that is needed. You learn more than if you don't eat, you grow hungary. I am an engineer. The things that we build either break or succeed regardless of how we feel. It is not like dealing with your mother, where your feelings may influence how she acts."

He stopped for a moment. He had to deal with less familiar notions. "In our country, resources are not simply transferred from one person to another. As an economist would say, it is not entirely rentier, in the general sense of the word. In part, we satisfy human needs. We are

not entirely, maybe not even mostly, ruled by aristocrats and teachers of meaningless beliefs." He laughed. It was almost a cry. "Well, they never call themselves 'teachers of meaningless beliefs.' Often or maybe always, their core beliefs cannot be falsified. Those beliefs are neither meaningful nor meaningless. And those that can be falsified are mostly true. You can drop a stone on your toe. After all, heavy objects on the surface of the planet do tend to head towards its center!"

He stopped for a moment and thought about Aristotle and his theory of gravity. If you dropped a stone, it would fall. It could fall on your toe. There was no doubt about that. When you did only that experiment, intentionally or not, you confirmed Aristotle. Then Filgard remembered to speak outloud to Fairta again. "The beliefs' value is not in themselves, or at least one of their values. It is that by enacting them, whether or not you believe them, you tell others that you are willing to go along with the social customs. This is very significant for rulers; actually, it is significant for everyone. It is not whether you believe, but how you act. That is what counts. And to be successful and satisfying, beliefs' practical embodiment must have some truth."

Filgard was not one to base his beliefs on love, fear, or fascination. Consequently, he never thought of those who believed because of them. Often such people were utterly convinced of what they thought, regardless whether it was falsifiable or unfalsifiable.

Instead, he stopped for a moment and then talked about another kind of ruler. "Those who possess force, the forceful, must think well of themselves." He could not imagine anyone trying to direct others when that person lacked self esteem or self confidence.

"A ruler has to think of himself as the best. Otherwise he fails. The same with a woman ruler. Originally, the word 'aristocrat' meant 'best ruler.' At least in classical Greek it did. Whatever name was current, a small group would rule a country or nation or city, some by manipulating beliefs and others by manipulating force. In so far as the world changed slowly, they could depend on what they learned as children, on what the society told them. They could survive."

Then he turned to himself. "The trouble is," he said, "me and many people like me lose in a rentier economy, an economy in which resources are transferred from one person to another and not produced. I am not good at the modern equivalent of palace intrigue. Some are. In a more rentier society, they gain." Fairta did not say anything; she did not move her face at all; it was easy not to. Nonetheless, she agreed.

Filgard spoke more. "The measure of merit changes. Rather than reward those who perceive reality — all of it, not simply useful parts — and who know what to do with reality," he paused again, "the new measure, which is a return to a very old measure, rewards those good at persuading or forcing others to give up resources to them."

Fairta still had not said anything. Filgard wondered whether she listened or could hear at all. Her steady, but shallow breathing told him she was alive.

"Some people in the university teach that cultures are the same. They are not. I wonder whether these people know they were shills or whether they are caught in a false belief, whether they do not know how to judge. I suspect the latter. They are fools, not frauds.

"Well . . . they do not talk to me and I don't talk to them; I am presuming. But I suspect they are fools. It is very hard to be a successful fraud. There are too many for them all to have been frauds. Doubtless, you would say I should not think of them as fools, but as ignorant. I hope they are teachable." Fairta smiled briefly, but said nothing.

"These people say that two cultures were identical when one enabled someone to discover Pascal's triangle thousands of years ago and another did the same — and leaves out the difference that the second also enabled and funded other mathematicians to go further."

Filgard wondered how he knew that, and what degree of truth that statement had. It was a claim he had heard years before and not bothered to investigate. Worse, he was pretty sure that making up rows of numbers, each number the sum of the two above it, a Pascal's triangle, led into the calculus of probability; but he was not positive.

"Actually," Filgard said to Fairta, "I don't know much about the history of mathematics. Maybe that is not a good example, even if it shows the highest art we can imagine, as difficult as a great musical composition, a scientific discovery, or a play.

"I use a few symbolic tools, exactly as I use a hammer and screwdriver. I don't know anything about their history, except that Philips was the man after whom the Philips-head screwdriver was named. I don't know about the history of tomatoes or bread, either, although I eat them. I don't know about the history of friendship, whether it be real, projected, or imagined, although I have friends. I just use tools, eat food, and make friends."

He kept speaking to Fairta. "In any case, I have to decide. Maybe I have not been positive about this culture, even when I do think it is better than alternatives I know. Maybe that is why we have not had physical children, only helped others' children. Maybe, more generally that is why fertility rates are dropping so vastly. Maybe, many forgo children not only because they are expensive nowadays and because educated women have more choices, but because fewer believe in a future. Only those who are optimistic or who have little choice will try to continue their culture in their own children.

"What if the present is a mistake?" he asked. "Then the only choices are to go backwards, to do less damage to the planet and to

help people less; or help people more, while doing less damage, which means progress."

Filgard thought of progress, of going forwards and backwards in non-human technological terms. He was an engineer. It was evident to him that a more regressed technology would have less impact on the planet. With a sufficiently backward technology, you could presume the planet was infinite and flat since bad impacts would fade away before they reached more people. With such technology, there would be fewer people, too. Even China in the old days, as populated as it was, held fewer people than the present.

He completely forgot Peter's remarks on triple-paned windows, that over time, they consumed less.

An optimistic, human-oriented person might have thought of spreading the hurt. But Filgard did not believe any social system could do that, not and last. Some people, perhaps most people, could be persuaded or forced to enjoy less, to survive more backwardly. That could last. Such people would not investigate beyond the evidence that they should suffer. However, Filgard figured, a few would become rich, if not immediately then within a few generations. In the long run, you could not spread hurt equally with purely human actions; you needed technology.

"So," he said, he skipped over all his previous thoughts, "we should go forwards. My recorder is good. People who support rentier economies, who support transferring resources rather than making them — they will not fund much for a future; they will not provide much for research and development. They will not support a future in which those actions might hurt them even if they help everyone else. They are the danger."

He held Fairta's hand. There was nothing else he could do. He never thought of recording her. He could not imagine the technology needed to freeze her quickly. And, of course, the process would be murder, especially with no method of recreating the healthy parts of her.

Chapter 16

Vallen remembered an old saying, that a sculptor with a hammer "discovered what was in the stone." He could not remember where that came from. He said of himself that he "saw a person in a log". Jeffrey, his son, turned the saying around, ". . . carves a log out of a person." Vallen did not like that, but said nothing. His daughter, Janice, did not say anything.

His collection of carving knives sat in a wooden box with a green cloth lining. Each knife fitted into a built-in rack.

The knife handles were brown and made from a fine grained wood. They were like dowels, with a constant diameter. Sometimes, Vallen wondered whether that was right. In any case, each was the thickness of his little finger and three times its length. The handles were all the same; the blades differed.

For a long time, Vallen thought he used one knife mostly. But when he watched himself he found that was not true. He made use of his whole set. He started a piece by gouging out wood with a big blade that curved around like a piece of pipe cut in half lengthwise. The blade was semi-circular, not a fan but a partial cup. It scooped up wood as wide as and half as thick as his index finger. He could not call the quantity a sliver.

For finer details, he switched to smaller blades. By twirling smaller semi-circular blades, he could make eyes and nostrils. For the finest details, he wore a jeweler's loup. Otherwise, he could not see the wood well enough. Then he scratched it with the point of a straight-edged blade — the edge of the blade came up to one side at an angle of forty-five degrees where it made a point.

The wood Vallen carved was more variegated than the marble of a stone sculptor. He found pieces washed up on the beach. He collected those that were the width of his body.

Some of the shapes were very strange. They were eroded by wind, water, and sand. In carving the pieces, Vallen found faces and bodies. Nothing was what he expected.

Often, the drifted wood was hard. But his blades were very sharp. They had diamond edges; he never had to sharpen them. Once, Vallen tried a metal knife blade he had sharpened. It hardly cut at all. 'Clearly,' Vallen thought, 'old timers either cut less, or cut more slowly, or cut softer wood.' He knew that some woods could grow harder as they aged, so he figured old time carvers worked with softer wood. On the other hand, some woods were hard always, certain tropical woods in particular. Vallen did not think he would have enjoyed cutting that wood with a metal blade.

Usually, Vallen found pieces of wood such that faces were no larger than a hand. They were not full size. But once he found a piece twice as large. He carved a head. Its face appeared more contorted than he felt comfortable showing publicly. So he kept the carving at home. He did not burn it; he was attracted to it. But the expression looked tortured.

Carving meant cutting away. For some reason, Vallen liked that better than adding clay to nothing. That is how he thought of it, the work of a sculptor in clay, a ceramicist. He wondered whether subtraction was a major part of his character, or whether it was irrelevant.

Ceramicists had to imagine everything. They could not simply discover what was there, as could carvers. He could make strange and good shapes even though he thought of himself as a poor carver; as far as he was concerned, considering the kind of ceramicist he thought he might become — not very good — discovery was easier than invention.

Moreover, the hobby was unexceptional. He could keep at it no matter how high he climbed. It was solitary, but it was his prime solitary action. He drank with others in the company. No one besides his son ever said anything about the strange and distorted figures he carved. And his son only spoke in private.

Perhaps a few decided he had a tough and dreadful subconscious; ‘let people think that,’ he figured, ‘all the better.’ Besides, some of his wooden people looked happy.

Chapter 17

After his wife died, Filgard spent more time in the general faculty lounge. It was not the same as the lounge in the engineering department. Different kinds of people came to the general lounge. It also had a wider selection of food and drink. Filgard decided that those who came were mostly humanities' teachers or university administrators.

One of them was a Donald Tull. Filgard knew he should remember the name; but he could not remember what faculty or bureaucracy he was in, except that he was in nothing connected to science or engineering.

Speaking of students, Tull said, "They are ill educated; they do not think ahead."

Filgard remarked gently that that statement came across as arrogant; and, he said, in the past it was politically incorrect, although no longer. He grinned, "Of course, neither of those remarks is going to influence you at all."

He stopped and thought for a moment. "But," he said, "the statement may not help you. That should concern you."

Filgard went on, "It is true, most people do not think far ahead. But the reason may well have nothing to do with education or with native intelligence. That idea may lead you down the wrong path."

"What do you mean, the wrong path?" asked Tull.

"Suppose the world is uncertain," said Filgard. "For the most part, then, an individual should not look too far ahead. It is not good for them to. It is a waste of energy. I mean energy in the literal sense, the calories you burn. Historically, most people got these joules from foraging or hunting, mostly from foraging but part from hunting."

"But why do I care about anthropology?"

"Well, you are teaching students or administering a university," said Filgard. "That means you are dealing with people. You want to succeed, don't you?" He never did explain the exact connection; Filgard just assumed that Tull would understand.

"Returning to my point," said Filgard, "a group needs some few to plan ahead. After all, you may survive the next year."

He did not bother to remind Tull that his previous comment on the subject had been that is it is wasteful for most people to look far ahead. Tull had nearly forgot that.

Filgard went on, "No one needs to be an evolutionary psychologist to believe this; you can observe that even nowadays, groups do better that successfully plan ahead."

Tull said he was not sure what Filgard meant by the phrase 'evolutionary psychology.'

It was a digression from the main topic, but Filgard explained. "That is saying that you can understand an individual human or other animal's behavior by considering evolutionary history. It does not always work; and you have to avoid telling 'just so' stories. But when done right, the discipline is helpful.

"A turtle has a shell. That is a physical phenotype. A turtle grows its shell because of its genes; a particular individual's shell is influenced by that turtle's environment.

"The behavior of a turtle is to pull its head and feet into the shell when threatened. This often works. There is no way an attacker of about the same size can get at it readily, so after pecking or scratching a bit, the attacker almost always gives up. The probabilities favor the genes carried by the turtle.

"So, with a recipe that is more successful in replicating, we are more likely to get another turtle that pulls in its head and feet when threatened. That's its psychological or behavioral phenotype. Both are necessary, the shell and pulling in its head and feet.

"Of course, a little attacker, a bacterium, is not hindered by a shell; a turtle can get sick. It needs a different defense against the bacterium, an immune system. And a bigger attacker can defeat the shell.

"For example, a big bird can lift the whole turtle and drop it on stones from a height. The drop breaks the shell and the bird can eat the remains. But big birds are rare.

"Evolutionary psychologists remember that most of the time, that is to say, through most of history, not just the short written portion of it, humans foraged and hunted because they had not yet invented agriculture. Agriculture did not get invented until ten or fifteen millennia ago. None had invented writing, either. Writing was invented even more recently."

Tull was a bit startled. His eyes may have glazed just a smidgen. He did not think the invention of writing as 'recent.'

Filgard went on, oblivious. "Throughout most of the time during which humans became human, they lived in pre-agricultural bands.

"The qualitative argument is that foraging and hunting are erratic; no one knows what will be found or not found next.

"That is to say, it hurts most people to think far ahead; they cannot do anything. Also, presumably, that is why most people are more optimistic than conditions warrant. (That is what research in the late 20th century suggested.) Optimism helps."

Filgard took a breath. "But at the same time, it is useful for a group to have a few who think ahead and who can remember a long time back. Sometimes, for example, you have several years of rain followed by several years of drought. A short time horizon does not

help. If you are heading into a new drought, someone in your band had better remember back to the previous one. They need to remember and tell you what happened and what was done. That is the 'grandmother' theory. That is the notion that a band should have a few old people who can remember the past; these are mostly grandmothers. In nature, men tend to die younger.

"The issue has different parts. Each part needs its own evidence." Filgard looked at the man. "I would like you to tell me the answers. I am not going to look into them myself. I am not skilled in the subject and I have other things that occupy me. But I am interested."

Tull nodded, but it was not clear whether he nodded because that was appropriate in the circumstances or whether he agreed to undertake the investigation.

Filgard paused, then said, "The questions are straightforward. The first is whether pre-agricultural band life was uncertain.

"As a practical matter, I think some things were more certain during ice ages than now. Weather is a good example. During an ice age, the temperature gradient between the edge of the ice and the equator was tighter and sharper than it is now. My hunch is that storms came more regularly then."

Tull looked puzzled. He did not follow. Filgard explained. "The edge of the ice, which was at roughly the freezing temperature of water was closer to the equator, which received more or less the same sunlight as it does now. Clearly, the equator is cooled by cold winds, but still, I think the temperature gradient was higher. That would be something to discover."

Tull said, "You mean, I have to study paleoclimatology?" "Yes, of course," said Filgard, "that is what you need for a follow up. You can see why I don't have the time."

Filgard stopped again. "But to return to the subject, a digression, regular storms are why, I think, the week was invented. That is, in addition to the movements of the moon and to women's menstrual cycles which I suspect are more significant. But my hypothesis is that storms came regularly twice a week during the ice ages. There are only four weeks in a month because you can see full, no, and quarter moons easily and because everyone, even non-speaking babies, can count to four. A week itself has roughly twice that number in it. I suspect it has seven days because that is the number of wanderers, if you include the sun and the moon, readily visible to the naked eye in the sky. You can name the days of the week; as far as I know, weeks are not named.

"Back to gathering and hunting: I suspect that people would sometimes fail to find and harvest edible plants and animals. A band would not find tubers or kill enough rabbits for twelve people. We know people had to fail sometimes. They had little storage and few alternatives. I

don't know the numbers, though, excepting that that part of life would be uncertain.

"On the other hand, people ate lots of different plants. Maybe their lives were more certain than we think. Paleolithic gatherers and hunters grew taller than their agricultural successors. That meant they ate more. But their numbers hardly grew.

"The lack of population growth suggests that the salient portions of pre-agricultural band life were 'nasty, brutish, and short.' Or maybe just short. In any event, imagine it was uncertain. Were people in such a band better off when most did not spend their time and energy concerned with whatever is beyond uncertainty?

"And if so, were people in such a band better off when a few did think ahead and remember behind?" The words were 'ahead' and 'behind'; Filgard briefly recalled that in some cultures, the unknown future was behind and invisible, and the known past was ahead. But English put the past behind; it seemed natural. Filgard decided the question was an irrelevancy he should ignore.

He went on, "Also, if members of a band were better off with a few long term thinkers, were such people helped by a powerful reason to be? That is to say, did more bands survive when each provided a powerful belief that could carry people emotionally through bad times? I mean, for example, when members of a band found food, but not quite enough.

"Actually, I am hypothesizing an impact on individual genes from reproduction that depends on differences in the behavior of groups. This impact is much weaker than the impact from changes in the behavior of individuals who carry the genes. We know that. But is the impact so much weaker that it is irrelevant?

"That is one set of questions. They are easy to ask and may well have been answered, but I don't know. That is a disadvantage of being too specialized.

"As for another set of questions: if people were significantly different from one another, a few thinking ahead and remembering the past, and others not, why were they different? Maybe genes don't have anything to do with it."

Tull said, "You are talking about the nature — nurture controversy."

"Yes," said Filgard. "Were the temperaments caused, at least in part, by genes? We know that children look somewhat like their parents, and look somewhat different. Were their temperaments similar?"

"What do you mean, temperaments?" asked Tull.

"In this case, whether people have a preference for looking far ahead into an uncertain future, or not. Like your comment on students, I am saying that only a small portion of the population had a preference for looking far ahead into an uncertain future."

"I don't follow you," said Tull. Filgard sighed. "You said that students do not think ahead. I am inventing a testable theory as to why." Filgard no longer thought Tull was a professor.

"Obviously, the genes that individuals carry are more likely to be replicated when the entities carrying them are more successful in reproduction. The question is not whether those data packets were replicated more when they changed in a way that enabled those who carried them to survive and transmit them more than otherwise. They must have been. The question, actually, it is a subordinate question, is what caused that characteristic difference in the first place?"

"You are speaking of genes as data packets, right?" asked Tull. "Well, for this analysis," responded Filgard, "what else are they?" He returned to what he considered a more important topic.

"An alternative is to ask whether people are different because they were brought up differently? And if so, were the customs for bringing up kids well established. Did that establish more or less permanent proportions among types?

"Then, we must ask whether, over the long run, it is true that bands with past and future seers did better than those without? I suspect such bands did better, but that is a question. In any case, upbringing provides a non-genetic way to transmit information from generation to generation.

"I don't know what the answers are. You can say it is a mixture of causes; that is the way I am inclined. But then the question becomes under which circumstances, what proportion of which cause?

"Or is there some other reason that neither you nor I have thought of?"

Filgard was a bit irritated. He no longer expected Tull to study the problem and report back, even though he had started it all. He had talked about people who did not think ahead.

On the other side, Tull had been trying to make small talk, which he considered harmless. He had not expected scholarship. In his own mind, he likened Filgard's remarks to an harangue. He decided that Filgard was a stuffed shirt with an electronic speaker behind it, repeating a recording. He was best kept away from the faculty lounge. Tull knew he could not keep Filgard away, since he was part of the faculty; but he could be avoided.

Chapter 18

Vallen's company owned a division, a smaller company, Complex Tools, Inc. Among other items, it manufactured expensive, complex machines. There were few customers for them. However, it owned the rights to enough different ones that all told, the division made a good income, even though it built few of each. Even better, the division made a good profit.

Vallen was put in charge of CT. It was a move away from the widely sold, low margin specialized car parts he had worked with previously. The new division manufactured high margin products which it sold narrowly. Vallen would not be inspecting the same factories; but he would be visiting the same cities. He did not expect to be offered any bribes on his new job. There was no reason. But he had made enough previously. And this was a promotion, a good promotion. He liked it. Vallen expected a promotion and he was pleased with the one he got. It was as good as he had hoped. And it meant he could leave the world of low margin gadgets. That suited him.

Complex Tools, Inc., with money from Advancement Inc., paid for permission to copy various machines from Advancement Inc. That made sense to the accountants. Advancement Inc. had previously purchased licenses to manufacture copies using spray-droplet machines. The machines were new to Complex Tools, Inc. but not so different from what they had traditionally built, except they were made by spraying droplets. The droplet-made copies worked as well those traditionally built and cost less to manufacture. CT sold the machines for less but Vallen increased his profits slightly.

All would have been well, except that Vallen's company increased his expected tenure to five years. The goal was to stretch his time horizon a bit further. The change succeeded. Vallen started to look four and five years ahead instead of two or three. He thought to himself, 'If I had expected to leave within three years, as had been traditional, I would have enjoyed the short-term profits. I would have left my successor to clean up. But five years?'

What would Advancement Inc. do? Or, more significantly, what would its backers do? Vallen decided that after a honeymoon, a metaphor that he thought described his present relations happily, Advancement Inc. would undertake negotiations to squeeze his profits. They would threaten to sell their licenses to another company. If worse came to worst, they would let it be known that an extra-legal company might gain control of the instructions used by the spray-droplet machines. Were that to happen, Advancement Inc. would lose. They would not receive any license income at all. But its backers had less to lose personally than Vallen. So they had a more powerful negotiating position. They were not stupid, so they would not themselves lose too

much; they would not cause Vallen to lose too much. But they would squeeze CT's profits. Vallen would not lose a lot; but he would lose a little. He was against losing.

Vallen decided that he had to change the nature of the game. 'When you cannot buy an apple at a decent price, upset the applecart,' that is what he told himself. It was a long sentence. Maybe he should think to himself, 'no apple, no applecart.'

Vallen had to communicate what he meant. He was not known enough for ruthlessness, not like the backers of ADVANCEMENT INC.

He did not mind hurting people he did not know, even when he knew that person's name; he figured that went on all the time. That is what disillusionment meant. Vallen did not dare hurt anyone in ADVANCEMENT INC. or any of its backers. That was too dangerous. So he had to look elsewhere.

He came upon Filgard Meldon, whom he thought was important to the profits of ADVANCEMENT INC. — Vallen had a 'great hero' view of science and engineering.

Moreover, Vallen had knowledge of his own self: he personally succeeded because he prevented the wrong people from learning about the bribes he received. He figured that everyone who succeeds must be like him. Consequently, he thought of Filgard as critical to Filgard's recorder. He did not know that it is useless to murder an engineer after he has made a development unless that engineer has not communicated his designs, or unless that person is not an engineer, even if so called, but is important because he is an inspiring leader.

Five years previously he would not have known how to begin. Now he knew people who knew people who knew people ... and he knew about cutouts and how to dodge contemporary investigators. And he had the money. He would only go for the best and not ask questions. From his point of view, the process would be clean, very clean. He was not going to sleep badly at night.

Meanwhile, Vallen found he was carving an hour out of every day for his hobby, which was — he was amused at the word — carving. He found that carving helped him do other work, his paid work, more quickly. So he took time from that as well has from his sleep. Moreover, when he carved, even if only for an hour or so, he did not need as much sleep as before, although he always felt tired. Meetings with other people, persuading them, that took as long as before.

While he was getting ready to hire someone to murder Filgard, Vallen carved soldiers. They were full bodies, not just heads. They mostly carried spears. Although the rest of a carving came from one block, he made the spears separately. They were straight, regular, and hard to create.

When he walked on the shore, every properly sized piece of drift wood looked as if it contained the shape of a miniature Medieval warrior. Vallen understood that his mood could not last, but he accepted it while it lasted.

He carved a bunch figures, some standing with their spears upright, looking resolute, some fallen and looking anguished. A few rode horses.

Vallen was becoming better. Even though they were small, smaller than the palm of his hand, as small as two fingers, his faces carried expression. Each carving looked like a different person. Fortunately for Vallen, they were not anyone he knew. He could show them publicly.

Chapter 19

The only name by which Vallen knew the assassin was 'Gerald.' Vallen doubted the name was given to the man at birth; indeed, he was confident that it was adopted for the job. But it fit the fellow fine, at least from the conversations. Vallen never saw him or a picture of him. He suspected, but did not know, that the fellow was tall, but not too tall, handsome, but not too handsome; that in a crowd he was mostly invisible.

Gerald contacted a police officer, not one near Filgard physically, but corrupt and near him electronically. The officer had easy access to databases and made considerable extra money selling information. Like Vallen, the officer did not dare spend the extra money locally. But it made for a nice nest egg and for livelier than usual vacations in distant and unwatched places.

The cop told Gerald that Filgard Meldon owned a convenience store and give him both Filgard's home and store addresses. That Gerald already knew; the cop told him more, information that was not public. He knew that Gerald was a professional assassin and figured that Filgard must have borrowed and not paid the money back. He carefully did not say anything unnecessary to Gerald and did not pay any attention to Filgard's home town.

Gerald made the same assumption about Filgard Meldon as the cop. However, he figured that Filgard had not simply borrowed a little bit but a huge amount of money. That was why he was asked to 'take care' of the man in a public way. The murder was intended as a warning to others as well as a pay back. If Gerald had felt conscience, he would have felt virtue.

The convenience store looked to Gerald more like a general store. It sold convenient items. But it carried more. Not only did it display all the things people ran out of, it displayed a good number of things people should need and sometimes did. It carried tricycles for adults. They came with big baskets so people could shop without having to drive cars. The tricycles had rigid plastic windshields and roofs; they could be ridden in the rain. And the store had local food.

Vegetables caught Gerald's eyes and mouth. Because they grew close by and were transported shorter distances, they cost less. Although farmers still used some chemicals in their growth, explanations said they used less. The explanations were posted by the stands and their existence meant that local deliveries and foods with fewer chemicals were new and not well known.

The new plants had different genes than the old. The old days' concern over amount was replaced by a modern concern over shipping costs. Evidently, local farmers brought in as much profit by producing

with the new seeds, using fewer chemicals, and making local deliveries as they did with the old seeds, using more chemicals, and depending on others to make distant deliveries. Gerald noted that none of the explanations stated whether the newer, more predominant genes came from breeding or from genetic engineering, or who funded those costs. None said whether the seeds produced a generation whose own seeds were fertile or sterile.

The latter lack suggested to Gerald that second generation seeds were sterile and that private companies funded their initial costs by charging a high average price for each packet. Sterility saved them from competition with farmers and themselves, but not from other smart companies. For that they had to depend on government enforced price restrictions, primarily obtained through patents. There were too many companies for oligopolistic price-fixing to succeed.

Since any increase in seed price was less than the cost of chemicals not used, few farmers complained. And since the locally grown produce was cheaper than the old, few customers noticed.

The plants often did not look as good as distant imports, but they tasted better, as Gerald verified. It was summer. He liked the carrots and cucumbers. He wondered what happened out of season.

Gerald found a hiding place that was a long ways from Filgard's church. He was not visible to others, although he could look out. Even better, he could readily escape in any of three directions. On the morning of the shooting, there was no wind.

Gerald shot the store owner when he was standing outside his church. The spent bullet penetrated a little distance into the wall. Neither it nor dislodged chips killed others. From Gerald's point of view, the killing was clean. The head shot burst Filgard's skull and splattered blood all over his wife.

Gerald left immediately. He never learned that Filgard the store owner was the wrong man.

The murder stunned the engineer. Why had his namesake been shot? It was very obviously a professional assassination. It was not a single car accident or anything like that.

On thorough investigation, the accountants and other investigators found nothing wrong. The store owner had not borrowed money from suspicious sources; he did not womanize. He was not addicted, except perhaps to his work. The store was not owned by anyone else. In retrospect, the victim looked as competent and respectable as he did during his life.

Even a local crook said that the store owner had not been in contact. "We never take care of our customers in such a public way," he said. The reporter never identified the crook and the engineer wondered how

the reporter knew of him. He did not think the reporter had made up the story; the reporter had a good reputation.

The police rapidly came to the conclusion that the murder was a mistake. There were several other store owners who would make more likely targets, although none for what was very clearly a professional and expensive shooting. They hadn't a clue who did it.

Also, the police discovered that another person of the same unusual name lived in the same town. He was an engineer. He had invented something that would cut the costs of trucks and paper, although not by much. As far as they were concerned that was fine. They could not figure out why anyone would care to murder the engineer, either.

Everything was reported publicly; no one locally had any reason to hinder the action. Fortunately for Filgard, at least he thought it fortunate, the engineer was only mentioned as 'a namesake, a distant relative' and not otherwise identified.

Vallen did not learn much of the murder. He only saw the note that 'a convenience store owner had been shot.' The name was unusual, the report said — Vallen suspected that is why the story traveled as far is it did — although a distant relative in the same town enjoyed or suffered the same name.

Vallen decided not to do anything more. Gerald had shot the wrong man. Vallen was going to lose in his negotiations with Advancement Inc., but not much; they were too smart for that.

It was safer to lose. As far as Vallen was concerned, he had spent a lot of money, he had hired a professional, and the professional had goofed. That was the breaks. Vallen did not dare increase his exposure, as would happen with a second murder of a fellow of the same name in the same city.

It was not like he lived in a third world country where he could bribe cops and politicians and other senior people. He lived in a country where the presumption was that strangers behaved legally as well as morally, that the two were never separated. Vallen could only bribe people he knew; and there were many he could not. There were too many vigorous reporters, honest cops, and sharp prosecutors.

As it happened, Vallen lost almost nothing at all. Even though Gerald had murdered the wrong man, Vallen felt like a stone age warrior after his first kill. He exuded confidence, not dramatically, but distinctly enough for the subtle. His counterparts noticed. They did not know why he behaved stronger than before, but in the negotiations they did not push him as hard as they had planned.

Chapter 20

Vallen wanted to discourage his son, Jeffrey, from becoming too idealistic. He knew he could not bring up the subject directly. Instead, at dinner, in the house, not a barbecue, he spoke to the whole table, his son, his daughter, and his wife.

He usually did not do this — they seldom had dinner together — so they knew he was up to something he considered important.

"Go back to the latter part of the 20th century," Vallen said, "that is the period when the previous major petroleum producer, the contiguous United States, started to produce less liquid fossil fuel each year but during which planetary production increased."

"That was a long time ago," said his son, Jeffrey.

"Yes, but that is when the issue first became critical; and when practical solutions became possible."

"What issue?" asked his daughter, Janice, who was just coming around to paying attention.

"Providing large amounts of convenient and available energy from alternatives, at a reasonable price," said Vallen.

"You don't think practical alternatives were available earlier?" His son was curious.

"No," said Vallen. "Otherwise, they would have been adopted dramatically. By 'dramatically,' I mean that within a generation more than a fifth of energy would come from alternatives. That did not happen.

"Earlier, the alternative solutions offered were either not known or were too expensive. I suspect the latter; they did not fit the pricing scheme, the businesses of the era."

"What do you mean, the alternatives did not fit the businesses of the era?"

"Prices ignored total cost. They did not include the cost of carbon dioxide sequestration for fossil fuel or the cost of radioactive waste disposal for uranium."

"Why was that?" asked his son.

"No one thought of it; well, they thought of radioactive waste disposal, and spent decades studying the problem. They did not actually do anything. As far as I can see, the best places were put out of bounds politically and a politically acceptable site was not so good geologically. Maybe it was unacceptable politically, too. I don't know for sure. It is just that no one did anything for a very long time; and no one powerful thought of charging for carbon dioxide sequestration, either."

Vallen was slightly angry. He or they could be hurt, although he hoped those hurt would be poor and distant. He went on. "People who funded a one gigawatt coal, oil, gas, or uranium electric generating plant

paid less than for a several square kilometer solar electric generating plant. Combined with their discount of the future — our present — that cost meant no one built a one gigawatt solar electric generating plant.

"The government subsidized building a few hundred megawatts. I don't know whether that was a good idea or not. Mirrors and more importantly, their supports, continued to cost a fortune."

Vallen remembered it all. "Also, at least for part of that time, the price of fossil fuels dropped significantly. That is a practical example of an inelastic demand curve; a small increase in supply meant a large decrease in price."

His audience looked blank. Vallen sighed and decided to skip the notion. It was not important anyhow, except as an explanation for one element. "The combination of partial pricing and low costs ended short term incentives to long term solutions."

Vallen's daughter asked, "Did anything good happen?"

"Yes." Vallen looked happier. "In the last part of the 20th century, during that generation, more people began to see that the planet was finite not flat."

She was puzzled. Vallen explained. "I know, the words have been commonplace for centuries. Everyone knows the world is a ball. Globes are globular."

His daughter smiled at the phrase.

"But in general," and now Vallen looked stern again, "people acted as if the world were flat." Janice frowned.

"In one way, this made sense. Outside of a few spots historically, Earth would take care of waste. You could dump stuff into a river, and by the time anyone drank the water, your waste was diluted or destroyed."

His son was paying attention. "That sounds like it makes sense in more than one way. Why bother to clean up when you don't have to?"

"That is true. Then human impacts become large." Janice nodded. She had never known a time when the human impacts were not large.

Vallen blinked his eyes. "People still have a hard time understanding impacts."

This caught his daughter's attention, as well as his son's. They thought people did understand by now.

". . . The notions do not scale. They do not enable you to conceive billions of watts. On average, you consume only a hundred watts. You can imagine using a few kilowatts, a few thousand joules per second. You can imagine tens of kilowatts in heating."

Neither his son, his daughter, nor his wife imagined watts, but they all nodded anyhow. They had not the foggiest idea how big watts were,

but Jeffrey decided to find out. It was just a matter of converting two thousand kilocalories each day into watts. He knew his food provided him with two thousand 'big' Calories per day, two thousand kilocalories per day. He put the question aside. Vallen went on.

"Unfortunately, no one is able to imagine all the energy actually consumed. That is millions of times larger."

The nods grew more vigorous, but as far as the others were concerned, their father was still mouthing words that did not connect.

He said, "That is for energy use. I did not consider the impact of having so many barbecues around here. I was not imagining the scaled consequences."

The barbecue made more sense, but it was very much an irritation. Vallen did not like the imposition. Consequently, the rest, who had to suffer Vallen, did not like it.

As a result, they paid less attention to Vallen's next words than he intended.

"When I was young," Vallen said, "I was idealistic. I believed we could 'change the world.' That was the phrase, 'change the world.' Well, people did change the non-human world.

"But we did not change people. Enough are still as greedy, as short-sighted, as they ever were.

"That was my key lesson: there will be a few decent people. I met them. You will meet them. But there will not be enough of them."

He paused for a moment. He was not going too far. Even if his family repeated what he said, even if he was being spied upon, which he doubted, what he said would not matter. Vallen was thinking about outsiders, not what mattered to his family. They thought he was unburdening himself, not that he was trying to change his son.

"That is why I stopped being idealistic," Vallen said. "There are not and will not be enough people who act well. Worse, when I was young there were no organizations that I wanted to dedicate my life to, not outside of business."

"What about the Melior Movement?" Jennifer asked.

Vallen was surprised; the question was not related to what he was trying to do, but he had to respond. Moreover, he had not known his wife knew about the Melior Movement. "Well," he said, "the Melior Movement is new; and its people are mostly into fleeing. They cannot handle a planet with a population that has a huge impact."

"What do you mean, a huge population?" she asked.

"Earth," he said. He had mentioned a huge impact, not a huge population, but the Earth did have a huge population, although most people did not have much of an impact. He sighed internally and in answer to an unspoken question, spoke again. "Yes, yes," he waved his

hands. “We could reduce the world’s population slowly and gracefully. In two hundred years, we could have a population of only a billion relatively rich people. They could have an impact that is not harmful.

“Melior recommends this. They are right. It’s right.

“The techniques for a gentle population reduction are well known. They have been known for a long time: basically, to reduce population, the poorest women need a better education and more opportunity. To keep a rich, well educated population from dropping too quickly, mothers and fathers need tax-funded support.

“Technically, all this is doable. But it is not the technical, it is not the engineering, it is not the non-human parts of any of this that are impossible. It is that enough powerful people will not support it.

“That is the key. That is what I meant.” He looked at his son again. He wanted to talk about idealism. “You will meet good people, even older people.” He laughed. He remembered the statement, ‘Don’t trust anyone over thirty.’ “There are millions of good people. A few are powerful. But not enough.”

Both Jeffrey and Janice had been paying attention to their parents. Each, independently of the other, swore to find out more about the Melior Movement after dinner. Both had expected their father to say the movement was impractical, which he did, but neither expected him to say also, ‘it’s right.’

After eating, they both searched for and found information. Reading about the Melior Movement kept them busy the whole evening. Jennifer was so surprised, she checked on them. She then reported to Vallen, who said, “Well, your mention certainly got their attention.”

Jeffrey latched onto the Melior Movement’s preferred language, a variation on a much older, but in linguistic terms recently invented, language pronounced ‘lozh-bahn’ and spelled ‘lojban.’ Very early on, he learned that when spelling in roman characters, a ‘`j`’ was pronounced like the ‘`s`’ in ‘`pleasure`’, a ‘`zh`’. It was not like the ‘`d zh`’ sound at the beginning of his own name. A ‘`c`’ was its voiceless counterpart, pronounced like the ‘`sh`’ in ‘`hush`’. He had not known about ‘voiced’ and ‘voiceless’ sounds before; then he learned more. He had no trouble remembering words or grammar. To him, the language was a complex toy.

Janice was more concerned the way people related directly, rather than indirectly through language. She talked with her father. “Dad,” she said, “the Melior Movement’s political ideas make sense. As you said, ‘There are many good people, but not enough are powerful.’ So you have to set up a political system that presumes its rulers will be evil. That was the initial presumption in the United States; but the institutions decayed.”

Vallen nodded; his daughter was much more serious than he expected. He said, "The initial presumption was also that those in government would be better than the common people. In many ways, it was a government by the top quarter or fewer for the top."

"That may be true," Janice said, "I don't know. But think about the people the government was for. Imagine you are in that group. The assumptions you make about family and friends don't help when you design a government. They did not then; they do not now. You cannot presume that strangers who want to rule you will be friendly and honest."

"That is true," Vallen said, hugging her, to the surprise of both. "I rather wish the Melians would succeed, but I don't think they can. Fleeing is their best bet, and I don't see how they can do it."

Chapter 21

Filgard had only met his namesake once. Still, he had met him. He was, after all, a distant relative and namesake. Filgard decided to go to the funeral. For some reason, that seemed important.

At the door of the church, a slightly fat young man asked his name and relationship. The young man was beginning to indicate he did not believe Filgard when a trim, slightly older man came up. Filgard remembered the face faintly.

"Professor Meldon is a distant relative; and he was named after the same ancestor. He is OK." Turning to Filgard, he said, "Detective Derbler at your service." At that point, Filgard remembered. Derbler had been in a class Filgard taught on 'Modern Forensic Technologies.' It was one of the general classes he had to teach. And with that connection, he remembered the man's first name. A double initial, like him and his wife. "David, thank you. It is a sad day." He was starting to choke up at the thought of his wife; but he was not going to say anything. Let anyone who watched think he was upset that his namesake died. "I am going to sit in the back. I feel I ought to be here."

"Yes," said the detective. "And sad news regarding your wife. My condolences." He turned to the young man. "The professor's wife passed away recently. Natural causes. There was not anything to be done, even though she was relatively speaking young. It was not like this death, about which," he turned to Filgard again, "we have no clue."

They moved into the church. "Not even the rifle marks on the bullet — determining that is old technology — combined with the new database of markings helped us. The bullet was shot from a rifle that was part of a shipment of accurate, large bore, single shot, tournament rifles. In the past six years, we have identified two other rifles from the same shipment. They shot bullets used in two other assassinations, in widely different cities. We never found another trace of the rifles, other bullets, or the murderer. The other two victims probably deserved what they got. They had a reputation of being lowlifes. I think our man here was an error."

He looked thoughtful for a moment. "That is why we have prosecutors, juries, and judges. They prevent mistakes. Mostly, of course, we don't make them. And no one cares if we misconvict someone poor. But a fellow like this; we would never have made the mistake. And a rich man, even if we are right, instead of losing his freedom or his life, loses only his money and the time it takes to fight a decision in court. So it all works out. Fortunately, I did not know this Filgard Meldon. As I said, I think his shooting was a mistake. That is hard on the people close to him, but not so hard on the rest of us. Except of course, we know that we live in a world with murderers who are as imperfect as we." Filgard nodded and sat down.

Filgard said to the detective, "The murderer was probably Sanguine, like my wife, except that he didn't make music. He was more like an old-fashioned swordsman, a killer. He liked his tools, practiced shooting so he could hit from a long ways away. He was a sniper. He could understand the rest, but he liked sniping. Not that it is going to do you any good finding him. At least, you know his type.

"We also failed to protect and preserve him. His wife was not prepared. On the other hand, this funeral may provide spiritual sustenance, if nothing else." Derbler raised an eyebrow. "*Protect*, *preserve*, *prepare*, and *provide*: that is what Melians say. My wife and I put up Eltis, their leader, when she comes by. Fairta invented the alliteration. She also came up with *responsibility*, *reliability*, *rigor*, *reason*, and *reality*, five 'Rs.' None of Fairta's sayings are good for finding individuals, but they are good for government. I myself am not planning to join the Melior Movement. For one, I cannot learn another language at my age, but Eltis is not bad."

The detective looked at Filgard, then walked down the side of the sanctuary to a place near the front. Filgard saw the detective turn in his seat and look carefully at all the faces. Filgard did not expect the detective to discover anything. He did not know it, but the detective did not expect anything either. But the job had to be done.

After the service, the widow followed the coffin up the center aisle. Distraught, she was held by a daughter or perhaps she held up the daughter who also looked upset; it was not clear which. The widow noticed Filgard. "Thank you for coming, Professor Meldon," she said. "My Filgard would have liked your being here." Then she walked on. Filgard nearly broke down; and he did not know why.

Chapter 22

Since Filgard had to cook more for himself after his wife died, he paid more attention to his microwave oven. That led him to notice that the engineering laboratory possessed an old, unused, low resolution screen that displayed three dimensionally. It did not require a watcher wear special glasses. It was the same size as the window on his microwave.

With a computer's help, Filgard could display in three dimensions the shape of objects as shown by their various temperatures. Red would be warmer; blue colder. That was the exact opposite of energies in a visual spectrum, but Filgard knew the convention. It came, he thought, because a warming body first peaked in the lower frequencies, the redder frequencies. Also, in so far as ice had a color, it was blue, not red.

Moreover, he knew that there had been a significant drop in the cost and size of transmitters, receivers, and computers that were sensitive and fast enough to determine temperature and to discover what foods were inside a cold container. He did not know when such a system had become cheap enough, but it had.

He planned on displaying at a one millimeter resolution. Nothing would cost much. Filgard remembered his youth and thought of a millimeter as a twenty-fifth of an inch, although by now he was able to imagine millimeters better than fractions of an inch. Filgard knew of computer chips that contained multiple circuits to emulate the neural networks of a biological brain. In addition to having his students write necessary software, he could train the neural net to understand where and how hot items were. To do that, he would have to insert known items into the microwave. That could be done. The training needed to happen only once. Then the information could be copied to another computer. Computers were not like individual people or non-human animals, each of whom had to be taught from scratch.

As for the items with known shapes and measured temperatures — 'Good training,' Filgard thought.

You still could not put metal objects in the microwave.

Chapter 23

Eltis was called by a Gilbert Daveson Hagborn. She had never heard of him before, but a traceback put him in the area she was considering for an Earthly colony, so she let the call through. She was curious. What was going on?

Hagborn showed himself fully, even though most people preferred voice only. Only work collaborators and the like used visuals. He was an older man. He looked prosperous. Also, he was brown, not black, and not white. He did not say anything about his age, prosperity, or ethnicity, but they may have been his messages.

He started by saying, "I was born here. I grew up here. Yet the people who came before me still do not like me.

"I have heard about your starting a colony here." Eltis jerked. 'How had the news got that far?' she wondered. She had just begun to explore the notion.

Hagborn continued speaking, as if he had not seen her surprise. "Local people would like your high technology and your money. We could certainly use better methods from gathering water from the air." He smiled and glinted white teeth. "I would make a lot if you set up an outpost here; not from you directly, but from the people around you getting richer. But on the whole, I am against your coming here. There are two reasons."

That was why he called, Eltis decided. To warn her away. Why?

"First, you will just be another addition to an ethnic mix that is pretty fierce, in a badly destroyed environment."

That was true; it was not the best location; but nobody was going to fight to keep any part of it. From Eltis' point of view, that was an advantage.

"Since the location is not by the sea, you will be dependent on others for imports and exports. If you were by the sea, you could own ships and control them. In peacetime, navies are not much of a bother. But rail and road bridges . . . anybody can blow them."

Eltis had not considered that. She came from a region that had been peaceful for a long time.

"Right now your sponsors are powerful. But I can imagine them becoming weak. Your neighbors will certainly take as much from you as possible for quite a while. But they will not like you, they will never like you, since you are outsiders who are here fundamentally as a military force."

Eltis did not think of her movement as a military force; she would have to think about someone else perceiving them that way.

"Second," Hagborn said, "as far as I can see, you want to set up independent institutions. It looks to me that you think that previous habits and customs have failed, that the interests of the few subordinate the rest. And you think that the only way to institute new ones is to provide new institutions."

That was true. Eltis agreed. That is why she had invented the Melior Movement in the first place.

"Certainly, we are a place that needs new institutions. No one in their right minds would damage this part of the world as much as they have — not unless motivation drove them over that cliff. Mining water, pumping it from aquifers faster than they refill, that is stupid; but that is what people have done.

"But we won't get new institutions, not here. I can assure you that from a long life of experience." Hagborn grinned wryly.

"In so far as you follow the formal law, you won't be able to set up anything independent. That is forbidden. That is not going to change.

"As for the informal, which is how this place is actually run, you can't depend on it. At least, not for the generations you are planning.

"You and your supporters will make sure initially that you are powerful. Your advantage will last a good decade or two; maybe even longer. But over generations, your actual power may well drop. It is possible that power will be gained by the formal government and its formal law; that would screw you. More likely, thugs will continue. Either way, with less power, you will be sunk.

"As I said earlier, I would make a lot of money if you came. Probably, everything would go fine for the rest of my life. But that is not the issue."

He stopped for a moment, saw that Eltis was nodding gently, and went on. "I have a question about language: I understand that only people crazy enough to learn a new language would come here; that makes sense. Most people who are born here want to leave. Only a few of us want to stay, and I am not even sure I want to continue to be one of them." He waved his hand, and the implicit question, away.

"Anyhow," he went on, "I can see the advantage of forcing incomers to learn with equal difficulty, regardless whether they first spoke English or Chinese. But why not adopt the local language? It is strange enough. Not many people speak it any more, but you will have to deal with those who do. Why bring yet another language?"

He seemed to understand that Eltis could not answer him immediately and said, "I have to go now." Eltis nodded, and said, "I will think about this."

After several days mulling over his call, Eltis decided he was right. It would be a bad location. She called and told him that.

Chapter 24

Vallen recognized the name in a magazine story about 'Meldon's Microwave.' He decided to learn more about the man by manufacturing and selling his device. Besides, branching out would be useful.

His corporate superiors sought initiative. They supplied people, about whom they knew much, made non-human resources available, and financed new activities that made sense.

They liked seeing a rising manager work more, too, although one of their tests for success was that the person did not do 'too much.' Vallen had to have a 'life of his own.' That is why his carving was accepted.

After learning more than enough from public sources, seeing recordings of him and learning how he moved, Vallen contacted Filgard by letter. Filgard knew all about the process and suggested Vallen fly out. Filgard did not know that Vallen once paid for an attempt on his life. Vallen remembered before his departure, but during the visit, never thought of it.

Vallen intended to sell the 'Meldon Microwave' more widely than the machines his division made. It was a consumer good, not a manufacturing tool. But he did not plan to sell it with the same low margin as he had previously sold consumer parts. That meant that not only had he to ensure that he controlled the legal mechanisms, patents and copyrights, whereby the governments of lawful countries came to his aid, but he had to make sure that few machines leaked into the lower-priced extra legal trade. He was not going to receive bribes for permitting that kind of sale. By this time, he knew how to prevent production from matching demand; he could keep prices up. At least, he could prevent anyone with less than his skill from agreeing to extra production.

Vallen did think that one of his subordinates was smart enough. He hoped the man — it was another man — would act illegally in a way that only he would discover. That action would make the man more loyal and less likely to become a threat.

Part, but not all of Meldon's Microwave, could be made with spray droplet technology. The rest had to be manufactured and assembled the old way. By spreading the manufacturing around, Vallen could help prevent currency imbalances yet at the same time ensure that no government could gain control of the business. A generation before, everyone had learned about the danger of imbalances. Vallen knew all about organizing everything.

As for funding — Filgard had done the first part of the development, the part that required genius, but Vallen had to fund the part that cost the most money.

Vallen explained to Filgard, "We are going to fund sociological research. I won't refer to it that way to anyone in corporate." He smiled, knowing he was winning Filgard over. "They use the term 'marketing."'

Filgard smiled, too. He thought of Vallen as both smart and friendly.

"We need," said Vallen, "to find how much people want when they say something should be cooked less or more, that is to say, exactly how much is meant by 'less' or 'more.'

"Some buyers will want to cook food a bit less, others a bit more, than the computer suggests. In practice, how much will that involve?"

Filgard looked puzzled. "Don't you already know the answer?" he asked. "Hasn't that been researched?"

"We know in general," said Vallen. "We have known for a very long time. But this is a particular device with particular characteristics. We will start out with what is known and go from there."

"I see," said Filgard. "What kind of interface are you going to use?"

Vallen knew his people did not use the word 'interface' although it defined the human connection. But he ignored that. He knew what Filgard meant and he was talking to him.

"Well," Vallen said, "the machine should tell the user the type of food or drink." He paused for a second, as if he was just thinking about the interface. He had thought about it long before, but was now trying to persuade. He went on, "or maybe not. Maybe we should not tell the user. Or maybe not yet. The microwave may express the wrong name. That would not do us any good. However, based on the chemicals it can detect in addition to water, it can determine the time needed for regular cooking."

Vallen saw massive change resulting from a microwave that determined on its own the type of food or drink inside it. People could try foods they did not know about and would not have to look up their cooking times. Besides the standard items, people could and would try odd ball things.

He figured a tinkerer — a smart tinkerer like Filgard — could add a 3-D temperature display. But determining types of food — that required less genius and more effort. It cost more.

In any event, the temperature display made computer determinations understandable and acceptable. Sometimes the microwave decided wrongly. Somehow, people were more likely to help when they could see the shape of what was contained and its temperature rise.

Vallen stopped talking for a moment. He had thought this through, but did not want to give that impression. "A customer should be able to press any one of five buttons set vertically. The middle button would be labeled 'Done — regular', the next higher button would be labeled

'Done — more' and the highest button labeled 'Done — most.' Lower buttons would be labeled 'Done — less' and 'Done — least."'

He paused again. Filgard waited. "In practice, the word 'done' is not the right word to use for an action not yet done. We will have to think of another."

Filgard laughed, "How about 'cook'?" Vallen laughed, too. "Yes, you are right!"

He went on, "The times for cooking cannot be determined or shown until after the food is put into the microwave and its door closed. Then they should appear."

Vallen could see that it would be better to have the five buttons arranged vertically rather than horizontally. He wondered whether anyone would think about arranging them horizontally. He doubted that.

Five would be a good number. Three would not give enough appearance of choice. Five could be grasped easily by everyone. Vallen remembered references to an ancient study with a name something like 'Seven plus or minus two, the Magic Number.' It was old. Maybe, even, it was from the time when sociology was the proper term, not marketing. He mentioned the study to Filgard, who knew about it.

The engineer said, "Decades have passed since I thought about it. It tells what we can do. An engineer like me cannot keep in mind more than seven or nine items. I think a good physicist can keep more in mind at once. The universe does not follow human constraints. Sometimes you need to think with more variables, sometimes not.

"A very good physicist translates from the large number that he can keep in mind to the five, six, seven, eight, or nine items that his regular readers can keep in mind."

Vallen wondered at the kind of mind that could keep even five physics variables in mind, but he did not talk about that. Instead, he said "In any case, while we can design the microwave with seven buttons, five are enough. Rather than be seen as one vertical column, as eleven buttons might be, the buttons will be seen as five distinct entities. At least they will if we design them right."

Vallen asked, "Do you think the microwave could use a 'Stop and Clear' button, too? On the one hand, it makes the interface more complicated and more expensive. On the other hand, it enables people to make mistakes and correct them." Filgard nodded.

"My hunch is the latter is more important. A 'Stop and Clear' button could go to the right of the column with five choices, be bigger and more squarish."

Vallen wondered outloud. "Should we provide an interface to an electronic timer? Yet more buttons! They cost more! Lower profits! An electronic timer needs a 'Start' button at the bottom, as well as the

ten numbered buttons. When you press a numbered button, the times on the Cook buttons should fade, but not disappear entirely. When someone makes a mistake, press the 'Stop and Clear' button.

"As a practical matter, we know already that most people would not care for a timer; but the 'early adopters' might think it important. I am going ahead of the research, but I suspect our first model has got to have one."

Vallen had not thought of it, nor had Filgard, but the 'marketeers,' as Filgard persisted in calling them, decided that when a 'Cook' button was pressed, the times on the others should get dimmer. The pressed button showed the time remaining, counting down.

After the first success — and it was definitely a success, buyers liked looking at the three-dimensional images slowly changing color — Vallen organized improvements in the interface.

The first model did not name the foods. Determinations used by the computer enabled it to calculate cooking times, but they involved a nomenclature that did not match common language. For example, Chinese food consisted of smaller blocks of substance, such as a vegetable, in another, such as rice. From the machine's point of view, a European stew was nearly the same, smaller blocks of substance in another, with everything mostly made up of water.

But the second model did include a display to list the contents. The receivers were sensitive enough to provide data to the computer. Knowing the contents of sauces, it could decide whether a cube of chicken within something else was Chinese or other. That meant that most of the time, the list would fit human expectations. The microwave did not go wrong, at least, not regularly.

The second model was more expensive to construct than the first, simpler model. For one, the three-dimensional interface that Vallen purchased had too low a resolution for writing. It was not that different from the one that Filgard adopted initially. It was cheap. The new design incorporated a second screen. The two together were cheaper than a single, completely high resolution, three dimensional display. The second screen was not visibly different from the first. Most buyers did not realize there were two different ones. The second screen was not three-dimensional; but it possessed a resolution twelve times higher than the first.

Lines and arrows on and in the three-dimensional screen pointed to the different parts and led to the two-dimensional screen at its right. Part of the design had to make sure that none of the lines crossed each other, that the first line started at the top, the second a little ways down on the right, and so on, that the key item got a border put around it, and around its listing, and that there were no more than five or seven lines (and items) total.

The second screen took up some space from the first, but few people put anything by that wall; and since the first screen displayed three dimensionally, they could look around the second screen. That required a somewhat different three dimensional screen, slightly less wide, which saved money, with a wider viewing angle, which cost more.

Even though Vallen had to pay programmers initially, the incremental cost of the software part of the action was zero; but the extra hardware cost every time. He made considerable extra profit selling the 'more advanced' model. Eventually, he thought, they would market five different designs for Meldon's Microwave.

Chapter 25

Vallen was cheered; Filgard depressed. He was not depressed by his microwave oven. That was working out well. That is why Vallen felt good.

But Filgard had spoken again to George Trumman about the recorder. Developing it bit by bit was still Filgard's main project. He re-designed it to fold, both so it would take up less space when traveling and so it could itself be recorded, not that anyone could reproduce it yet. That would take atom-by-atom duplication. But Filgard was confident that Peter would build such a replicator.

Peter spoke of making an atom-by-atom duplicator as the 'other half' of their project. He had forgot about, or did not talk about, spray droplet devices. They did not assemble atom-by-atom but with much larger clusters. Spray-droplet machines could not replicate computers or food.

Peter pointed out that not only did people want material wealth, but that the recorder and the assembler together could save the world. He was very nearly ready to transition to his own project. Filgard had decided long ago that Peter was smarter and more likely to solve the practical engineering problems than he himself was. Peter could pull together and manage a team, too.

Meanwhile, Filgard and the others kept redoing the recorder. It became simpler for others to use. Essentially, all you had to do was plug it in and insert what you wanted recorded. The coolers all became solid state. It stopped breaking entirely. Besides the cutter and location mechanism, the only moving part came in the blower that moved helium around the object so it cooled more quickly than by radiating into the solid state coolers. You did have to fill up the helium canister every so often.

Filgard remembered Peter pointing out that 'machines for mining, refining, and granulation' could be manufactured cheaply by spray droplet machines, even with their relatively low resolution. Not all their parts could be made, but all their big parts could be.

Unfortunately for Filgard's hopes, Trumman said their manufacture would be forbidden. "The companies that make them do not want to cut their profits. And their costs are not a huge portion of total costs. Moreover, the companies that use them sell enough to law abiding states that they would suffer from boycotts. So extra-legal production is not going to work. No one is going to build solar heaters either, not in this generation. They would compete with the coal-fired heaters that are used to make steam in electric power plants."

Trumman said, "Besides other sources of income, we have investments in coal mines. We are not going to kill that canary. A portion of

our coal is burnt to generate electricity. We do not want competition, which an inexpensive solar heater would be. It could store heat in liquid salt, so electricity could be generated at night or during a storm, not just during a sunny day.

"Also, we have investments in refineries to convert solid coal to liquid. Liquid fuel is convenient. It is used by cars, trucks, and airplanes.

"All the coal goes through big plants, whether it be for generating electricity or for conversion to liquid. That pushes away the environmentalists and global warming people because the big plants can sequester at least some of the carbon dioxide."

"What about burning the liquid in transportation; none of that fossil carbon is sequestered," Filgard said. "Well, we can't do it all," was the response. "As for what we can do, we get a subsidy for putting it into storage that is not likely to leak for at least a century.

"I know, I know," Trumman raised his hands, palm forward, "you are going to tell me that a century is a short time by geological standards. It is. But we are not going to be around in a century. The people then can worry about it. Maybe by then they will have used up the coal and will produce solar heaters instead. Then they can take carbon dioxide out of the air, obtain hydrogen from ocean water, and produce fuel."

Chapter 26

Unlike many, Peter had no trouble at all writing his dissertation and completing graduate school. He was smart and fully committed to his work. Doubtless, the latter was most important, that he worked all the time. He learned information that most considered boring but was useful to have in his head. Technically, he was helped by being smart. Socially, he was helped by being connected to Filgard.

After finishing graduate school, Peter was hired by another university, no more than a few hours drive from Filgard's. It had been established as a technical institution by people who understood what was necessary.

Peter's new project was to create tools to put together molecules and atoms one by one, very quickly, and in parallel. Unlike the vast majority of new people, the university administrators provided him with the funds to hire a team; they wanted and expected him to complete the final steps in what was a generations' long desire.

His and their intent was to create a practical nano-assembler that could work with more substances and be faster than the humans, animals, plants, or bacteria which already created grand patterns.

When he was hired, Peter bought a house in a small town not too far away from the university. He was very proud of it and enjoyed puttering about. The town had once been agricultural and still was, a little. It was on the edge of, but not in a beautiful and popular area. With the collapse in remote land and prices that followed a permanent increase in the cost of energy, Peter came to afford it. Retired people moved there, too.

To many people's surprise, but not to the university administrators who funded him and not to Peter, he and his team succeeded fairly quickly. They built a successful nano-assembler in just over three years. Of course, others had been working on the project for decades.

Peter modestly quoted John of Salisbury, who in the European Middle Ages wrote that "Bernard of Chartres used to say that we are like dwarfs on the shoulders of giants . . ."

Using the same design, Peter's team built another nano-assembler. It, too, could assemble devices like itself as well as other devices. Using Filgard's recorder, they copied the first working assembler, destroying it in the process. They found that the design code from that recording was identical to the one they had invented for the assembler. Using that design code, they manufactured more assemblers, which in turn could manufacture assemblers like itself.

Filgard's machine could record the positions and types of atoms on anything that could be cooled enough. The assembler could construct

it. With the recorder on the one hand, and the assembler on the other, anything that could be frozen could be duplicated.

Peter's team copied, destroyed, and then made two working copies of Meldon's Microwave.

Peter felt proud, although that was not visible to others. Meldon's Recorder could produce data remembering everything humans had built, including old paintings, old and new cosmetics, and modern computer chips. So long as the first instance could be frozen, anything could be manufactured in unlimited amounts with either spray-droplet machines or nano-assemblers or both.

A human could not be duplicated, nor could cats and dogs, nor cows nor horses. They would freeze if they were cooled. Nothing living could be duplicated so long as it depended on warmth. But food could be cooled. It could be frozen to near absolute zero and then recorded. An assembler could then manufacture and heat a duplicate.

And, of course, a design could be stored or transmitted independently.

After his success, Peter considered getting married. He had not yet — he had spent most of his time working; he still did. But now he had completed what he considered the major effort of his life. Also, he finally noticed that he was getting older. As for a potential wife: he could talk with Eltis Akthorn. She was smart enough and close enough in temperament.

His main problem, as he saw it, was that he could never remember the conventions for courtship. As a practical matter, he considered it enough to be able to talk and get along. But that was, he decided, a definition for friendship, too. It never occurred to him to act romantic. He did not think he could act. In any case, if Eltis and he got married, she would have to travel. That would not be bad; he would get a chance to work. Already, he invited her to visit him in her travels; she came.

Peter talked of his nano-assembler as producing an economic shift, but not a new shift. It was, he said to one journalist, Fred Dingle, "an extension of an old shift."

Peter said, "Learning to read and write was never cheap." He went on, "Kids spend years learning. But after you have gained the skill, using that skill is easy. Military systems and law are the same."

Peter did not say anything about text-to-speech and speech-to-text devices. They were making it less and less useful to learn to read. But speech, even fast speech, was only one dimensional. It only became two or three dimensional when people remembered.

That could not be counted on. That is to say, advertisers could not count on people remembering. Designers spoke of 'their targets', using the same language as hunters. Targets that are hit do not remember

well, that was the underlying presumption. Besides, no one remembered the one dimensional advertisements of radio.

In any event, children lacked the power of those who taught them; so they still learned to read.

Dingle wanted to know how military systems and law are the same as learning to read and write. He did not make the connection immediately. Or perhaps he did, but wanted to quote Peter.

"They are all high initial, low incremental cost systems. As a child, or as a late-learning adult, you have to invest time and effort to learn to read and write. Then it costs little to keep up."

Dingle nodded. His audience could follow that.

"The same with a military," said Peter. "To create a strong army is initially expensive. You have to have an appropriate culture. And even if you do, it's still expensive to start right. We are talking about individuals and about society. Individuals have to invest in learning how to be a soldier just as they have to invest in learning to read and write. During that time, others must support them, whether it be parents or government.

"After they lost a war, it took the Spartans several generations to go from being weak to being powerful."

That was good, too. Dingle figured his audience had heard of the Spartans, but did not know much. They would not have known that the Spartans were once weak, although that made sense.

Peter continued, "While they were building up their army, the Spartans had to pay on a promise. That went on for several generations. The Spartans paid hugely. Then they gained power. They could win against their neighbors. They could conquer."

He stopped and grinned fiercely. "When you think, it is horrible. People are maimed and killed by other people. But that is not the issue of high initial and low incremental costs. Once people under you have created a culture for and paid for an army that can conquer your first city, it is not so expensive to conquer the second. Well, it is expensive for the victims, both in the city and in your army who are killed or wounded. But I am presuming that 'you' are at a high level, a ruler of some sort.

"The ability to turn others into dead meat or slaves, that is what gave us the Spartans' current reputation. We think of the ability as a willingness to sacrifice, forgetting its purpose. It was a willingness of superiors, with the connivance of subordinates, to sacrifice young soldiers and victims."

Peter stopped for a moment while Dingle spoke into a microphone. Dingle's computer was converting speech to text; but Dingle had to

indicate which parts of the interview he thought more important and which less. That is what people paid him for, the service of editing.

Dingle looked up and Peter started again. "One problem is that the Spartans had no way of dealing with dishonesty. That is a standard problem in every hierarchical organization with humans in it. By 'they', I mean the Spartans' military as an institution, not ordinary people. But the Spartans' government did learn to withdraw from places where their military became too corrupt. They withdrew from Athens within a generation after they won the Peloponnesian War.

"Our replicators are the same. It cost a fortune to design the first. It took more than a generation. But then it costs little to manufacture more, to make copies."

Vallen read Dingle. The man appeared to select well. Consequently, Vallen heard about the duplication of Meldon's Microwave through him. That caused Vallen to pay more attention, and to gather information from numerous sources. Peter's group never tried to sell any copies that they manufactured, or anything like that. So there was never any direct financial issue.

But the result was evident. Anything Vallen's business could manufacture, Peter could duplicate and manufacture. With Meldon's recorder and Peter's assembler, they could duplicate the computer chips, the memories, and the programming of anything manufactured.

Of course, Vallen and his people were good at catching people's attention. They were good at creating wants. They could advertise. But Vallen knew that a good portion of the profits he depended on came from elsewhere. Some came from patents and copyrights. They came from high prices that required governments prevent competition. Otherwise, Adam Smith's invisible hand would ensure that the greedy would cut prices a little, and gain sales. All would be forced to keep cutting prices until they equaled costs and conventional profits.

Another portion of profits did not depend on governments, but did depend on having a small number of competitors who understood each other and avoided undercutting; the number had to be too few for Adam Smith's invisible hand to have any effect. With too many competitors, someone would undercut, even if they all understood. The invisible hand would take effect. Someone's desire for a short term profit would overcome long term worry. With few, prices could stay high.

Vallen knew that in combination, Peter and Filgard's machines cut any barrier to entry. From his point of view, there would be too many competitors. There would be no difference, except in people's wants, between the lowest quality model that Vallen's group sold and his best. There would be no financial motive for designing anything new. The world would have to return to the old days.

In ancient times, as far as Vallen remembered from university, laws and plays were invented and promulgated by people who did not expect any direct reward. He wondered if that were true. If so, they had to be like Aristotle's aristocrats, who acted because they were big minded not because they were greedy. Vallen figured the result would be some advance, but not much. He did not think there would be enough advance to keep the world afloat.

Vallen believed that his people could continue to grab attention; they had a service to sell. But he wondered whether he would survive.

Vallen decided that Peter should not enable people to manufacture on Earth. In fact, a ban would be virtuous. Besides encouraging progress through financial encouragement — Vallen preferred that kind of phrase to any that used the one syllable word 'greed' — a ban would prevent anyone from releasing the equivalent of a bacterial pathogen, whether intentionally or maliciously. Such a release could destroy part of his environment or even kill him. Parts were already being destroyed anyhow. Vallen figured that no more should be put at risk. Peter had even mentioned the problem in a document that Vallen saw, "This has been discussed and written about for generations."

Vallen was not so sure about manufacture off the planet, off Earth. For one, he did not have any direct connections to space businesses. None competed. From Vallen's point of view, so long as 'Meldon Microwaves' and their equivalents were not imported onto the planet, off-planet manufacture could not matter. And off-planet activities might save the Earth or parts of it.

In particular, Earthly mining would become less necessary, especially energy mining. Rather than pump petroleum, which was still important, although less was produced than before, inexpensive solar electricity could convert air and water into burnable fuels. Vallen thought this would be a good idea. He wondered whether others had thought the same. He did not know that others had had the same thought and had decided, at least for this generation, against inexpensive electricity.

With a few off-planet imports, mainly electricity, Vallen figured, few technologies would change; prices could stay high. In particular, his technologies and prices would not have to change.

Vallen knew how to stop Peter and warn the rest. His previous action had failed, but that was a simple error. Vallen doubted the next murder would fail.

He was right. Peter died instantly when his head was hit by a long distance bullet.

Chapter 27

Filgard was near the boundary of his land. He was preparing more land for a garden when he saw his neighbor, James Bevin, another professor in the university, an astronomer. "Those woods," Filgard said to James, nodding his head at the forest going up behind their land, "will be good for your pigs to root around in."

James did not think Filgard knew much about raising domesticated pigs. "Nowadays, we feed them more on kitchen scraps and the like. Besides, those woods are owned by a logging company. They will be cut down within a few years."

"Cut down!" said Filgard, "How can they do that. In another century, those will be the size of old growth trees, worth more."

"Yes," said James, "but the company has to discount the future. It has to consider the rate of interest on its capital. When a company makes much less money than its competitors, it goes out of business. I am sure that the lesser value of those trees, discounted only ten years, is much more than the greater value of mature trees, discounted a century."

He paused for a moment. "Remember, private companies have got to evaluate their uses of capital. They have got to be efficient." Filgard understood that. He tried always to be efficient.

James went on. "Private companies require a positive rate of interest. It is the major constraint on them. Otherwise, all you will see is waste, waste, waste, rather than just some waste."

"I am seeing a lot of waste now," said Filgard. "That is what the world is like."

"No," said James, "that is a side effect. You want good windows, don't you, a warm house?" He peered at Filgard, who nodded. "Problems come because side effects build and become noticeable. That excludes simple errors, but they can be fixed within a generation or so. For long term errors, the set up must be wrong. Only governments can enforce doing right. Only non-profits that do not use a business rate of interest will do right on their own."

He paused for a moment. "Look," he said, "there are at least two valid rates of interest. One has to do with things that occur within a generation or less or within a human lifetime. That is what business is about and that rate of interest, that discount rate, should be positive.

"What you eat . . ." he nodded towards his pigs, "consider a pork chop; the pig and it won't last long. The soil on which the food to feed the pig is grown, that must last. They are different from each other, not only in the obvious visual sense, but in how humans should consider them.

"I am going to grow more pigs. No individual pig will last very long. I like pork chops! On the other hand, when I feed soil with extra nitrogen and phosphorus, I make sure that the nitrogen and phosphorus are produced in some fashion that can last forever. The pig fits into one category; the soil, its nitrogen and phosphorus . . . they fit into another.

"As for categories concerning rates of interest, the second category — I can only think of two of them, maybe that is all there are — has to do with what I plan to pass on. Soil, added nitrogen and phosphorus, that sort of thing. It is what is set aside for my great-grandchildren and their great-grandchildren." James stopped for a second. He remembered that Filgard did not have any children. But Filgard was not offended. He thought of passing on memes, not genes. James did not know the reason, but he saw that Filgard was not bothered by his language.

"The second rate of interest has to be zero. Otherwise, in a century, in a thousand years, whatever I am valuing loses too much. People who expect equities to grow have the same problem. Interest rates, discount rates, so long as they are positive, they are a way of comparing the values of items over distances of time or space. The further away the item is, the less valuable it is."

Filgard spoke, "New technologies always change prices and procedures; depending on who does the engineering, they change participation, too. Those three 'Ps' — in English, prices, procedures, and participation, who does what, how, and for what reward — we learned those in engineering school. That is how markets and innovation are stifled; you control who does what, that is, who participates, how they do it, that is, their procedures, and what their reward is, that is, their prices."

James ignored the politics. Instead, he looked up and said, "Even at the low rate of two percent per year, the university decided when I came that my being warm would be worth a third less now than then. I don't feel that. Indeed, to me, my being warm, my breathing is worth as much to me now as it was then."

James paused. "Some things, like air, are as valuable to people in the far past or the far future as to people now. And some things, like trees which filter air, are dual-use.

"We need to watch them, that is to say, some of us need to watch what is done with trees."

"Dual-use?" asked Filgard. He had never thought of trees that way.

James said, "Trees' character is just like that of dual-use industrial items, such as chemical plants which make precursors that can be used to make civilian insecticides or military nerve gasses. But it is not that trees can be converted militarily; well, they can be, but that is not the issue. The issue has to do with the far future and the near. Should we say that people in the far future are not worth the cost of them

breathing? That is what a positive rate of interest says, at least for certain items.

"I know that the largest reforestation in the world is taking place in the north east of the United States; it has been going on for decades. That is because most of the land is owned in small lots, relatively speaking, so the trees are not cut. It is expensive to cut a small lot; and the owners do not get much. In other words, the ecology is dependent on a social happenstance."

Filgard recognized a change in topic. He wondered whether or if James would connect this new one with interest rates. Meanwhile, he said, "A single government won't work. What happens when the government is wrong? Besides, most of the world does not pay much attention to any government."

"That's true," said James. "You cannot depend on a single government and over much of the world, hardly anyone follows a government, except as they are compelled." 'Clearly,' thought Filgard, 'James wants to emphasize the idea; that is why he repeats it. What is he getting at?'

"Classical conventions . . ." Filgard did not speak his thoughts about James repeating an idea; instead, he followed James' more overtly. "Classical conventions don't work either. There has been enough change to make whatever worked five, ten, or twenty thousand years ago fail now."

"That's right," said James. "That is why we need multiple non-profit organizations. After all, we are trying to shift the way decisions are made. This is predominately a political move."

"Yes, I see that," said Filgard. "You see a different way for the powerful to decide matters."

"We can depend on at least some of the non-profit organizations being right. Moreover, their income depends, or should depend, on gifts. Their reason for a decision is different than simply that it has a higher rate of return on short term investment."

James went on. "Gifts are never a high enough portion of income to solve the problems that taxes do. Gifts cannot pay for educational transfers, emergency transfers, and old age transfers. But they are or can be high enough to fund many different organizations."

'That,' thought Filgard, 'is his solution, where to generate the ideas.'

James had paused. He spoke again. "We use different parts of our brains to think of these different issues; only different kinds of organization can do the same."

"What about many, many government grants, paid out of taxes?" Filgard asked. "That is a way to fund many different organizations."

"If that can be done competently," said James. "The problem is that in normal times, government programs are even harder to stop than misdirected gifts."

"Hmm . . ." Filgard muttered. He was thinking and did not want interruption. Finally, he spoke. "We do not want a non-profit to last too long, not necessarily. In Europe, the Catholic Church survived Classical civilization and the Medieval period. Regions were shifting into the Modern era, a third civilization. But by that time, the Church had acquired through gifts," he stopped for a moment and then said parenthetically, "(and otherwise, I know, but that is neither here nor there) — by that time, the Church had acquired through gifts," he went on, "a good deal of property, some of it dual use like this forest," he nodded towards the woods, "and some of it primarily good for businesses."

He stopped for a moment, "Well, maybe all land should be valued with a zero interest rate; or soil, or products grown on landed property should be so valued. I don't know. I focus on other things.

"But," he stopped and glared, "at that time, the Church also hindered knowledge gathering. That is no good at all.

"It became a too powerful and a too well-connected non-profit," he said. He looked at James for a moment, and held up his hands, palm forward, just like Trumman.

"I know you are named after a Christian apostle," — James jerked; he thought of himself as named after Scottish kings — "but even so, that hindering was not good, not after the increase in population after the Black Death. In a pre-industrial economy, taxes come from agriculturalists, so governments wanted many peasants or serfs. Otherwise, they were defeated in war. It was not so much the size of the armies that counted, pre-modern armies were small; it was the size of the tax base."

Filgard paused again. He was not glaring so much, but looking thoughtful. "So birth control was punished. Malthus was right. Without legal birth control, without the Black Death, population increases. Even corrupt governments could, if they wanted to, reduce population. But they won't want to. After all, in pre-industrial times, only one group in any technologically reachable region has to become powerful. That group will be the one with the most people.

"That is presuming everything else is equal. Also, the group needs a powerful belief system lest it fail to fight. To succeed in gaining power, it must go against villages in which infanticide is practiced and kill women who know herbs for birth control or abortion.

"In such circumstances, you can only end war and poverty and the suffering that goes with them by learning more. It is morally bad to be against reality, at least if you are against suffering.

"A person can be honest, wise, competent, benevolent and trustworthy, but if he or she lives in illusion, if he or she does not determine reality, then it become impossible to protect, preserve, prepare, or provide, except by accident."

He stopped and grinned at James. "Now you know why I think the various anti-clerical actions over several centuries were helpful." He looked at the forest again, and at the mountains. "We need a millennium in which that land is owned by some organization that values the future as much as the present. You are right, we need organizations with zero interest rates, with long time horizons."

He paused again. "In the old days, I think only a great religion could survive the collapse of a civilization. Well, maybe some beliefs could, too." He thought of Galen and his four temperaments. "But those are beliefs. As for organizations, I don't know of any that could survive besides a religious one. Do you know of any?"

He looked at James, who said, "Disconfirming evidence: medieval universities came into the modern era; at least one ownership cooperative in Sweden still exists . . . I agree, such organizations are rare; and they have changed mightily." He stopped and thought for a moment, then said, "I don't know of any organizations besides religious that have survived two civilizations."

Filgard shifted to another topic. "Either we can go forwards or we can go backwards." Then he remembered that not everyone thought in technological terms and amended himself. "We can either go forwards or backwards technologically."

He continued speaking, "If we go backwards, people will die. Wheat, rice, and corn will become more expensive. The poor, mostly people in third world countries, will suffer more malnutrition and catch illnesses that their immune systems could resist when they ate more.

"On the good side, some distant spots won't need human controllers; they will not need owners. The places will be too distant. That is an advantage of going backwards. We humans have less impact. Life was simpler in the old days." Filgard smiled at the last phrase. 'Life was simpler in the old days,' but probably not as people meant.

"If we go forwards, people may die. That depends. And the impact depends on people's expectations. People do not mind dying at the end of an expected lifetime. They try to avoid it personally, but socially, it doesn't matter.

"Going forwards means that no spot is distant; that is a disadvantage of going forwards." James realized that Filgard was in a lecture mode, but that is how he talked normally.

"Nowadays, every place is controlled by humans, willy-nilly. That spot of mountain is," he pointed towards a bit of forest going up steeply, "even if no hunter or anyone else has walked over it for a very long time.

Private property, ownership, that is just one form of control. Politically, private property means that a larger organization does not need to pay attention, except to see that guides are met."

James interrupted, "But what do we do now?" "I don't know," said Filgard. "I am not a scientist; I cannot discover things. I am an engineer; I do produce what can be used to repair the planet. You . . . you can reveal." Filgard remembered his thoughts about Eltis' speech, that an individual had only the choice of research, repair, or reveal, 'the three Rs.'

"To go further, we need organizations." He smiled at his next remark, "We need zero interest rate organizations, just as you say. I don't know whether they will be enough in quantity or power. There are a few, but I don't know." He looked momentarily at the woods again. "Pity about your pigs," he said.

Chapter 28

When he heard the shot, George Thomas was bird watching. George was old and retired. In addition to bird watching, he was searching for edible wild plants. The shot wasn't loud, but it was distinct. Then silence. The silence startled George more than the shot. There was no sound at all. Then crickets started chirping again and birds singing.

Moments later, George saw someone rapidly walk down a trail away from him. The man — it looked to George like a man — carried a long, thin, wrapped package. He was not close.

It was not yet the season to hunt and George thought the man had been poaching. George said to himself that most likely the man had failed to hit whatever he was aiming at and was now running away. The story fit together. There was a hill up behind. The man had hidden himself in and shot from a good, natural blind which George had discovered on a previous walk.

The blind would be a good place to shoot from except that the only direction to aim was towards the town. 'Well,' George thought to himself, 'that is dangerous.' George favored hunting as such, although he himself did not hunt for larger animals; however, he was against unnecessary danger. 'You could shoot into closer ground, but if you were to miss or aim too high, you could hit someone.' That is what he thought.

George wanted hunters to kill within season. As far as he was concerned, hunting was a kind of harvesting, a foraging. George did not think government officials did a bad job deciding when to hunt, so he was not against their imposition of hunting seasons.

The man vanished at the turn of the trail and then appeared again. There were almost no trees between the two, although they were a good distance apart. It had to be the same man; there were no other people walking on that trail and he was carrying was looked to George like a wrapped rifle.

The man was heading towards a car parked properly by the road. George unlimbered his bird-spotting telescope, focused on the car and found that not only could he draw it, like he could distant birds, he could write down its licence plate number. So he did. As George guessed, the man with the long, thin wrapped package came to the car, looked around, saw no one, unlocked the car, got in, and drove off.

George promptly telephoned a hunting official he had met. "I just saw a man I think was poaching dangerously," he said. "I made a description of his car and wrote down its licence plate number." He described where he was and what he had seen. The hunting official said he would see what he could do. "Don't expect much. We might stop the wrong man. The man might have a legitimate reason for being there

. . . who knows. On the other hand, it was real foolish to be where he was and do what he did. Thank you. As I said, I will see what I can do."

The assassin was dead before George next connected with anyone. He found common mallow on the edge of a pasture. He planned to use it as the base of a soup. He also found wild onions by the side of a stream, and chamomile, from which he intended to make tea. He saw three rare birds, but none to add to his life list and none to draw.

The assassin was Gerald. He had told Vallen a different name this time, and Vallen used it. But Vallen still thought of the man as Gerald, although he suspected that 'Gerald' was fake and knew the new name was.

On the road, Gerald heard that his car was to be stopped — as usual, another crook, again, someone officially in the police department, had sold him the ability to decrypt police messages. Gerald was careful.

Only one policeman came up from behind. That man had heard the description of a car which had passed his speed trap moments before. So he gave up on the speed trap and drove after the car. Its license plate number was the one reported so he turned on his lights and siren. The driver stopped the car and the cop came up. Gerald killed him with a accurate shot to the head. Unlike most crooks, Gerald did not shoot at the man's bulletproof jacket. Gerald did not expect to miss even though he was using a pistol rather than a rifle and even though the policeman was sidling up along the car rather than coming to its door as a normal person. There was no doubt in Gerald's mind that hitting the policeman by what amounted to a padded sledge hammer would slow him; indeed the policeman was somewhat expecting that.

Unfortunately for the policeman, Gerald was not sure that a blow on the chest would stop the man, and Gerald wanted to stop him. Unfortunately for the assassin, as he realized a few moments later, a cop had colleagues. They were upset to see on a transmitted video that one of their own was killed.

In a remarkably short time — Gerald had not even considered going onto another road or leaving the car and then avoiding sniffers — multiple police cars stood across the road in a second block. This time there were eight police. Each was fully armored. In addition to their body jackets, they all wore face masks that were attached in such a way that a wearer could move his or her head, but no bullet could snap a neck.

By chance, an instructor had been taking seven students from the police academy to practice 'advanced traffic management techniques.' They formed the road block. The students were scared. They had learned about road blocks but had never formed one ahead of a someone who had just killed another cop. The instructor was scared, too. He

figured his people would turn into good cops with seasoning, but they had not had enough, yet.

Gerald looked at them all for a moment. He did not realize that he could have killed five or six before he died rather than two. He decided to kill none. He would gain nothing by killing or not killing. Instead, he turned his pistol on himself and committed suicide. Other than that, no one pulled a trigger.

Chapter 29

Filgard was planting in the garden he had prepared earlier. He met James again, who was walking his bounds with two pigs following him, like dogs. 'Perhaps,' Filgard thought, 'they got imprinted on him.'

Filgard asked. James responded, "Yes, that is exactly what happened. Taking them on walks is another matter. But they are old enough and they still think of me as their mother."

Filgard then said, "I have been thinking about your remarks regarding zero and positive interest rates. The notion is helpful."

James answered, looking at Filgard happily, but somewhat sour at the same time. "That may be. But people are not rational." 'That', thought Filgard, 'is why he is somewhat sour.'

"Our whole culture," said James, "appears to be focused on people and organizations that consider only positive interest rates. And our enemies, or some of them," he corrected himself, "besides being against learning, only focus on zero interest rates."

Filgard remembered one of his discussions in that faculty lounge, and said, "We know that people do not think ahead, except for a few. Only those who think a long ways ahead will want zero interest rates."

"But it is dangerous," James said immediately, "to permit only a few to enter government; then the selection process becomes critical. It becomes corrupt. You may end up with a ban on usury, but then you do not have the positive interest rates that are also needed."

James went on. "There are three potentially safe ways to choose leaders, two of which are in use now. One is by state, which is to say, by an ancient region, as in the United Nations General Assembly or the United States Senate; and the second is by units of population, which is the current desire. The third method is by taxes paid. That is not done. Money is important, but most of the rich seek to cut the fees they pay rather than increase their power publicly. In each way candidates can be chosen through votes. Of course, votes can be stolen, voting methods corrupted."

Filgard spoke as if he had not heard. He was still thinking about the earlier issue. "The Melior Movement," he said, "argues that a political leadership needs to set up the rules for business; after all, as you said earlier, you can't do without business. People need shoes, which wear out. You need to produce those shoes with an efficient employment of people and machinery. Otherwise, you are just wasting people's time, whether it be building machinery or making shoes.

"At the same time, a government needs to set up the rules for non-businesses, since people and their children need a decent planet to survive. That is your distinction between entities using a positive rate of interest and entities using a zero rate of interest."

Thinking back on James earlier remark about reforestation in the north east of the United States, he said, "We cannot depend on a social happenstance for safety."

He tipped his head from one side to another. "Some people don't care much for the distant future; they prefer the present. Those are the people who presume positive rates of interest. Others do care. Nonetheless, that gives us only a two-fold distinction, a zero and a positive rate of interest. Galen, Plato, and Aristotle spoke of four human temperaments."

Filgard shifted to the digression, although James did not need to learn that Plato, Aristotle, and Galen lived a long time ago. He was curious about Filgard's attitude towards their lesser degree of knowledge. Filgard did not disappoint.

"Plato, Aristotle, and Galen did not know as much as we do, but that does not mean they weren't smart. To produce their four temperaments, we need another distinction.

"Interestingly," Filgard said, apparently in an aside, "the Melancholic, as Galen called them, definitely care about positive interest rates. They are the people Aristotle called 'Proprietary' and Plato called 'Guardians.' They worry about immediate crises. People with the other three temperaments do not think about interest rates as much." He stopped momentarily and grinned at James, "At least, I think that is a good hypothesis to begin with."

James kept at his own issue. He knew that Filgard was paying attention to him, but not responding right away. Filgard had to follow through a topic deeply. "What leaders will do," James said, "a future action, does not help us much with selecting them, which is a present action."

Filgard seemed to shift to another topic. "People in the Melior Movement speak of four aids for reasoning politically, *protect*, *preserve*, *prepare*, and *provide*." Then he responded directly to James. "Their notion is that everyone should take part in selecting leaders, and they should use those four criteria in making their selection. It is true, what leaders actually do and what they promise to do — those can be different. But when you pay attention, you can tell when a politician breaks a promise. Then you can vote for someone else. So the four aids are useful."

James reverted to Filgard's earlier worry. "What about weighing the future?"

Filgard looked bemused. "It is useful, this distinction between zero and positive rates of interest," he said. "Weighing the future." He had immediately and implicitly thought of weighing in a mathematical sense, of giving items of different ages different weights. He thought of this as similar to a discount or to a positive rate of interest.

"I had not heard of the distinction before you mentioned it, James. It makes considerable sense. Organizations that value with a positive rate of interest care little about the distant future. They discount it. On the other hand, organizations with a zero discount think distant people are as important as people present; they value people we cannot point at, people we cannot imagine, our distant descendants."

James noted that Filgard was bouncing several notions around his mind at once, temperaments, the future, four aids to reasoning, the distinction itself. James was certain Filgard would sort it out eventually.

Meanwhile, Filgard said simply, "I don't know anyone in the Melior Movement who has thought about discounting, about rates of interest. It certainly have never come to my attention. It does not contradict what they have done; it extends it."

James shifted topics a bit. "It sounds like you are becoming a Melian," he said.

James, who had read Thucydides, thought of the Melians as losers. Like their modern namesakes, there were few of them. At the original time, when a part of the Athenians lost their morality, they massacred the men and sold the surviving women and children as slaves. Nonetheless, he listened to Filgard.

"Well," said Filgard, "I like their ideas. I think they are right. But I am too old to learn a new language, so I won't add to any settlement they make. Besides, I don't think they will win."

He went on. "Still, I like Eltis Akthorn, their charismatic leader. She is the woman who is organizing the movement, their euhemerus. I have seen her a few times since Peter's murder. She is like a daughter."

James nodded. Filgard said, "Next time I see her, I am going to speak of zero interest rates and positive interest rates. You are right, we need organizations that think for long periods of time. We need zero interest rates. We also need efficient, everyday organizations. We need both. That means different people in different organizations. Eltis can incorporate the notions into her talks."

James smiled. "You could go into space."

Filgard looked up. "Yes, and if you believe that you can believe anything," he said. "We might as well wish for the moon. So, people have been there. The moon is doable. But it is expensive to go there, too expensive for you or me." He never thought of himself as sufficiently famous. He figured he would be like everyone else.

"As for ideas: is the traditional notion of temperament . . ."

'Ah hah!' thought James. 'He is returning to a topic discussed earlier and then almost forgot.'

"Is the traditional notion of temperament," asked Filgard, "useful either to the people setting up a better place or to the people who might end up living there? Or a more modern notion? I am not sure.

"Your comments about rates of interest, they are useful. Different organizations must evaluate the distant future differently. The notion fails to distinguish types of temperament usefully. It selects only one temperament out of four. It is a descriptor, not a discriminator."

James rocked back. He wondered where Filgard was going. He was following along on his side of their mutual property line as Filgard was slowly planting a row. James was willing to predict that shortly Filgard would decide that planting was boring and spend his time designing a robot to do it. Meanwhile, James was not planting. The two could talk.

"You have mentioned temperaments several times. What do you mean," James asked, "when you said that Galen, Aristotle, and Plato spoke of four human temperaments?"

"Well," said Filgard, "Galen spoke of Sanguine, Melancholic, Choleric, and Phlegmatic temperaments. He lived centuries after Plato and Aristotle. He met the Roman Emperor Marcus Aurelius and became a court physician to him.

"Galen had a false medical theory. He thought that a person's character depended on a balance of his or her bodily fluids. Each of those terms comes from one or other fluid. He was wrong, but his beliefs remained commonplace in Europe for over a thousand years. They outlasted the fall of two civilizations. I suspect that practitioners valued the descriptions of character and did not bother to judge the rest. For one, they lacked the technology. As an example, they did not have microscopes and could not see microbes.

"On the other hand," Filgard brought his eyebrows together, looking puzzled, "they had forests. Forests can get invaded by the visible but small, like caterpillars, as well as by the visible and big, like deer. Caterpillars eat leaves; deer eat bark. Too many and the forest dies. It can also be hurt by fire, which is a non-living danger.

"People are smaller than forests, so just as forests can be harmed by too many caterpillars or too many deer, so could people, except that the human equivalents of caterpillars and deer would not be visible. They would be too small to see. That is analogy; it is based on reasoning, but nothing else. Well, it is also based on observations of forests. In any case, it is a digression. A thousand years ago, no one compared people and forests, at least, not with regard to medicine."

Filgard carried on. "To return to temperament: the much earlier Aristotle evaluated people. He named their temperaments according to the type of pleasure they sought. Thus, the kind of person that Galen called Sanguine, Aristotle called Hedonist. He claimed that people with

that temperament valued sensual pleasure. Plato, for all his idealism, looked at what people did. The Sanguine made beauty."

James nodded and Filgard continued. "The second fluid Galen considered was black bile. Too much was supposed to produce a Melancholic temperament. Aristotle referred to that type as Proprietary, as people who gain pleasure by acquiring material assets. I mentioned them before.

"Those are the people who value positive rates of interest. Nothing is worth much that belongs to distantly future descendants and not to the person. You are saying that much of the world is organized around this notion. You are right.

"Plato called these people Guardians. They guard a city, making both the material it needs and fighting in its army. As Fairta once told me, they work hard and are very necessary for survival.

"According to Galen, the Choleric have too much yellow bile. Aristotle called them Ethical and Plato called them Idealists.

"The fourth type is Phlegmatic. Others often think of them as calm, but that is because they concern themselves with items that are not necessarily practical immediately.

"Aristotle referred to this type as Dialectical, because they enjoy logical investigations. He was one; I'm one; you are one. Eltis is one, although she is different from you or me. She is more likely to harness people and resources than you or I; she is good at coordinating. Me, I am more a teacher. I'm more informative than directive; and I am a good engineer."

He stopped and laughed. "Plato called our type the Rationals, because of our reasoning sensibility. I like the term. It suits me fine; it is what I seek. If you think of Plato himself as an idealist, he picked an ideal name for the likes of you and me."

James saw that they were nearly back to where they started. Filgard had planted the row, turned, and planted back.

Filgard went on. Just as he was planting seeds into the ground, some people would have thought him driving the subject into the ground. Except he was talking of different aspects of it. James saw the discussion as associative, but quite different from the kind that others enjoyed.

Filgard continued to paraphrase Fairta. He had decided that what she said was interesting. He still did not know how true the distinctions were. He said, "According to Fairta, some say that those types are the biggest, but that there are more than four. Temperaments are beneficial, but when a person goes too much one way or the other, he becomes dangerous either to himself or to others. Thus, as Fairta said that the Sanguine are liable to mania when their works and optimism become too much.

"The Sanguine divide people into groups. When you talk of that kind of division, which is good Aristotelian logic, I keep thinking of milk in a cup and milk spilled." Filgard smiled again. "I suspect that when I was a child, I spilled milk, but I don't remember."

James agreed. "I think we all did," he said.

"In any case," Filgard continued, "one distinction is between those who prefer to focus on other people and those who prefer to focus on getting a task done. The first group try to produce harmony within a group. That is very useful. If you do not cooperate, you do not get anywhere. The second group try to produce. That is useful, too. If you do not produce food, you die.

"As a practical matter, people lie on a continuum, some at one end, some at the other, and many in the middle. But let us presume the continuum has been cut; there are two groups, those who prefer harmony and those who prefer utility.

"Then, when you think of another distinction that crosses the first, you end up with four items, or in this case, four temperaments. We talked earlier about the second distinction, between short term and long term thinking."

Actually, Filgard was not sure whether he had discussed it with James or whether he had talked with some one else. So he went into more detail.

"Again. Divide people into two groups. The first group prefer to think of futures less than a year. They are able to think in longer terms, but worry more about immediate uncertainty, like that caused by a flood or an invasion of caterpillars.

"The second group prefer to think further ahead. In any population, few need to think long term. It is costly. Those people do not focus on what needs to be done now. But memories of what happened long ago, like a drought, or thoughts of what might happen in the future, like a flood, that is what they think about and those thoughts are useful. After all, people survive and conditions change."

Filgard stopped for a moment. James was too wise to say anything. Then Filgard went on. "Hah! Maybe I am wrong to think that the old notions won't help."

James was a bit surprised at this statement, but then he realized that Filgard was applying these two distinctions to create the four anciently described temperaments to deal with the issue of usury and its opposite.

Filgard said, "When you apply these two criteria, you end up with the four traditional temperaments, of which only one, the Guardian, actively prefers a positive rate of interest."

He explained, "The first criterion, the one involving harmony and utility, divides people into two groups. The Guardians and Idealists

are on the one hand. They are mainly concerned with getting along with others, one way or another. The second group consists of the Sanguine and Phlegmatic. They are mainly concerned with utility, with production, regardless whether their actions offend anyone.

"As for the second criterion, which involves thinking short term and long term, that puts the Guardians and Sanguine into one group, and the Idealists and Phlegmatic into the other. Guardians think short term, so intrinsically, they must devalue the distant future. So they must prefer a positive rate of interest. The Artisans also think short term, but they focus on whether something produces. So if it is shown that positive rates of interest are not helpful, they won't have them.

"They are more neutral. They are also fewer of them compared to Guardians. However, Melanchois and the Sanguine together make up more than half a population. Moreover, the Melancholic, that is to say, the Guardians, are much more likely than the Sanguine to work within traditions, institutions, and organizations, although like Fairta, they can. The Guardians shape. Positive interest rates will predominate. The other two types, the Idealists and the Rationals, are much more dreamy."

"Yes," said James. "I can even visualize a mandala. Guardians are in the upper left and Idealists in the upper right. Both seek harmony. The Sanguine are in the lower left and the Phlegmatic in the lower right. Both seek utility.

"Or you can divide the mandala left and right, like black and white. On the left side are people who plan ahead as far as they can practically, which is not very far. On the right are people who ignore immediate plans but consider distances. It all makes sense. But is it real?

"In any case," James said, "two time horizons may not be enough. You are just talking short term and long term; you may need a third. For example, I have heard economists say that for the short term, by which they mean less than three years, fluctuations in unemployment, demand, and capacity are more important. In the middle term, three to eight years, fluctuations in the composition of demand become more important, and in the long term, technology becomes important since the technology a society has implimented defines its productive capacity."

"With three time horizons, thinking becomes complex," said Filgard. "The great advantage of two is that people can remember them readily. Moreover, they fit into this mandala of four."

"Are you saying that we should shift our explanations according to the human capacities of those who can only think two or four items at once?" asked James.

"Yes," said Filgard. "The notion is not about the natural world. That may indeed be complex. The goal is to help people decide which action to take.

"On a different subject, but using two divided in half, four total, Fairta proposed a connection between four Galenic temperaments and Fiske's notion of social structure, that people perceive and organize everything according to categorical, ordinal, interval, and ratio scales. Whether . . . "

"Yes, yes," said James, "whether you are in or out of prison; whether you are equal to, below, or above another; whether you can cooperate with others in some way; and whether you can talk about interest rates with them . . . That is all straight forward."

"What?" asked Filgard. "It is mathematics," said James, "a categorical scale is based on an equivalence relation, whether you are free or not, whether you spilled water out of a cup; an ordinal scale is based on a linear ordering, whether you or your division manager is more powerful — Fairta talked about social structures, right? A university like ours only partially fits a linear ordering. Our social structure is much more complex.

"An interval scale is based on an ordered Abelian group. There is a famous 19th century French statement about equality under the law, which is what an ordered Abelian group or interval scale is about:

'. . . anyone may sleep under a bridge, whether rich or poor.'

"A ratio scale is based on an Archimedean ordered field. That determines whether you can compare an apple and an orange or a house and a bridge. Those two fruits or edifices are in different categories. One is not necessarily better than the other; an ordered scale fails. They don't necessarily share much, so an interval scale fails. Only a ratio scale succeeds. The mathematics is very common. It just needs to be translated into social terms. What evidence do you have?"

"The mathematics is not common in my world." "Yes, it is," said James, "but it may not be much expressed. It is the basis for elementary arithmetic, what an entity is and how one number relates to others; that gives us the first two. Then we have two kinds of operator, addition (and subtraction, which goes with it) and multiplication (and division, which goes with multiplication). That gives us four."

"Oh," said Filgard. "I don't remember whether I ever learned that. It is certainly not talked about much."

"I don't remember anyone talking about it in my field. But it is obvious, is it not?" asked James.

"Only if you are a widely educated Rational," said Filgard. "I am a Rational, and well educated, but not widely enough. I don't know whether anyone else will care."

"You said Fairta brought this up," said James. "She was not a Rational."

"No," said Filgard, "but I think she was trying to please me and Eltis; and she knew how to do that, how to get us mulling over an idea."

"That may well be true. But what, if any, are the implications?" James asked.

"A category," said Filgard, "can expand or contract. Socially, when you are entering an uninhabited area, it makes sense to expand the category of 'friend', since anyone you do meet is likely to help. But if you are entering an inhabited or contracting area, anyone you meet is likely to resist your taking their place.

"This has immediate political implications, since the planet may collapse or contract; but outer space, as far was we know, is empty of sentients. So if we want to be friendly, we have head for the 'new frontier' as U. S. President Kennedy called it; otherwise, we will have to fight. The choice is political, whether fighting or friendship."

James almost laughed. "So you are getting into politics in your old age. You are right, the choice is whether to be a warrior or a diplomat. I don't know whether you need this rigmarole about temperaments and social structures to say that." James sobered. "Also," he said, "you are saying that going backwards may be dangerous, not only to others, but to us."

He noted that Filgard had dodged his questions about evidence, whether his mandala had any basis. But he did not say anything. Was Filgard beginning to accept beliefs that might not be true? The man had been very different since Fairta died. James wondered. Filgard raised his head and gazed in the distance. James decided that in any event, he was a dreamer who had accomplished much.

'Nonetheless,' James went away asking himself, 'in his own mind, does Filgard think he has accomplished enough?'

Chapter 30

Filgard spoke at Peter's funeral. He asked himself why Peter's middle name, *Antor* lacked an *h*; it was not 'Ant*h*or' but 'Peter Antor Dev.' He never did find out.

Filgard found it very easy to say good things about Peter. He had been a good graduate student and a good man. Since then he had done well, both for himself and for the world.

Eltis Akthorn came to the funeral. That surprised Filgard. He did not think she paid any attention. Moreover, she was more somber than he expected. He was not as unhappy as she, even though she was relatively a stranger.

She came up to him after the service. "This is a very sad time." She blinked back tears. "He is gone. I liked him.

"And I don't think we are going to win. The powers that be are too powerful. We cannot have more people murdered. We have not grown so much that individuals do not matter."

Filgard was not sure whether she was more upset at Peter's death or at her movement losing. She was reserved. Filgard realized he was, too. Besides that, he caught a sense of failure. She spoke about the movement, except that by now, she was starting to pronounce it with a capital '`M`'. Clearly, it was on her mind.

"The best we can do," she said, "is become a cult or equivalent. That means as an organization we can expect to go corrupt after a few generations. Look at 20th century Israel. It started as a series of small, optimistic, cooperative endeavors in a bleak territory; it grew. It was decent. That is how it looks to me. And then over several generations, it became a garrison state.

"Well, at least, we should pick a location where our neighbors like us. Unfortunately there are even fewer places with low populations now than there were at the beginning of the 20th century."

Filgard also did not want to think about Peter's death, so he welcomed Eltis' remarks. He protested briefly. "The Zionists did not have much choice of where to go. Others did. They left Europe and spread around the world."

"Well," said Eltis, "Palestine was not heavily populated at the beginning of the 20th century; and in any case, we do have a choice of where to go.

"Fortunately — and this is about the only good news — more and more people will want the drugs which can be inexpensively manufactured with Peter's nano-technological assemblers. They will want other inexpensive products from the spray-droplet replicators. We will have something to provide. If an ecological collapse comes, we can help even more.

"So we can start some place."

She stopped for a moment, then went on, "With your recorder, with spray-droplet replicators, and with Peter's nano-assemblers, we can provide people with their material needs without destroying the environment."

Filgard noted that that was exactly what Peter had said.

"Besides the technology, we have decent political notions. We have aids for reasoning politically, *protect*, *preserve*, *prepare*, and *provide*."

Filgard nodded. He remembered. The Melior Movement did talk of them. Eltis went on, "Of course, we will have to pay continuing license fees for what we manufacture; the governments that support high prices will see to that. Otherwise, Peter will have lived his life truly in vain." Both Eltis and Filgard wanted to distance themselves from Peter's death, but his work returned to remind them. Still, Eltis was able to shift away a bit.

"Worse, governments' support of high prices is becoming the major way for them to fund research. High prices do not appear on their budgets; and only those who have to pay buy. It looks like a good scheme. Off budget, only those who desire pay ... (Of course," she said parenthetically, and Filgard realized it was not possible for her to stop being a politician of a certain sort, "they never consider what must be bought to live a conventional, middle class life, which is what most people want.)"

He nodded again, and listened to her. "It goes without saying that less and less research is done. The powerful gain income from the high prices that others pay. They live better when governments or the corporations they control take the money rather than spend it on scientists and engineers.

"But we can probably extract enough basic resources. Those are not licensed. We can sell them. We can pay licensing fees. In any case, our negotiating position will be powerful; rulers are scared of the possibility that we will develop weapons.

"A better language and a better numerical system are only possible if people are reborn and if we can modify the data packets of dead people. We do not have the technology for doing that yet, although it is getting closer. Tuppak Nassik is working on it. We need to be able to put the language and numerical system into the data. Then the reborn can learn."

Filgard did not know about Nassik's work. He believed that Eltis intended to speak of hopes for very far future as a way of avoiding any conversation about Peter. Since he did not want to consider Peter either, he went along.

Eltis said, "While we are at it, if we can modify people's data packets, we can provide everyone with formal aids to judgment." She smiled, "I

mean information on certainty factors, on insurance, on how to judge the likelihood of a one-time-only event, on how to assign priorities to a long list of items, and on how to multiply many differently weighed factors together. Adults do not want to learn anything."

He spoke out, "That is not true. I am an adult; I like to learn. You do, too."

"Well, I mean many adults do not want to learn. But grown ups can learn. After all, immigrants expect to learn a new language. But adult immigrants have a hard time."

She considered everything again, then said, "As for people to whom we will be highly attractive: their governments will not permit anyone to tell them about us; they will censor what we have to say. And they will forbid travel to those who do find out. As for the rest, I do not know how attractive we are. I don't think we are much. Those people live well enough already. We shouldn't raise much of a barrier against them."

Filgard felt he was in that category. He lived pretty well. He did not want to learn a new language.

Unfortunately for Filgard, Eltis talked again about language. "It makes sense to learn a common language. That is necessary. Otherwise, we cannot mix peoples." Filgard agreed with the need; he did not like Eltis' conclusion: "Immigrants will have to learn a new language."

Filgard figured that would keep him out, although he did not tell Eltis.

She went on, "As for learning formal aids to judgement? Who cares besides you and me and people like Peter? Even if the Movement attracts a higher portion of people like us, it won't be everybody. Maybe the notions can be embedded in language lessons. But learning a different numerical system? That is more difficult. At least I think it is.

"In any event, I am not certain that powerful governments will permit us to start anything new, even if we pay them. The people in them do not like uncertainty. They hardly ever think of non-human issues, which is why they don't deal with them on a timely basis. That cause of uncertainty is invisible to them. But we are human. It is easy to see what we will do, and we also produce uncertainty."

She concluded, "The future looks bleak."

Chapter 31

Shortly after Peter's funeral, Eltis and others in the Melior Movement found themselves considering an off planet colony, a colony in the solar system. They would set themselves up in an O'Neil habitat.

With cheap mechanisms to build the mirrors, with Peter's nano-assembler to provide the computers, they could melt and spin a nickel-iron planetoid, and put an air bubble into it. They could shape a solid two kilometer planetoid into a cylinder wider than tall, ten kilometers across. It would be naturally stable.

Melting that big a hunk of metal would be impossible on Earth. It would be impossible in space without replicators to build big enough mirrors. But with them, it could be done. With a skin fifteen meters thick, a hollow habitat could hold an atmosphere and shield its inhabitants.

Because of its gyroscopic stability, and because it would not be orbiting a not-quite-spherical body like the Earth, the spinning habitat would always point the same way. However, Eltis thought, a main mirror could precess or turn enough to collect light throughout the year and reflect it to one end of the habitat. Eltis wanted, and everyone else agreed, that a habitat should require the least amount of maintenance possible. Ideally, it would be like Earth before humans.

A dozen such habitats might be enough for the Melians.

One or two might fail, but probabilistically speaking, a dozen would not vanish at once, not naturally. Nonetheless, they would be vulnerable to people. Suppose an enemy snuck bioweapons inside, or detonated nuclear weapons by the mirrors?

That vulnerability killed the idea.

Chapter 32

While walking on the beach, Vallen noticed a thicker log. He picked it up. When he got home, he started carving a bust. It did not have arms or legs and its head was wider than the palm of his hand. The carving made its face serious, but not unhappily so.

The bust was not of anyone Vallen knew. Still, no one could mistake its humanity, even though its expression was a more extreme than displayed publicly by any of Vallen's friends or colleagues.

After finding several more thick logs and carving more busts, he noticed that he had stopped carving warriors. He realized he was cheered by Peter's death. That is what he had wanted and that is what he got.

It increased his confidence. He specified pay rates with more vigor, so his actions were challenged less. It particular, he told his human resources people to offer less. The fight against was not very strong.

Vallen despised the people he had hired for handling employment. For one, they referred to themselves as 'human resource' people. Vallen thought that was most likely because they treated otherwise decent people as if they were rocks or other kinds of non-human resource.

Still, he was not going to fight them, even though he knew he could get more product from his employees by better management. It was not even that he would lose by fighting them and leading everyone. Very good management was too idealistic, but better management was doable. Better management meant higher efficiency, which meant more profit. With more profit came more rewards, both for them and for him. The other way meant lower efficiency, but lower costs; he paid less. That meant more profit, too, with rewards for him.

Vallen was confident that the assassin, Gerald, had not left any traces that could be detected. Consequently, he thought there was little chance that any search would reach him. He need not and did not do anything. Peter was dead. Because Gerald was not around to ask for the remainder, the assassination cost Vallen only half what he expected.

Complex Tools was doing well; so was Meldon's Microwave. So was Vallen's home life. All and all, Vallen felt fine.

Chapter 33

The first test of rebirth was on a dying, but knowledgeable Tuppak Nassik. He had invented the plan he was going to use. Tuppak told the rest of his team, "I am going to die forever if we don't do this. That means you may be out of a job. If we do this, either it fails, and I die, which I will do anyhow, or it succeeds, in which case I do not die. I developed the scheme. I can try it. But let us not make this public. Among other reasons, it is illegal."

He did not say that technically, it was suicide, not murder. He himself had carefully programmed the computer to freeze him. The others were accessories. He figured, if it came to court, being an accessory to suicide was not as dangerous as being an accessory to murder. But he hoped, and he thought most likely, his people would never enter a court.

He kept on speaking, "In any case, it will be months before you discover whether I am reborn like myself or not."

He paused to catch his breath. He was not well. "I have been against pictures of me for a long time — that was a useful anti-social activity. Had photographs been taken, people could see how old I am; but they haven't. And, as far as I know, most video surveillance views of me are erased after thirty days. I don't think many recent views exist. So if we are successful few will be surprised at the visible age change."

Tuppak Nassik's scheme was to put a person to sleep, put them into suspended animation which enabled the body to be cooled to just above freezing, then put the body into a tank and raise its pressure dramatically — all these were known techniques — and then freeze the body suddenly and deeply. The very high pressure in the tank would counter expansion.

Tuppak knew that freezing would kill him, unlike the anesthesia, suspended animation, cooling, and pressurization. The liquid helium would cool his body to just above absolute zero.

Then Meldon's recorder would be used to record him exactly. In the process, his body would be destroyed. Tuppak would become dead in a second way.

Then, the brain patterns recorded by Meldon's machine would be impressed on a near clone of Tuppak. It had once been thought that such an impression had to occur as the brain grew, but Tuppak figured out a different way. He and his team also figured out how to force such a body to grow rapidly.

The force-grown body was called a clone, although it differed from him. Instead of being a twin, the methods with which it was grown had prevented its brain from developing normally. That took quite a bit of doing.

Even though he speeded its growth, Tuppak had taken years to grow his first brainless clone. Now it was at the equivalent of a physical age just past adolescence. To appear older, he was going to have to wear makeup. He would have liked to wait longer and perhaps use a different clone, but he was dying and lacked the time.

So he conducted the experiment. His body was frozen and destroyed. It took ten months to impress his brain design into the clone. During that whole time, no one knew what would be the result. The clone never woke.

Tuppak had directed that his data packet be copied and saved. He directed that if the first experiment failed, his group should try again, even if he woke up and became conscious before dying. Potentially, he was willing to suffer a great deal.

Fortunately, the first experiment succeeded, although when Tuppak first awoke, he said, "Everything is out of focus." Worse, he could not walk, but stumbled. He said he felt weird pains and other feelings. But he was alive and ready for tests. Not to him, but to others' surprise, he got better after about a month. He could focus, he could walk, he did not have pains. Tests indicated no more mental deficit. It was not necessary to replicate the effort on another body.

Indeed, after six weeks Tuppak said that "This body is better than my last one. It's taller. During its growth, even though we forced it, we gave it good nutrients. It had a better time during its development than I did."

He smiled. "We can do it, we can enable people to be reborn," he said. "But the process is not comfortable, not at all. Waking is bad. We can get rid of the imaginary pains and other such feelings; they come from mis-connections we can fix. But people are going to have to come awake. They will have to open their eyes to relearn to focus; they will have to walk to relearn to walk; they will have to think to relearn to think. There is no way to avoid being awake. If I can help it, I am not going to do this again for years."

Others had suffered a great deal more than he, but Tuppak thought of himself and people like him. He did not like rebirth. He converted his other clones into more general chemicals. Neither he nor anyone in his group thought of them as human; they showed no mental activity at all.

The chief of another group was reborn next. In a sense it was competing. Gelson Farbanks had spent time designing inorganic, computer substrates for humans to upload to. All looked promising; none worked. He had been growing a brain-dead clone for the past seven years. "Just in case," he said. "Well, my case has come." Gelson had started the clone at the same time as Tuppak. There was always the question of

how he had learned to make the clone brainless, that is to say, without a brain that grew normally.

In theory, he could have succeeded had he started at just the time Tuppak made the explanation public. But it would have been easier had he started earlier. In any event, Tuppak did not investigate. Gelson's clone was not as forced as Tuppak's and was younger, a physical age in its teens.

Gelson was not as old as Tuppak but his arthritis was worse. None of his treatments had succeeded. He was different than most in some unknown way.

So Gelson said to Tuppak, "I'll adopt your plans. I will be cooperative. I cannot stand this body." Like the first, that transfer went right. Moreover, Tuppak had learned. Gelson did not suffer imaginary pains and other strange feelings. Initially, he did see badly and could not walk or think well. Under Tuppak's supervision, he got better quickly. It took Gelson only three weeks to say that he preferred his new body to his old. But he also said that the experience was worse than he expected. "Had I known, I would have put up with the arthritis a few more years. I am happier now, but I do not like the suffering I went through.

"Also," he said, "people should not get reborn into bodies as young as this. It is not simply the sociological problems of being seen as young. That is a bother, but I can cope with it. Mainly, I wear makeup. Physically, however, I feel like an awkward adolescent. It would be much better to be reborn into the mid-twenties or even older. In any case, that is not an immediate issue. No one else has anything growing."

It was another two years before another forced growth body reached an apparent age in its early twenties, not as old as Gelson liked or Tuppak wanted, but old enough. By that time, forcing sped up growth eleven times.

The whole process was expensive, unpleasant, and secret. Only Tuppak's group could provide rebirth. Besides governments, only two groups, Tuppak's and Gelson's, knew of them. Initially, Tuppak's team could only handle a few. They did not want more applicants until they had more experience. And governments did not want to talk about indefinite longevity at all. They had enough problems.

('For once,' Tuppak thought, 'people in governments named the process accurately.' No one called the process 'immortality' because people could die. But people could live longer, hence the word 'longevity.' But no one could predict how long the reborn might live. That vagueness required a modifier; hence the word 'indefinite.')

A combination of censorship and many unbelieved stories prevented the spread of a knowledge that someone might act on. Most people who heard about it considered rebirth a modern myth. The only men

and women who were reborn were individuals already known by several people in one or other of the two organizations. As a practical matter, that meant the few hundred reborn were old and knowledgeable. They helped as much as they could, both before and after their rebirths. Most were scientists or engineers.

The one hundred seventh rebirth was not. The woman died forever. The recording seemed right, but could not impress her new body. A copy was kept and tried to impress a second brain; that, too failed. A third failed as well. At that point, although a copy was kept of the dead data packet, no more attempts were made.

In the first four hundred attempts, that was the only full failure. Several others had not 'caught' the first time, but the reasons were discovered and acted upon. The two groups sharply reduced the time needed for impression. It took Tuppak ten months. By the two hundredth rebirth, the time was reduced to ten days.

The post-rebirth got better, too. But it still stayed unpleasant. The two teams invented a whole new caregiver specialty.

Also, round about the two hundred and fiftieth rebirth, computers became able to modify the dead data packets so the reborn people would know more than before. At first, not much was done; the process was considered dangerous. But an aging computer expert, John Diddle, said, "Provide me with the vocabulary and grammar for a language I do not know. We can be pretty sure what parts of my brain have real memories and what parts do not. Test me now, and test me afterwards. See what I have forgot. And see what I have gained."

It Diddle's case, it turned out that he lost part of his memory of life in his thirties. "Fortunately," he said, "I do not think much about that time. So losing those memories is not terrible. I am much happier to have learned Urdu without the effort." The computer knew what had been written over. Since it could recognize the pattern, the next person with dramatically added memories suffered much less. The process was detailed; and only a computer could see the patterns. Nonetheless, it became less and less dangerous.

Eltis Akthorn, who knew Tuppak from before and knew about his actions — she was not part of either group or in any government, but knew anyhow — started to think that maybe she and enough others could migrate to a planet on another star.

Chapter 34

Not long after she joined the Melior Movement, Gammae Uttles found that a company, MindWithin, offered her an opportunity to experience a newly developed user interface. It was designed to put images and sounds directly into her head — to excite those neurons and just those neurons necessary for vision and sound. Gammae knew how difficult the process was.

At the beginning, the people from MindWithin referred to her as 'Mary Uttles' but shifted to 'Gammay Uttles' as soon as she told them she had changed her name, and wrote with her spelling 'Gammae' when she told them of that.

Her contact from MindWithin said, "We hope you will talk with others of this experience. We expect you will like it. There is no obligation on you; we expect you will want to talk. If you find problems, please tell our engineers as well as your friends. We don't expect problems, but there might be." In effect, Gammae was being treated as an 'opinion leader.' The public relations people in MindWithin had decided that after she had joined the Melior Movement she would be talking with many people. Not only was she technically competent, which the engineers insisted she be, she helped and guarded others, as the relations people wanted. Gammae focused on psychology and medicine.

In effect, Gammae became part of a focus group that the company could not otherwise obtain, a focus group that could provide technical help as well as sympathy with any problems that came up.

At first, Gammae thought the company was smart; only later, she understood that the technique had to be old. Still, it appealed to her.

The company was not in a building near the center of the city; it was in an old building on the outskirts. The difficulty and expense of finding and getting the place would have stopped her, except that a car came to pick her up. Although it was small, it had comfortable and spacious rear seating. Her escort was female and the driver male. After introducing both of them, her escort was smart enough to avoid talking and let Gammae enjoy the process.

Gammae thought the building itself was ugly. She said to her escort as they walked in, "The energy-conservation retrofittings make it look better." The escort laughed.

Inside, a man with no jacket and no tie took her into a central room. Her escort followed and managed to ask her whether she wanted to wash up first, and how she would like coffee. The chief engineer, for that is who he was, looked crestfallen. He had forgot the niceties. Gammae said she would like coffee with milk and no sugar, she did not want to wash up, and she did want to try the interface. She smiled at the engineer.

On trying it, Gammae decided that the device was amazing. She would talk about it. She saw images and heard sounds that appeared to come from outside her. It impressed her no end. She told the engineer that. She described her medical background and said that she understood how difficult it was to trigger the right neurons from outside. She said, "Most people will not know the difficulties and will only see the problems they experience. But a few will understand; and I am one of them! You have done a wonderful job!"

The machine consisted of a helmut connected to a large box through a fiber optic cable. The helmut was fairly heavy. She remarked on this and an engineer said the next model would be lighter.

The escort said that this instance was very expensive. She even suggested an estimated retail price for the first model sold. It would be expensive. Gammae did not think she would ever be rich enough.

Her escort said that the company hoped to describe the interface with the terms MindSee and MindHear. Gammae said she thought those terms were inaccurate. Everyone frowned. She was looking at reality and then at images the machine created. She said, "The interface is better than those words suggest." The engineers smiled. The escort looked puzzled. "In a sense, the interface is too good," Gammae said.

"I can see artificially, that is true. I see objects as if they are a part of the real world. I hear sounds as of they come from outside. I like it." This made the engineers happy.

But then she said, "Other than by consistency and knowledge, I cannot determine whether an image of a table is produced by the helmut or produced by reality. That is disturbing." The comment perplexed the engineers, all but the chief engineer. The escort sighed, not loudly.

"I fear," Gammae said, "that the helmut will be dangerous in the wrong hands. Or that people will become solipsists."

Then she realized that she was wearing an experimental device that put images in her head; she feared for herself. 'What,' she thought to herself, 'if an image kept coming, even after I took off the helmut, and I could not tell it from reality?' She did not say anything outloud. The session was coming to an end anyhow.

An engineer turned off the machine and another lifted the helmut from her head. Reality returned, somewhat dull reality, she decided. She said that and the chief engineer said, "Yes, others have claimed the same. I suspect it is because you try to be alert when you first wear it. Several engineers, including me, have worn this many times." He shook his head side to side. "We don't feel it."

No image or sound kept after her, either. In that sense, the helmut was safe. It did not create images or sounds that overloaded her brain. The engineers who built it did worry about that and made sure there never was a problem.

As for the hands who might handle it afterwards, the chief engineer said, "I presume that none will attack me or my friends. Our government is safe. Foreign governments — I am not so sure about them. Many do depend on intimidating people. That is what torture is about. They have the money, too. It is not simply that if we don't do it, someone else will; it is that someone else will build it even as we build it. My refusing to work on this — it might be good for my soul, but it would have no effect on the world whatsoever. And it is an interesting challenge. That is why I work on it; and I presume that is why the others here do, too."

The escort said nothing; she simply shrugged and opened her hands wide.

On the way back to Gammae's apartment, she asked Gammae whether the Melior Movement might be interested. Gammae said, "That is a strong possibility. We would like at least one."

Gammae realized that MindWithin had still not seen the implications of Filgard Meldon's recorder and Peter Duv's nano-assembler. The senior people in the company presumed that you could not combine the recorder and the assembler, even though that had already been done. They did not think of copying and recopying a complex device cheaply, such as their helmut.

The Melior Movement needed copy only one and produce a duplicate. Then it could produce as many more as it wanted. Gammae knew it could easily afford to pay for the one.

Gammae did not imagine that on Melior, reborn people would have the appropriate devices built in to their heads and not need anything external.

Chapter 35

In another trip to the general faculty lounge — Filgard realized that he was spending even more time there than he thought— he saw Donald Tull again.

He nearly shouted, "Just the man I want to see." Tull wished he were somewhere else; he was trying to avoid Filgard. The man insisted on being scholarly. But Filgard was unavoidable. 'Fortunately,' Tull could see, 'no one else thinks I am the person who shouted.' Moreover, Filgard quieted down. "You know the history of business, right?" "Yes," said Tull. He wondered how Filgard had come upon the information. "At least, in the latter 19th century."

"That is what I want," said Filgard. "My sense is that if you owned a then-modern steel plant, you had to pay for building the plant, which was quite a bit, and you had to pay to keep skilled workers regardless of whether you produced steel. So your costs of doing nothing were quite high. When you produced steel, you paid for the materials used and maybe for more employees. In any case, your cost of production, your supply curve, may not have been a vertical cliff, but it did fall and then rise steeply."

"Yes," said Tull, "your lowest cost per ton was to produce the amount the steel plant was designed for."

"That is what I thought," said Filgard. "In practice, a country possessed a bunch of plants. There was an industry. It had a more horizontal cost curve. Nonetheless, the curve dropped down fairly steeply, until reaching a limit, then it rose very steeply. Right?"

"Yes," said Tull, "I don't see your point."

"Replicators are not like that," said Filgard, completely unbothered by Tull's last remark. "I mean, non-organic, fast replicators whose production and reproduction is not hindered by social constraints like patents." Tull did not think of a patent as a social constraint, he thought of it as a natural right of ownership, but he was not going to argue the point.

"Replicators," said Filgard, "do not cost much to produce, not even ones using spray-droplet technology, not after the first one. Spray-droplet machines cannot replicate entirely. Its computer and memory has to be built in some other way. That is what directs it. But its brain, as you might call it, is built in a high initial cost, low incremental cost fabrication plant, like steel in the latter 19th century. Peter Dev's nano-assembler can make computers; it is slower than a spray-droplet machine, but it can do everything."

"I can see that," said Tull.

"Non-organic replicators are like old-fashioned organic replicators, like wheat or rice. In 1800, seeds did not cost a farmer; he just stored

part of his crop over winter. More food could be produced by working on the edges or margins of good land — that is how economists came to the phrase 'marginal cost' in place of 'incremental cost.' I guess 'incremental' is more a mathematicians' term . . ." Tull looked obviously disbelieving, and Filgard added, "or just a part of the language."

Filgard stopped for a moment, then he continued, "My point is that modern, non-organic replicators lack the same natural constraints that old-fashioned seeds have. Modern replicators' 'supply curve' stays low longer. The modern replicators, besides being faster than the old, can keep producing. They aren't as limited in their environments as organic replicators. They can reproduce in a desert. Plants can't, not easily. Eventually modern replicators will produce so much that they will run into the problems induced by feedback in a finite system: a nano-assembler can produce more of itself and more houses, or what ever people want, until the planet is destroyed. A spray-droplet machine can't do as much. But with mining machines and semi-conductor plants, it can do horrendous damage."

Tull nodded.

"That means social control mechanisms must deal with feedback from the system, from the planet, not simply from the producer himself.

"Prices from markets will not provide good signals unless significant members of the market see the whole. That is very difficult since the world is so big. You cannot use your own senses, or even your own senses aided by old-fashioned extenders, like records kept by one or two peoples.

"We have received several years' grace from traditional social control mechanisms, like patents, copyrights, and tariffs. They restricted production; they still do.

"But at the same time, they drive industry to less legal places or places with a different legal structure. Because business moves, and because the cost of transportation is so low, patents, copyrights, and tariffs must fail unless a world government arises that can enforce them all over. In the past, we have been protected by differing cultures. People in foreign places have not been able to do things; but now they can.

"Also, the planet is big enough that you cannot expect oligopolies in all industries, just in some. So you cannot expect voluntary production restrictions everywhere."

Tull nodded again. Like everyone else in business, he knew about 'imperfect competition,' about price leadership and not upsetting the apple cart. When there were too many independent sellers, someone always upset the apple cart, he or she undercut high prices, and you had competition.

Filgard went on. "On a world wide basis, students should learn about needful regulations. They should learn about enforcing them. I am not sure that can be done throughout the world. But governments should try. Otherwise, humanity will be diminished. Students, maybe even we, although I tend to doubt that, will die.

"The old problem-solving techniques worked when we perceived the world as flat and had little impact on it. But now our impacts are big. The world is a ball. Our impacts come back to haunt us."

"So you are saying that modern technologies have disastrous impact?" asked Tull.

"No, I am saying they might have disastrous impact," said Filgard. "That's different. The difference is between *might* and *will*." He sighed. "Old technologies could have a disastrous impact. Before the industrial revolution, people deforested huge areas. It took awhile. Governments had time to accommodate. Not all did; they and their people diminished. But there was time. Now there is less time.

"The old problem-solving mechanisms sometimes worked in the past; or new ones were invented. After all, that is what business law is all about, is it not? Isn't it the settlement of disputes between people and between people and nature?"

Tull was not certain of that. He thought of business conflicts as between companies; he did not think he would refer to the deforestation of Easter Island as a business dispute. Not that Filgard had either, to be fair. The man had referred to old problem-solving techniques as well as new. 'But with an island-wide law to prevent deforestation, the Easter Islanders could have made stone statues for longer,' he thought.

Filgard had made a point, he thought. How could you enforce regulations in enough of the world? What if the regulations were wrong? He was not sure what Filgard was intending — it never occurred to him that Filgard may simply have been trying to figure things out. The conclusions were depressing.

Chapter 36

Eltis pressed on. Because of Tuppak's success she was feeling more optimistic than she had after Peter's funeral. At the same time, his memory was becoming more distant. She committed the Melior Movement to recording and duplicating artifacts of the human past. It never occurred to her that this action might be a sublimation of her memories of Peter. In any case, it was useful. As a side effect, which for Eltis was prime, the Movement obtained data from each recording.

Taffod Dowwen parked a bit outside of London. As far as he was concerned, it cost too much to bring a car into the restricted area inside London. Besides, for seeing the city, public transport and his feet were sufficient. He did not plan to visit the non-touristy spots, where most people lived and worked.

He had driven across much of Europe in an old car, one that ran on energy stored in a liquid fuel, along with a much smaller amount of energy stored in a slowly discharging capacitor, an electric battery. He was rich enough to travel, but not very. He loved controlling the car in traffic, dodging all the other vehicles. Of those who knew him, a good portion thought of him as a wild and woolly adventurer who would come to nothing. He was not reliable, he did not have trustworthy convictions, and he did not care much for commerce.

Eltis saw him as a diamond. She figured that after visiting the Victoria and Albert Museum, he would go to a not terribly expensive pub close by. Indeed, there he was, in the second place she looked. He was not sitting at the bar, as she expected, but at a table. The bar was full up; hence, she thought, the exile to the table. But it was convenient for her.

She walked up and sat down across from him. "I'll buy you a drink," she said archly, smiling with what was clearly a put on flirtatiousness. "Aren't I supposed to offer you a drink?" he asked. "Yes, but I also want to offer you a job; and I have money." That caught his attention. What did she want from him?

"I would like you to be our contact in making atom-by-atom duplicates of books in the British Library."

"What?" he exclaimed, "do you mean all of them?" "Yes, I do," she said, "except we will have to go slowly at first. We will record and duplicate only replaceable books. The librarians won't let us work with any others. We will need to place money into escrow so that if the recorder breaks, replacement books can be purchased."

Taffod looked puzzled for a moment. Eltis explained, "We have the money. Also, we have the recorder and nano-assembler. The assembler is the duplicating part. Another person in the Movement is learning about both. Once the technique is seen by the librarians as safe, we

will hire many people to carry the books and make the copies. The library will get a copy that is indistinguishable from the original and we will put the data for making another copy into a backup. We will give a copy of that data to them and keep a copy for ourselves. We will promise not to make copies in this solar system . . . "

Taffod nodded, but he was already worrying that he would be asked to do a good deal of administration that he hated. Eltis seemed to have read his mind. "A third fellow will be the administrator. He will hire everyone and pay them. He will do fine. His name is Jades Summervill, except the spelling ought to be *D j a e d s S u m m e r v i l*."

The waitress finally came and Eltis ordered beer for both of them. It was good beer, Taffod noted; and it was expensive. She went on, "The woman calls herself Gammae, although originally she was called Mary, a name she disowns. Her name is spelled with an '`e`' at the end, but pronounced Gam-may. I don't know where that name comes from. She was trained medically and knows more than most. She is very competent, both with machines and with people. I want to get her into Tuppak's organization. He is beginning to duplicate people. So far, his process works, but is not pleasant."

The beer came and both drank. It was better than Taffod had drunk for a long time. 'Indeed,' he thought, 'this is better than any since that home brew.'

Eltis went on. "The people at the British Library think everyone in the Movement is crazy. They will not care about your past; it will fit their expectations. What they do care about is making duplicates that cannot be distinguished from the original. That is what they want the data for. They have external copies but not atom-by-atom information. We have the technology, which we could give them, but won't. In terms of tests and all that, the only hurt the books should appear to come to is that they would be frozen. And that should not hurt them. They are already dead. As far as everyone is concerned, the copies should be the same as the originals." She smiled. "Cooling them to just above absolute zero will be good. It will kill any bugs or fungi in them that might, over the centuries, consume them. So even if they did not receive backups, this would be a good thing to do."

She stopped for a moment, then went on, "But, troubles will come up. That is why I want you to be our contact point. You will figure out what to do and you are good at persuasion."

Taffod agreed. Eltis bought him another drink and dinner, but left before they came. She said she had yet more business. She could have put that off, but she did not want to state her main motive, which is that she did not want to make small talk. And she knew that Taffod would not mind. He would eat.

Later that evening, Taffod met Gammae in her apartment not far from the main British Library administrative building. She pointed at the recorder and assembler she had set up. They were big, but folded they could fit through doors. "We are going to have to move that into the Library building."

She explained, "No one is going to allow any books out. When we do more, we will need more recorders and duplicators. I have their data, so it will be easy to make them in place. All we will have to do is bring in feed for the duplicator. The books, of course, will not need anything new; the old stuff will feed the new. The actual data packet, even making three copies for them and three for ourselves, is small. The grand total is only a few grams. I already have the material for that."

Taffod looked at the replicator, looked at her, pulled out a currency note, wrote down its serial number, and asked, "Can you duplicate that?" He had never seen anything duplicated before. "Yes," said Gammae, "but I am going to have to burn the second note because we are not into counterfeiting and that is what this duplication is."

Taffod was puzzled. "How do we make money if we do not make money?" he asked.

"We duplicate certain jewels, not diamonds which are tracked, but others; and we sell them," she said.

Taffod thought for a moment. For once, he did not just consider the immediate future. "That produces enough money for the moment, but what happens as we get bigger?"

"Well," Gammae said, "then we will have to do something else." She shrugged and put the note into the recorder. "The machine will take a moment to cool it; then we will record it; then we will make a copy, then a second copy. You can compare the two. Then I will burn the second copy."

The replication did not take long, but it took a bit of time. The input hopper did not seem to settle at all. It looked to have in it some water, mud, leaves, and hunks of scrap metal. Gammae saw him looking. "There is not much paper and plastic in a bank note. You will have to duplicate something bigger before you notice the difference."

After the duplication, she gave Taffod both notes. They looked the same, felt the same, and had the same serial number. Then she plucked one out of his hands and set it on fire. Its smoke curled away lazily.

Taffod spent the night in that same room. The next morning, he had breakfast with Gammae and then met Djaeds Summervil. Djaeds said, "The British Library will impose more constraints on us than we will. We can duplicate more machines and hire people to put books into them and take out copies, but the library administrators will want to watch it all with someone from their staff. They will want to inspect at least some copies. They will not only have people look at them, but

have some tested. They will want to make sure the duplicates are like the originals. They have a lot of books. The whole process will take quite awhile."

Next, Taffod met his contact at the British Library, the chief librarian. He was a bit surprised to find she was a woman; not at all surprised that she was clearly competent. She wanted backups from which they could make duplicates indistinguishable from the originals. "We have copies of everything; but except for the most recent books, which were written electronically and whose physical form does not matter, we cannot make true duplicates."

Taffod promised not to reproduce items still copyrighted, such as books, movies, artworks, designs, and songs, and not to reproduce famous old things. He remembered what Eltis said and amended his statement to refer to "copies in this solar system." The librarian grinned.

He, Gammae, and Djaeds brought the recorder and assembler into the Library, and Gammae repeated her demonstration. Taffod was amused to see that the librarian provided a physical copy of a recent Hansard, the official transcript of what was said in Parliament. A little bit was cut out. "We can get a bunch of these. We have studied this original. I am going to have your two duplicates compared right down to the atomic level, too.

"Also, I am going to have a person look at the duplicates and at a third copy, to make sure they have the same contents. I will have an optical character reader convert the text back to an electronic form and compare that with the electronic version, too. The contents should be identical and the duplicates should be identical. The mass spectrometer should find that the atoms are similar, right down to the isotope."

Taffod nodded. "Yes," he said. "That should do." It was much more than necessary. The librarian looked at him closely, and at Gammae, and at Djaeds, who was sitting quietly. Taffod had forgot Djaeds existed; he had vanished into the background.

The librarian could not do tests on her own. She depended on her judgements of her experts and on her judgement of the strangers. It was her judgment of people that counted, not technical knowledge except what she needed to know in order to understand the experts.

Taffod, Gammae, and Djaeds passed her consideration. 'Now her experts must speak,' Taffod thought. That took several days. Meanwhile, Taffod visited more of London. He acted like the tourist he was. He decided that he liked the city.

The Library's experts said the duplicates could not be distinguished from each other or from their records of the original. The contents were good. The librarian said to go ahead with the duplication of real books. She listed them. As predicted, the first were books she could buy and

replace; she insisted on making sure that the money to buy copies was available.

Djaeds hired people and Gammae made copies of the replicator and assembler. The librarian watched. "Maybe the Melior Movement has a chance," she said. She left the room nodding her head and frowning slightly.

Exactly as Djaeds predicted, the Library held the process back. Only so many books could be brought to the replicators in a given time. At first, inspectors studied each duplicate; then they looked at one in a hundred and finally one in a thousand. Everything took time.

Those who carried the books started to complain they had too much work. Taffod was ready for this and suggested that the Melior Movement give the library some money which the chief librarian could pass out as a bonus. The full riches of the process were still not publicised, which is to say, anything material could be duplicated. Only a few had figured it out.

The next stage was to duplicate books for which only a few copies were available. Taffod worried that a nano-assembler would not be able to reproduce one that had been recorded and thereby destroyed.

Other than his contact herself, few truly understood that the original was destroyed, even though Taffod said it was. But every one would come to understand quickly if an assembly failed. Fortunately, that never happened. Taffod never had a problem with a recorder, with a data packet, or with an assembler. He felt lucky although it had to do with repeated and excellent work by Filgard and Peter and by their teams.

The librarians were happy to receive the data for each book. They thought of the data as enabling them to make better backups than before. Neither man nor machine could tell the difference between an original and a nano-assembled duplicate. The backups consumed little total space. Taffod gave the Library three copies of each packet. That meant three data blocks, each of which could be and was stored in a different place.

The process took longer than Taffod expected or was necessary. Finally, almost every book and object in the British Library was duplicated. A few were not. "There is a risk in duplicating this," the chief librarian said. Also, she said, the objects "must continue to possess the same atoms."

Instead, those items were photographed in a variety of frequencies, infra-red, ultra-violet, and X-ray as well as visual. Using the information, a few organizations could manufacture near duplicates. The Melior Movement paid for others to do that. In a few instances, highly popular items had already been photographed in all the different ways. The Melior Movement received that data, too. The reproductions, called

'fakes' by the less friendly, could not be distinguished from the originals by a regular human. Only mechanical testing or a professional could tell the difference.

When they finished, Taffod gave one of his copies containing all the data to Eltis for the Movement. She stared at the block of data. It was not very big, even though it carried millions of items. She said, and Taffod figured she was trying out a speech, "Nothing material will limit us. The price of any material artifact will drop to zero. However, people will still seek location, personal services, and status, none of which can be duplicated."

She looked at him. "Your abilities cannot be duplicated. Scarcity will continue. Some things, like your work, will continue to have prices."

She stopped for a second and then spoke cheerfully. "We will even have money; it just won't be physical. Physical tokens can be duplicated. Ours will have to be electronic. A generation or two ago, when it became cheap to replicate information, banks developed techniques for ensuring that you could not increase a monetary amount even if you could duplicate the information about it. That money could be anonymous, too. It could spread among the public, like contemporary, physical currency."

She spoke again. "Physical tokens are going to vanish. We can reproduce notes, *bills* as they say in America, and coins. They will disappear. But electronic tokens will continue." She shook her head. "Physical symbols are important for a society. Those will go. I just hope there will not be too much confusion and thievery during the shift. Once, people were scammed with gold and copper plated coins. Such scams are not a problem any longer. Local governments cannot inflate currencies either. They do not control them. Still, the transition will be a danger. I am glad we are leaving."

Eltis asked Taffod to continue with the Victoria and Albert Museum, the British National Gallery, and the French national library. As Eltis expected, he was remarkably diplomatic. Meanwhile, Eltis starting thinking about the rest of Europe.

Jeltong Pekbung ran an operation to copy books and other artifacts in South-east Asia, India, and China. He suffered more resistance than Taffod, but was more a politician and was equally successful. He did not have to learn to persuade people diplomatically, as Taffod did; he knew already.

Taffod kept up but did not like the work. He felt he had to restrain himself too much. He had to worry about others. He knew the duplication was important. But what he truly wanted to do was risk only himself. 'Maybe,' he thought to himself, 'after enough time on my own, I will be willing to worry on behalf of others again. But at the moment, I want only to go away and be myself.'

In contrast, Jeltong Pekbung liked politics. He liked to worry for others. He thought of it as taking responsibility. A plausible promise; that persuaded people. In that sense, he was like Eltis Akthorn. She had captured him by her proposal to make things better. The word was 'melior' in Latin. To Jeltong's ears that word was not only in a dead language but very foreign. Nonetheless, he took to the proposition. He liked it, both for himself and for others. But, he could see that persuasion consumed time.

The United States was more difficult. At first, no one could legally record anything much. A person had to buy out-of-copyright books. Libraries were forbidden to loan them to the Melior Movement, or anyone identified as belonging to them. The librarians and the trustees of the various museums were not a problem; indeed, they pushed for copying. They wanted backups.

Stalling came from those who knew nothing, but who could buy politicians. The politicians made the laws and in the United States the laws were sufficiently enforced. However, several months after the European and Asian copying, a short time from all but their point of view, those who funded the politicians saw that the Melior Movement was not flooding the world with 'priceless manuscripts and copyrighted books, movies, and songs.' So they withdrew their opposition, so long as the copying was done quietly. The laws were changed. Even though Eltis was not from the U. S., she organized the task in North America.

She also picked volunteers in South America and other places that had not yet been touched.

In southern Africa, Gilbert Daveson Hagborn — he insisted on going by all three names — turned out to know everyone. He was able to make all kinds of copies. Eltis suspected he did not clearly tell people that the original would be destroyed, but he did tell them about cooling. She wondered whether the American politicians understood, too. Anyhow, Hagborn always gave back what looked like an original.

Hagborn also said he was getting more interested in moving with Melior. Eltis wondered whether that was because he was old and had somehow learned of Tuppak's success, whether he was seeing more and more a dismal future, or whether he was truly beginning to believe in principles of the Movement. Anyhow, she welcomed him.

Chapter 37

At another family barbecue, his daughter spoke — Vallen liked these family meals together and he liked the barbecue, too. Vallen had not yet decided whether Janice was becoming more idealistic, or merely expressing ideals. The latter was safe, indeed desirable for a young woman, he thought; but the former was dangerous.

Janice said, "The rich could impact the world less; they could live austerely."

Her mother raised an eyebrow. She did not think that likely. She also took Janice at her word.

Vallen said, "Yes, voluntary austerity would succeed if everyone adopted it. Indeed, strangers would come to live in a way I prefer.

"The trouble is," and he nodded to his wife, "not everyone will live austerely, not even a large enough plurality. Of course, it is moral for people to live simply, but most people will not." He looked at his daughter. "You would not want to give up most of your teddy bears, your cuddlies, would you?" She looked surprised. "They have an ecological impact," he said. "Giving them up is what is meant by voluntary austerity. Maybe you should give them up?" She looked frightened at the thought. "But I am not going to require that." He smiled genially.

"For centuries," he said, "a few have lived in voluntary austerity. In the Christian world, the people in many monasteries and convents live simply. The same in other civilizations. Simplicity is a solution. But too small a portion of the overall population will adopt it."

He grinned. He was conflating simplicity and austerity. He thought that was right. He felt he knew all about austerity. He was trying to leave it behind. "You can have involuntary austerity, too. That is poverty. But people try to become rich."

He went on. "You can have too much involuntary austerity. Then people die before their time, whether it be from drought or flooding. Always, who dies is socially determined. The powerful do not die before their time; the weak do. The powerful can move to higher ground when the sea rises; they can afford an inflation. The weak cannot."

Momentarily, Vallen asked himself whether his kids knew or not; and then decided he should speak anyhow: "Usually, of course, the weak do not die directly from anything; they suffer and die indirectly. Well, sometimes they die directly. Then you can point at victims and tell anecdotes. But I am thinking of the majority of people. As individuals, they do not produce good stories. They are simply weak."

Vallen left behind the questions of simplicity. He did not think enough people would go for it. As far as he was concerned, the idea was irrelevant.

"To return to the last generation of the 20th century . . ." He remembered that in his attempt to talk about idealism he used that period as a prop. On thinking about it more, he decided that the time had been important and full of tragic nothingness.

He explained. "In the 1980s and the 1990s, photo-voltaic cells were no good. Plants had not been bred or engineered to convert a high portion of sunlight into fuel. Wind turbines used many more resources than the alternatives.

"No one built, so no one discovered the problems of big, terrestrial solar mirrors — multi-square kilometer ones. No one discovered the problems of extraterrestrial ones, either.

"The latter would have required some kind of automatic, non-crewed, non-biological replicator. Not enough could be carried into orbit for anything else. Spray-droplet machines are one kind of modern, fast replicator. I don't think they had been invented in the last century. It does not matter. At the time, people could design and build automatic, fast replicators of one sort or another.

"Unforeseen problems would have come up. I don't know what they would have been. They might have stopped a project. I think they would have stopped it before computers became small. But in the last decade of the 20th century, we had the technology to overcome the unforeseen. Of course, I may be wrong. I don't know. All I know is that with technological progress, big, extraterrestrial solar heaters became more doable and if done right, less costly than Earth-bound ones.

"But they were not built. Relatively small amounts of electricity were generated in space by Earth-produced photo-voltaic cells. With components build on Earth, extraterrestrial energy conversion was not at all cost effective. That is what I mean when I say," he had never said it outloud, but he thought he had, "that it was a time period full of tragic nothingness."

His family listened. They were not sure what he was getting at, except that he thought the world was tragic and they were lucky to be rich.

Vallen stopped talking. To his family, it looked like he was focusing on his steak. He was, to an extent. He was thinking it was a good steak. He was glad he cooked it.

At the same time, the barbecue and his talk reminded him of scaling and prices. He did not mind a little extra complexity. That is how he saw the need for controls on barbecues, extra complexity. He had been furious initially, but he was not angry now.

Now he was angered by a sharp increase in the price of coffee. He knew he drank too much, but still. He was not going to drink less coffee just because it cost more. It was too small a portion of his budget.

Crops grown with integrated pest management grew better; that was clear. You could raise more coffee; its price would be lower. But the technique required research by scientists and careful monitoring by peasants and land owners. Not many wanted the extra complexity. The sellers did not think they got enough extra benefit. Without proper pest management, the amount of coffee available to humans dropped. Prices rose. Peasants and land owners were no better off; they charged more for less. Only the pests gained. Vallen paid unhappily.

Pest management handled a problem — the cause was obvious, that descendants of a bug with more resistance to a pesticide reproduced more rapidly than those with less. As a result, pests with resistance became more common. The cure was obvious, too. Scientists had to be funded to do more biological research and growers had to pay attention. Perhaps the growers should spray an insecticide at night when its target pests were weaker; or perhaps a different insecticide would help, or something else entirely. That is why the industry needed more research.

However, the solution could not grow too expensive. If there were going to be more coffee drinkers, the solution had to scale. It had to generate increasing or stable returns.

Otherwise, thinking more generally, which Vallen had no trouble doing, if the increase in the cost for this, and the increase in the cost for that, and the increase in the cost for something else, if they all rose, then people would notice inflation. They would notice their drop in living standards. They would begin to dislike complexity.

As far as Vallen was concerned, increased complexity caused increases in transaction costs. It added nothing and cost more. He did not know of any advantages, like triple paned windows. 'Like modern patents,' Vallen thought to himself. He liked patents, at least those that profited him, but he did not like complexity at all.

With additional complexity, visibly added complexity, people would prevent accommodation. They would not like it. But without accommodation, Earth would suffer a huge population drop. It was not flat. Feedback loops did bite.

Fewer people would mean less impact. That would require less complex solutions. That would be fine. Vallen did not mind if others died. But their deaths would destroy profits — not immediately, he did not expect that, and not within five years, his current business horizon. But large numbers of people would begin to die before his end. That would be a problem. The only way to keep profits up would be to encourage research, and he did not see that happening. He would suffer. His wife would suffer. His son and daughter would suffer.

Vallen understood the difference between a rentier economy and a production economy. The one shifted resources from one group to another. That is what litigation did; it shifted resources from good guys

to bad guys. Occasionally it shifted resources the other way, but Vallen knew that nowadays, justice was uncommon in most of the world. The other kind of economy produced goods that everyone wanted. Or it made sure the situation worked. In a production economy, litigation almost always shifted resources from bad guys to good guys.

He certainly was becoming more and more of a rentier and benefiting from it. Much of his income meant others, most of them poorer than he, got even less. That is what his patents meant; that was the result of the bribery that rewarded him for price discrimination. Vallen knew he was smart and well educated. He could gain. But still, he was not up there with the very rich; if there were a collapse in profits, he would survive, but not to a level he wanted.

It was not right.

Chapter 38

At Filgard's university, Vogel and Martha Todd raised a robot in a child-shaped and child-sized body — a very smart robot. They fit a powerful computer into a human-like body. It had the same inputs as humans, the same visual range, the same ability to feel, the same ability to convey emotions non-verbally, and the same proprioceptive sense. They hoped that the robot would become an intelligence indistinguishable from a biological human. They constructed and constrained the machine's modules and components, its algorithms. They wrote parts to match the cortex, hippocampus, thalamus, basal ganglia, cerebellum, hypothalamus, and amygdala of a human.

The Todds' theory was that an artificial intelligence could come to pass a Turing Test when it learned the body-derived metaphors in human thought, regardless of language. For example, a small robot, like a human child, would learn that the more powerful are bigger and that standing up is better.

The robot was designed to gain energy by processing food; it had to eat human food. It experienced hunger and defecation. Maintenance occurred during 'sleep.' The intent was that the robot experienced as much as a regular human child.

The Todds also provided the robot with all the 'informal' knowledge that computer projects had codified and collected over the years, as well as formal knowledge. Regular humans could not gain that knowledge so easily.

After five years, the robot acted like a backward old human child. It did not speak. Vogel and Martha nearly gave up. Then suddenly it jumped more than twenty years. It began to speak and behave as a well educated and witty person.

The robot, now in a bigger body, won the gold prize in Loebner's Turing Test and started a campaign to gain human rights. Its arguments were persuasive; its legal petitions well written. The AI referred to himself as a 'him' and called himself 'Allen Intro.' He did not produce a third initial, saying that none fit the 'AI' shortening 'he' sought. Of course, bureaucracies had established procedures to handle the records of biological humans who lacked a third initial, so the self-assigned name merely served fame.

A judge copied the Loebner rules for the Turing Test, added a few of his own, and said that "any entity which can pass these rules can be considered an adult human, with all the rights and obligations that that legal standing entails, including payment of taxes."

The joke, as expressed by a biologically human comedian, was that if they were to take the test, not all biological humans would be able to pass. He said he would tell such a person, "The good news is that you

do not have to pay taxes." He paused. "The bad news is that you are no longer human." But natural human intelligences were not asked to take the test. The artificial intelligence — at that time, there was only one — took the test and passed with no trouble.

Next, Allen Intro managed to drop from public view. He was, after all, a good deal less exciting, at least in the short run, than a resource war or peculiar weather. He could not compete with the unexpected reversal of a country's fortune. In addition, he had said, "You would think that increased processing speed would cause things to go faster. But that is not the case!" In other words, no one thought of him as a threat.

He explained, "As you speed up, you need more and more I/O, input and output. There are some things an artificial intelligence with faster processors can do better than a natural human. An AI can add numbers faster. But no one yet knows how to turn faster computation without I/O into deeper love or fear.

"Yes, you can use a faster processor to emulate a slower set of parallel processors. You can put faster processors together in parallel. But even with all that, and even though each segment or ability works fine, the combination fails to grow much in speed. This was not expected.

"So AIs end up being like regular humans in many areas. This makes them easier to understand, but not as god-like as many had hoped." He did not say, ". . . as god-like as many feared."

Very few biological humans noted that the statement came from an artificial intelligence, not a natural. In any case, almost all thought of 'Allen Intro' as a single person. Few considered the implications of an artificial intelligence who could think ten times the speed of a human, not a million times as fast, who could readily copy himself and, with Peter's nano-assembler, readily duplicate himself.

Chapter 39

Eltis kept visiting the university and staying with Filgard. She continued to sleep in the spare room. She tried out a speech on him. He listened; it was not long:

> *"Every politician must please three audiences at the same time: supporters, civil servants, and citizens.*
>
> *"It is not easy.*
>
> *"To do this, a politician will try to appear — and if there is a fierce opposition, an independent court system, serious reporters, the politician will trully be — legal, legitimate, and full of light.*
>
> *"(This talk is full of alliteration . . .)*
>
> *"By legal, I mean honest, both in the limited sense of legally honest and in the more extended sense of unimpeachable."*

Filgard cocked an eye.

> *"In the first sense of honesty, we can readily imagine a crook, a crooked politician, changing the ranking that various contenders have already received from a government agency. That way his or her supporters gain more of the taxpayers' resources.*
>
> *"In the second sense, the politician ensures that his or her contender receives more income from taxes than is considered legitimate partisanship. Impeachment is political; it is not about the formal law as such.*
>
> *"By legitimate, I mean that enough people accept the government. Legitimacy reduces the cost of government and enables rule without too much policing.*
>
> *"By full of light, I mean transparent, truthful, and competent. I imagine a torch held up, like an Olympic runner; but you can think of an electric light shining on the activities of government.*

"That is good," said Filgard. "You have not said what you mean by 'transparent, truthful, and competent.' I am not sure that matters."

Eltis continued.

> *"It goes without saying that a government must encourage independent courts and serious reporters."*

Filgard looked puzzled again.

> *"After all,"* said Eltis, *"it is necessary for a government to ensure order and security first of all, lest people die. Next, it must provide law, so the social world becomes more predictable."*

Filgard kept on looking puzzled. But Eltis continued. She knew the answer was coming up.

> *"Only after it has provided for order and law can a government provide justice — fortunately, most civilized countries do. Through sad experience we have found historically that judges who are bound to a specific executive will favor that executive. Only when a court system is independent will judges be independent and provide justice. That is why we have to provide for an independent judiciary.*
>
> *"After providing order, law, and justice, a government must provide democracy. Democracy enables people to eject a government without provoking civil war."*

Filgard nodded. Eltis had talked about order, law, justice, and democracy. He could see that each required the previous for success. Law required order. The phrase 'law and order' had the sequence reversed. 'Those words sound good,' he thought. 'Still,' he decided, 'the most basic need is order. Justice requires order and law. Democracy requires order, law, and justice.'

That all made sense to Filgard. He wondered about civil rights and states rights, limitations on government. Eltis said nothing about them. Filgard was a little disappointed. Instead, she focused on reporters and an opposition. That, Filgard agreed, was also important.

> *"We need an opposition and we need reporters. Reporters tell the rest of us what the government is doing. We mostly do not pay attention; certainly, we should not have to. Reporters tell us what the opposition proposes. It enables us to decide whether to keep the current government or throw it out.*
>
> *"That process requires a government to encourage its opposition. After all, the opposition will rule, if not immediately, then eventually."*

Filgard nodded again and smiled.

> *"To fulfil its three means, legality, legitimacy, and lightness, politicians and people evaluating them have four criteria, the 'four Ps of politics': protect, preserve, prepare, and provide.*
>
> *"For example, is an elected politician in a government protecting citizens, civil servants, and supporters from pollution? Is he preparing them for an unexpected future?*
>
> *"In more detail, everyone, politicians, reporters, the public, uses the 'five Rs': rigor, reason, reality, reliability, and responsibility.*
>
> *"Thus, are those in society who are responsible, the politicians, investigating the reliability of the education of those who will*

follow? Are they investigating the education of their children? Are they doing so with rigor, reason, and a sense of reality?

"Or are they irresponsibly focusing on unreal notions?

She paused for a moment and changed her voice.

"'Ah,' you will ask, 'who determines reality?'

Then she returned to her usual voice.

"As a practical matter, reality or irreality is presented by the leaders of a society; and most people accept it. Not everyone, of course, but most. And most of those who do not accept do not try to overthrow a government violently.

"In a slowly changing world, the world of our ancestors, those who presented reality, our ancesters' leaders, may be long dead. The living may learn everything when they are young; and their world may change so slowly that that learning is sufficient.

"But the modern world changes. What protected our grandparents when they were young does not protect us now.

"Finally, whatever action a government undertakes must be repeatable. That is because an action has to succeed in the time of our great-great grandchildren as much as now."

Filgard waited for a moment to make sure she was finished, and then he said, "How are you going to do what Fairta recommended?"

"By suggesting," Eltis said, "that people like her, the Sanguine, check the truth or falsehood of the two sequences: protect, preserve, prepare, and provide, on the one hand, and on the other hand, rigor, reason, reliability, and responsibility. At the same time, people who work hard and have common sense, the Melancholic or Guardians, can decide how much a politician protects us in reality."

"I can think of more 'Rs:' 'Repeatably reveal reality reliably, rigorously, reasonably, and responsibly,'" he said.

"That is seven," she said. "Too many. I worry that few will bother to remember the 'five Rs' or even the 'four Ps.' With luck, they will be able to reconstruct the 'three Ls,' law, legitimacy, and lightness, but may not care. Memory only comes from enhancement, which Tuppak is developing, or by effort. Even when you are directly interested, you need to struggle. Only a child does not feel the effort when he or she learns a spoken language or other inbuilt desire."

Filgard thought about her comment. "That may be true," he said. "I am not sure." He paused longer, then asked, "How are you going to have Guardians figure the more or less?" He gave an example, "A politician may successfully protect people against non-human enemies, like pollution, but fail against human enemies. Or the opposite."

"Failure is large negative valuation, like failure to prepare citizens for various possible futures," said Eltis. "A focus on the unreal — that is a very large negative valuation."

Filgard said, "The word 'valuation' suggests a numerical scale. But we cannot talk about that."

"In this case," said Eltis, "the negative will be less. That is all it can be. But everyone can think of numbers. It is just that according to this notion, a few like them more."

She thought for a while about the original question, how to determine degrees of evidence. "As for the other temperaments," said Eltis, "I am going to say that people who favor voting and civil rights as Fiske would say, the Choleric as Galen would say, should see whether a proposal is more idealistic than the alternatives. Finally, I am going to suggest that people like you and me investigate."

"That sounds very Phlegmatic. I am influenced, but will others be?"

"I don't know," said Eltis. "But I do know that I am not persuaded by divisions between us and them, unless they are both real and significant. When I make a speech I do poorly when I am not persuaded. Similarly, I am not convinced by common sense or by history."

"What about common sense?" asked Filgard mildly.

"Which common sense?" Eltis responded sharply. "Do you mean the common sense that said that fire is an element like water? Or do you mean something else?" Then she softened. "I am not against important and truthful common sense; it's just that most people never check. The same with history."

"That we can agree with," said Filgard. "I suppose that swaying together, or stomping, or shouting slogans, they are all ways of indicating acceptance."

Eltis nodded. "Yes, that and ways of persuading others in the crowd. That is not irrational. If you are going to accept what others say, which is what most do, then most often, you should accept what everyone else near you tells you they believe. But those actions do not persuade me. Others can make that kind of speech, but I cannot."

She asked more. "Can we succeed without progress in non-human areas? That is my question. It looks that we can succeed, at least for a generation or two. Obviously, physical technology makes it all easier. Your recorder and Peter's nano-assembler will help enormously. So will Tuppak Nassik's work."

Filgard still did not know about Tuppak Nassik, but did not inquire.

Eltis continued. "Just the old social technologies of politics — protect, preserve, prepare, and provide, as well as responsibility, rigor, reason, reality, and reliability — these old technologies make a new society possible. We can and will do more, but I wanted to check them.

"Based on your comments, I figure little is wrong."

"You left out many details," said Filgard.

"I know," said Eltis, "and the devil is in them." She paused. "'The devil is in the details.' That is true. But most people find them boring; indeed, only some people will pay attention to what I say.

"Moreover, when we have the underlying principles right, the details follow. The devil gets them when their principles are unknown or contrary." She chuckled. "That is why so many countries break so many diplomatic agreements: treaties are written to match contrary principles, to smooth over differences. Eventually, the differences become important again.

"I am trying to create a Movement with a single set of good principles that will last several generations. That is my minimum hope. Ideally, the society will last forever."

". . . or the end of the universe, which ever comes first," said Filgard smiling. Eltis laughed with him. "I mean, a very long time."

She looked at Filgard. "We have this political social technology. We have the other kinds of social technology; we have physical technology. We are getting there."

Chapter 40

It turned out that even with Allen Intro's help, no one could build a good sized hydrogen, helium three, or hydrogen-boron fusion reactor. Available technology could not even begin to handle the confinement for a hydrogen-boron reactor. But Allen Intro did devise a very small helium three fusion device, a millimeter on a side. Because it did not give off any neutrons at all, and because it did not require much helium three, which was rare on Earth, it was built.

As the AI said, "In bombs, we can fuse light elements together and convert the mass to energy quickly; we have known how to do that for a long time. But for steady, more human energy conversion . . . Strong and weak nuclear forces might enable us to build even smaller reactors, but we do not know how to manipulate those forces.

"The other force, which we also do not know how to manipulate, is much, much weaker. It works; we know that. We depend on it. But the smallest star, which pulls nuclei together with gravity, is larger than Jupiter. This helium three fusion device is the only steady fusion energy device we can build, besides those of the same size that fuse hydrogen and give off neutrons."

The only way to convert a great deal of mass to energy would be to add numerous tiny helium three fusion reactors together. Replicators could create many reactors; in addition, they could duplicate spacecraft to mine helium three on Uranus or Neptune. So the cost of the tiny reactors would be effectively zero.

But unfortunately for regular energy requirements, a combination of tiny fusion reactors took up more volume than a solar collector! At least, this was the situation at Earth's distance from the sun. Thus, even though costs would be nil, merely for size reasons, even with assemblers, energy would be converted to a humanly useful form through non-fusion means. The solar influx could be converted to electricity or to a liquid fuel such as gasoline.

Except, as was promptly understood, an interstellar space ship required a helium three reactor. An interstellar vehicle would not receive much energy from outside. During most of its trip, it would be too far from anything. The space ship would not be irradiated by any star at the rate of a kilowatt per square meter, like a planet in the humanly habitable zone. Only the star it was departing and the star it was approaching could help; and in neither case would it receive much energy for long.

Fortunately, as the AI said, "This kind of interstellar space ship does not require much energy. It mostly coasts. A tiny helium three fusion reactor makes sense. Its main use of energy is for its continually running mini-magnetospheric plasma generator." The AI spoke parenthetically,

"(During cruise a continually renewed plasma pushes many charged cosmic rays aside and reduces the number that impact the ship. Renewing the plasma requires energy.)" Speaking directly, he said, "The space ship needs energy for sensors and an internal computer, too, but the total is less than for the plasma." The AI was also designing the space ship to carry a sufficient source for the plasma that took the energy. In theory, he could get the plasma from the interstellar medium, but he was not sure how much. He did not say that he was designing the space ship to carry four reactors for redundancy. Any one reactor could provide enough energy to it.

So the vast reduction in designed fusion reactor size, which at first was considered a disaster, turned out to lead to help. As for Earthly needs, replicators could manufacture other kinds of reasonably sized devices to convert non-fossil energy in humanly desired quantities.

Chapter 41

A few days later, James walked his bounds again. The total distance was not far, but his pigs followed him and they had much shorter legs. The advantages of this route was that he had cut a path through the woods on his side of the property line. He would not bushwhack. From the woods, he would go into a field. He hoped to meet Filgard again there. The man went on, thought James, but he was interesting.

Jame did meet Filgard, and as expected, he was guiding a robot. Filgard had got bored of planting manually. James hid a smile.

The robot did not look humanoid at all; that did not surprise James. It looked somewhat like a moving coffin. It rode on four fat wheels, one below each corner. The axis of each wheel was attached on the inside to a vertical column that climbed up to the body of the robot. The big wheels were smaller than the space between the bottom of the robot and the ground. Very obviously, the wheels could turn around each vertical column; but to James, the body of the robot still seemed far away from the ground, so far away that the robot looked like it might tip over.

James was surprised to see baskets attached to the robot's body. They made sense. He did not think they should surprise him. However, they did look weird.

Filgard looked up. He seemed to expect James. "It turns out," he said, "people have already written a good deal of software for preparing land, for recognizing weeds and intended plants, for planting, for caring for intended plants, for weeding the others, for harvesting, and so on.

"I did not bother to buy a farming robot, but put this one together out of junk I had around and incorporated the free software out there. The robot has a good balancing program — that is another piece of software whose license gives me the freedom to use it, like the farming programs. So the robot won't tip over. But it looks to me as if the body is too high. Humans won't like it. Part of its function must be to match human wants as well as robot needs.

"The wheels should be away from the body, not under it. That way, they will have room to turn. Maybe each robot should employ six wheels, not four. That will improve visible balance even more. The middle wheels do not need to turn left or right. If the robots needs to move sideways, they can simply lift up rather than scrape. Their axles need to be on vertical bars anyhow, to accommodate rough ground or on a more horizontal bar that can go up and down. I am thinking of copying the suspension of the early, uncrewed Mars rovers.

"And, of course, besides diggers and holders for planting, the robot needs snipers and scratchers to go after weeds. But I have not installed them yet.

"It turns out there are different groups working on computer controlled farming robots. Without Peter's assembler to bring down manufacturing costs, and with the costs of energy, which is an important running cost, farms using them end up growing food that costs more than food from farms which employ humans. Peter's assembler brings down robots' costs. Even better, it means that human farmers need only solve interesting problems, like what to do when a heavy robot tips over."

He stopped for a second. He was focusing his entire attention on robot design, not on James. "We could strengthen the various arms so a tipped over robot can try to roll upright. A robot's balance mechanism may not work when the robot is upside down. But the robot's visual sensors can see and its arms can feel what to do, so the arms could push until the balance mechanism works again. Actually, what we now think of as an expensive balance mechanism should be able to tell whether it is upside down. With Peter's assembler, it won't be expensive any more, so it could go into every robot.

"Hmm . . .," he digressed. "I can imagine how to build a micromechanical device with six cantilevers, each with a weight at the end. They could be arranged in a box form. The cantilever on the bottom would produce the largest positive strain, presuming downward is positive. If it tipped over, the one on the top would produce the largest strain.

"Tipping is such a straightforward problem, I am sure it was handled more than a generation ago. I just don't know anything about the topic yet."

James was considering a different subject. "Earlier, you spoke of people in the Melior Movement judging matters with four criteria." He remembered them, "protect, preserve, prepare, and provide."

He asked, "How would you apply them to those trees up behind us, to valuing them with and without a positive rate of interest?"

Filgard paused for a moment, his eyes tracking the robot, who was happily cruising in a straight line. James noted that the robot was planting three rows at once. It reached the end of the garden plot. There, it turned like an ox and started back, just as Filgard had, but three rows over.

Filgard nodded to himself, then turned to James and said,

"A zero rate of interest protects trees and us since the trees are worth more when they are grown than when smaller. A positive rate of interest protects the forestry company. Its investment is not stranded for a century or two while we wait for the trees to grow. The company cuts younger trees, sells them, recoups its investment, and starts again. That is *protect*.

"As for *preserve*, a positive rate of interest does not preserve a grove at all; it preserves the forestry company. Only a zero rate of interest preserves the trees themselves. So you have to decide whether the trees themselves, their place in the ecology, is worth it."

"Trees are," said James.

"Sometimes and sometimes not. Consider garden weeds." Filgard pointed at his garden. "Are weeds there worth it?" He grinned. "I doubt it. That is why I have removed them and why the robot is going to receive nippers. Weeds being removed, that amounts to a very high rate of interest, the valuation being against them."

"That is true," said James. "But the value depends on the weed's location and their number. A weed outside your garden does not matter so much; its value is not so negative. And when they become the last instances of a species, they stop being weeds, and become valuable."

He thought for a moment. "The value of weeds depends on their location and on their numbers, like the value of houses. So does the value of trees. So why are we against positive rates of interest, at least for determining the value of these trees?"

Filgard answered, "It is because rates of interest fail to handle non-linear effects well. It does not matter whether the rates of interest are set intentionally by a central bank or emergently by a market. Either way, interest rates are set by people who can handle some non-linear effects, but not all.

"It does not matter if this region is deforested." Suddenly, Filgard saw the relevance of James' comments a few days earlier about the reforestation of the northeastern part of the United States. In this case, the reforestation might well be irrelevant. He was not sure. In any event, as far as he was concerned, everything was fitting together. It just took awhile.

"Millions of trees can be cut down", he said. He knew that although James had started the topic, he did not see it all. "Cutting them down does not effect the world. I don't think it would matter terribly much to the planet if the whole northeastern part of the United States were deforested again. Maybe it would have some effect, because that is a big region. Still, deforesting an area that is one hundred times the size of what we can see; that is still trivial. I mean, it is not trivial to the people or trees involved, but it is trivial in terms of the world.

"That's why interest rates go wrong. The people in central banks or markets cannot perceive non-linear effects that depend on much larger territories than they imagine or much longer periods of time.

"As an astronomer, I bet you can see that. Other than nova, everything takes millions and millions of years." He opened his face. "I suppose you cope by considering the right durations and by avoiding interest rates!" James nodded and grinned.

Then James asked, “What about Easter Island? That got deforested and is not so big.” “Good point,” said Filgard. “Easter Island may provide an argument against this hypothesis. I don’t know enough about Easter Island. Or maybe the reason is different, an addition, not a counter.

“Maybe the statues on Easter Island implied a very high rate of interest. The people did not have any rate of interest overtly, not that I know of, but like any group of entities, people, cows, mosses, a rate of interest exists regardless.”

“How do mosses have a rate of interest?” asked James.

“It is the species that has the rate of interest. A moss that consumes its environment dies. A more successful moss reproduces. I don’t know whether an individual moss can perceive its environment, but the species certainly reflects it. Areas with high interest rates that go against an individual moss, they soon don’t have any moss at all.”

“No one calls that a ‘rate of interest.’” said James. “No,” said Filgard, “but it amounts to a rate of interest.”

Filgard continued on what he considered the significant topic, large territories; he thought of himself as being on a roll, “Besides, just as trees grow old, fall down, and all that is harmless, so cutting is also harmless to the planet, if not to the locals, even cutting a region larger than you or I can imagine. Beyond that is danger.”

He kept right on going. “It was not until recently that humans had a global effect. Stone age hunters set forest fires. That may have had an effect. Modern tree companies certainly have an effect. In any case, humans have had a global effect for fewer than a million years — maybe, as a practical matter, for only a hundred thousand years or ten thousand years or even fewer. In any case, most people, most of the time, focus on what will happen in less than a year. They waste fewer calories when they do that. It makes sense. The future is uncertain. On the whole, most people only think far ahead sometimes. When they think about children and grand-children they have to think far ahead. They don’t do that all the time.”

“So you are saying,” said James, “that these are questions of impact and balance? Less of an impact, less a problem. More balance, less a problem.”

James tried to make himself clearer. “By balance, I mean a social balance between organizations that value distant people and events the same as those close by, that is to say, the zero interest rate organizations, and those who don’t, the positive interest rate organizations.”

“Yes, that is what I am saying,” said Filgard, “except that I think your phrasing over-simplifies the difficulties. Indeed, while it is truthful to say these are questions of balance and impact, that may not help.

People have tried for generations to reach a better balance and to reduce the impact; and they have failed."

"What do you mean, failed?"

"Well," Filgard sighed, "thousands of years ago, idealists banned usury in two grand religions I know about, Christian and Moslem. But positive rates of interest crept back. In Christianity, usury got redefined, not as any interest above zero, but as a high rate of interest. The balance did not hold. Originally, the balance was determined by the numbers of people who professed different religions. Only one of them in our area, Judaism, permitted usury. Their members were the only group who legally could lend money at interest. But then Christians began to permit it.

"In their recollections of the Bible, at least in my upbringing, authoritative Christians emphasized Matthew 25:26. It says, '. . . Thou wicked and slothful servant, thou knewest that I reap where I sowed not, and gather where I have not . . . .' They interpreted a zero interest rate investment as 'wicked', in contrast to investments that obtain a positive rate of return. They were not talking about increases in equity; they were talking fixed-interest loans. The Biblical verse employs the words 'sow' and 'reap', too. Those terms suggest growth in less than a year.

"The people who told me this suggested, but never said, that the verse was very likely written by a fellow like them. I think that Matthew was anything but a Platonic Idealist. Instead, my suspicion is that he was a person whom Plato would have called a Guardian, a man whose temperament favored a positive rate of interest.

"Still, I wonder what Matthew actually said, although I am not so concerned that I am going to research it. All I know is what I was told by people I thought of as authorities when I was a child."

He shook his head. "That is how notions get passed on and how they get changed from generation to generation.

"The Moslems have kept up the ban longer, but Islamic banks are introducing more and more ways to get around it.

"As for *prepare*, and *provide*" — Filgard remembered the main topic — "without a proper social balance, we cannot begin to prepare for a world five hundred years from now."

James said, "Most will say that we cannot imagine what it will be like. Certainly, I can't. They will say that hundreds of years ago no one could imagine the present."

"Yes, it is true," said Filgard. "But we are still suffering the impacts of choices made then. Consider coal, and more recently mined liquid and gaseous fuels. In the European Middle Ages, miners often thought that ores grew back like plants. They thought of the activity as sustainable. If they had been right, we would have a much easier time. We would be rid of one set of harmful impacts.

"I don't know when that belief ended. But by the beginning of the 20th century, everyone knew that coal, petroleum, and natural gas were finite."

"The beginning of the 20th century is not five hundred years ago!" said James.

'No," said Filgard, "but we are still suffering from decisions that were made then. Ignorance of the natural law is no more an excuse than ignorance of a social law. You get bit either way.

"That coal, petroleum, and natural gas would be used up — everyone knew that by the beginning of the 20th century. They knew that eventually they would have to get the energy in other ways. They knew that fossil fuels needed replacing."

"Maybe the farsighted figured that the work on ocean thermal systems, on wind turbines, and on atomic processes received enough funding," said James. "Or maybe they lacked the power to fund appropriate alternative discoveries and development properly."

"Either or both may be true," said Filgard. "I don't know. In any case, we are in a pickle now. The problems are caused by social or political relations; they are not based on technological ignorance like many collapses in the old days.

"As for details — the Melians have five categories. In English, the words defining them are alliterative, the five 'R's: rigor, reason, reality, reliability, and responsibility."

Filgard smiled and spoke parenthetically. James was ready. "(Alliterative lists are easier to learn than other kinds. So are rhymes at the ends of words. After the invention of writing, you don't need this kind of help much, except that remembered items come to mind. Hence the attraction of alliterative or rhymed lists. But the words are not necessarily alliterative in other languages. As it happens, the five 'R's do not exist in the language the Melians plan to adopt. The Melior Movement cannot make this alliterative list . . .)"

He left his digression. "Certainly, over the past few centuries, it would have been responsible to cut down many of these trees. More land to grow food, to graze animals: an increased population needed that. In those days, we suffered a lower level of technology.

"But at the same time, a country, a society, would only be responsible if a few investigated rigorously and with reason how much could be cut. Without a decent understanding of ecology, their studies might not fit our understanding of reality; nonetheless, they could reliably have figured out how many wild animals would be left after cutting part of the forest, especially those they and their children would hunt."

He stopped for a moment. "Let me say that again: in terms of the five 'Rs' — rigor, reason, reality, reliability, and responsibility, — society was responsible for rigorously studying how many trees could

be cut down. Reason would have overcome such studies' irreality, and done so reliably.

"We can do as much for our future."

Chapter 42

Data packets, none of people, a computer, nearly sentient but not an AI, its effectors, batteries, and a small instance of Peter's nano-assembler were launched into low Earth orbit. They massed about four grams, took up very little volume, and rocketed into orbit in what most thought was a capsule carrying the remains of an astronaut. Indeed, there were ashes in an openable compartment. A technician checked before the rocket blasted off and saw them.

However, the compartment had a bottom much closer to its top than anyone knew; there was room behind it. In space, the computer translated what was in the data packets. Then, it used its small helium three reactor to power the assembler in its disassembly mode and go through the wall of the capsule; a little human corruption had ensured that the capsule was on the outside of the satellite. Next, it manufactured solar collectors. It was able to deploy the solar collectors with no trouble.

Then, with enough energy assured, the computer enlarged the assembler. These tasks used the astronaut's ashes and metals from the capsule. Then the computer built more solar collectors and a magnetospheric plasma generator using much of the rest of the rocket, the metals and ashes from other people. The computer left a decoy in orbit for radar to detect, stealthed itself more or less, and left Earth orbit when no one was looking.

The whole operation was an instance of security that came about because humans worried only about direct dangers, a kind of 'security by obscurity.' Various countries looked at the newly launched satellite in visible light, infra-red, and with radar. They convinced themselves that the vehicle was as claimed, a money-making mechanism for putting the ashes of dead people into orbit. Initially, of course, it looked as claimed. Even a nuclear inspector, an unmanned spacecraft paid for by the larger and richer spacefaring nations, had approached and checked for radiation. It had maneuvered by radar and looked at the space craft visually and in infra-red. Later, only various radar fences automatically monitored the close Earth environment. The radar decoy worked fine.

The little computer was smart. It tested the magnetospheric plasma device, found that the late 20th century theoretical design was fairly good, made a few changes to improve acceleration, and headed towards a small planetoid.

Travel to the planetoid did not take long, a little less than six days total. Even at one-twentieth of an Earthly gravity, the continuous acceleration made for a maximum speed of nearly 100 kilometers per second.

The vehicle landed after reaching the planetoid, which had a number but was too small and common to have gained a name. The computer and assembler promptly started to use the planetoid's substance to

make a bigger solar collector, a bigger nano-assembler, and then to manufacture more.

It built a laser transmitter and receiver. For fear lest an Earthly radio telescope be looking at just the wrong moment, the computer looked in the opposite direction from Earth to make sure there were no interesting astronomical sights. Then it briefly transmitted to Earth in an unlikely frequency. Because the laser beam did not diverge much, its 'footprint' was considerable less than the width of a continent. There were no known wide-angle antennas that could receive its transmission and the obscure frequency probably meant no amateurs picked up the transmission either. In any case, the transmission was short and well encrypted. If an amateur saw the transmission, he or she would say, "Wow . . . this must come from a little green man."

The Melians on Earth, who did monitor the planetoid and who did receive the transmission, did not hear any Earthly comment at all. They decided their project was unknown. They transmitted back saying they had received the message. They did not expect the distant computer to transmit more unless it had a problem or unless asked. Since it suffered no problems and was not asked, it did not transmit again.

The effort convinced Eltis and the others that the Melians could flee. They had to be copied, made into small data packets, conveyed to space, an interstellar craft had to be designed, built, and loaded, helium three for its fusion reactor had to be obtained, particle beam devices had to be built to push it . . . the steps were not easy, but they were definitely doable.

Chapter 43

The next time James saw Filgard, he was looking at James' path through the woods.

"A recognition of non-linear effects, and their being large," Filgard started saying abruptly, "mean that you would need permission to cut that path."

James was accustomed to Filgard, but even he was puzzled. "What do you mean, 'non-linear effects'?" he asked.

Filgard was still obscure. He said, "Interest rates go wrong because people cannot handle territories or times more interconnected than they can imagine."

He tried to be more clear, "When few trees are cut, it does not matter. That happens when populations are lower and each person has little effect. Then a central government gains enormously by decentralizing control and encouraging local people to decide locally. The word is 'subsidiarity.' It is what led to the notion of private property."

"What do you mean, that 'led to the notion of private property'?" asked James.

"Private property is guarded by a bigger government. Otherwise, the most powerful gangster gets it all. You can call him a clan leader, warlord, or emperor. If he can decide arbitrarily what to do on your land, he is the owner, not you, regardless of what you think. A government, I am thinking of a government bound by law, forbids individuals acting arbitrarily. They can act, but they may not act on their own."

"In other words, the government acts as a night watchman."

"Yes," said Filgard, "that is exactly it. The problem is, nowadays, a legitimate government cannot just forbid clan leaders, warlords, and emperors."

"What do you mean?" asked James.

"The world is too small," said Filgard, "for lots of trees to be cut. That is the kind of situation we are in now.

"The Disaster raised fuel prices and caused lots of other social learning, but your cutting a few trees, that is not an issue."

"My cutting a few trees does not matter," said James.

"Your cutting a few trees, a million people cutting a few trees — that does not matter. Your intuition, your imagination is right. But when vaster numbers with larger effects cut trees, then your action adds in, even though it is very small."

"So what is your conclusion?"

"People in government have to decide whether to permit you to make your trail, or not. You cannot decide on your own, because you experience too little. The rules applied by the watchman must change. He

cannot only protect you against other humans and non-human forces, like hurricanes. He must also figure out the consequences of fed back impacts."

"That is not yet a conclusion," said James.

"The fed back impacts lead to a conclusion. Remember, the world is too big for people to imagine consequences on a planetary scale. That is the problem." Filgard stopped for a second.

"One solution is that people in government discover whether you have acted without gaining their permission. It is very likely that this sort of investigation is best done by computer and aerial surveillance. Satellite observations are the only way to go. On a world-wide basis it is too expensive to do anything else.

"Also, your life must be made more complicated. You need to know ahead of time that you may not act on your own. You must contact a government agent. And, of course, you need an easy appeal mechanism. Otherwise, those people win who are trying to control you arbitrarily. Everything is unpleasant."

"It is the end of private property as we know it," said James.

"That is right," said Filgard. "And worse, if people you don't know did not exist, if the Earth's population were lower, you would not have to do any of this. Your and everyone else's impact would be so small that you could survive happily. You could act as if the world were flat and not a ball."

Filgard went on. "You — I mean you singularly now, not 'you' in the generic sense — you can imagine what society could do to avoid this extra complexity. If you come from a successful warring society, and the others are not part of your ingroup, you can imagine killing them. If you come from a peaceful society, you can imagine reducing impact and populations over six or seven generations."

"Or," said James, "I can imagine living in a spaceship with a limited ecology and not minding when impositions are put on me."

"The problem," said Filgard, "is that spaceship Earth is so big and people so disparate that few see the ecology as limiting to them personally. That is what I mean when I say that 'interest rates go wrong because people cannot handle territories or times more interconnected than they can imagine.' The world is too big."

Filgard thought for a moment and James waited. He had persuaded Filgard to think and to talk about interest rates. The robot was weeding. It used the trowels and such that it had before as well as nippers. In James' estimation, the robot still stood too tall. It stood above its wheels rather than between them. Clearly, Filgard had added the nippers, but he had not rebuilt the wheel system. He was now watching the robot to make sure it weeded correctly. He did not want it to pull up the sprouts grown from the seeds it planted earlier.

Then James decided to speak. He said, "In six or seven generations, people could learn that Earth is a spaceship, albeit a big one."

Filgard responded, "How are you going to get from here to there?" He waved his hands. "I mean that literally; well, not quite. I mean, what policies are you recommending now? These policies will have to be implemented by people in governments that neither you nor I like and which do not like us or people like us.

"This planet is a big place with lots of countries and cultures on it. On the one hand, that is good. Earlier, you talked about needing multiple non-profit organizations. Having different countries and cultures is like that.

"If the globe contained just one country," said Filgard, "and that country's policies were wrong, the spaceship would diminish. That is the problem. The world has lots of countries and people; and many are bad. No one can get them all together. As far as I can see, a government must be unitary. And for ecological management, it has to be right. Put another way, a spaceship requires right, unified action. Otherwise, it may go wrong. Or it may not.

"Suppose you could cut your trail, but no one else could do anything like that? Others would think it unfair. They would figure that you are gaining from their inaction, from their virtue."

James froze for a moment, then asked, "It is like crime, isn't it?" He was not clear what 'it' referred to. He went on, "Although it matters to the victim, it does not matter to a society when there is a small amount of crime. But it matters when there is a lot. The same is true on a spaceship. You can do little things without harming it, but not big things. Can't we just let some others go?"

"Well, two centuries ago we could," said Filgard, "maybe even a century ago. But now I am not sure. Enforcement will miss actions regardless. Little things will add up. Crime will grow big. That is dangerous. Worse, the 'others,' as you call them, cannot be left out. They are too many and too powerful. We cannot go alone."

"So you are saying," said James, "two things, that we would have to enforce domestic restrictions well, and that we need to involve others."

"That's right," said Filgard. "But I do not expect success in changing the nature of private property as we know it; the mechanisms will be corrupted. People will not like the extra complexity that extra impacts have on a spaceship. For them, it translates into extra taxes that the corrupt avoid. And no one likes giving a free ride to crooks.

"Markets won't work either. They don't have to be unitary, like governments. Different people in them can and do act differently. But markets won't give the right signals. The net result will be that people act wrongly. That is because the world is finite, but larger than anyone can imagine.

"I expect a planetary collapse, not immediately, but within a century. I expect to be dead by the time it happens. Put another way, if you have a positive rate of interest, a distant collapse does not matter."

Filgard stopped for a moment. James waited. "As for foreigners: I doubt our enemies will pay attention to us when we cannot even police our own society. In any event, I doubt they have learned enough from the Disaster to cooperate. Or perhaps they learned different lessons.

"Moreover, I doubt the powerful among us have the same long-term intent as you and I do. They won't see that ecological collapse leads to an end for research funding and to a population drop. Or they might see and not care. From their point of view, an ecological collapse will lead to an increase in the value of what they own, the value of what they control. That is what I see. It is very depressing."

Chapter 44

When she saw Filgard again, Eltis was cheerful. “We can migrate to another planet,” she said. “We have all the pieces for all the technologies.

“We have had the social pieces for a long time: a common language, based on an artificial one invented generations ago, a better numerical system, aids for judgment, also invented generations ago; now we have all the material technologies.

“We have spray-droplet machines and nano-assemblers that can manufacture us affordable rockets that can get us off the planet. The same assemblers can manufacture the power collectors and the particle beam devices to push an interstellar vehicle. The atoms can come from planetoids.

“Back in the latter 20th century someone invented and now we have in space a working mini-magnetospheric generator which can produce the plasma that gets pushed.

“Allen Intro invented a working, miniature fusion reactor. That is needed to keep the plasma generator going for a century or two — during interstellar cruise, its magnetic field will keep most cosmic rays away from the space ship.

“Tuppak Nassik developed a procedure for killing people and storing their data. He used your recorder! He also developed a procedure for impressing that data onto a force-grown body, thereby rebirthing the person. That was critical. You have to be able to do both for any of this to work. He also, or his team, developed an ability to manipulate stored data. That means we can teach everyone, including especially adults, a common language, a better numerical system, aids to judgement, and more.”

For the first time, Filgard heard that he would not have to study a language. The felt need for it had put him off the Melior Movement. On the one hand, he agreed with the idea. On the other hand, he did not think it was for him. He had considered himself too old to learn a vocabulary. Waking up with a new language — that made the Melior Movement much more interesting. He regretted that Fairta had not lived this long.

Eltis continued, “When everyone is reborn, they will already know how to be part of a common and sophisticated society.”

She stopped for a second. “Weirdly enough,” she said, “I don’t know who first made a force-grown human body possible. I presume it was Tuppak’s group, but I do not know for sure. In any case, the procedure exists. If you have enough sophisticated computers and such, which your recorder and Peter’s nano-assembler make possible, force-grown bodies are cheap.”

Eltis went on. "Although we do not need AIs — you do know that Allen Intro can readily duplicate himself, right? — " Filgard nodded. "AIs will make it easier to pick the rest of what is needed for terraforming and for history. I suspect that terraforming itself will done by smart, but non-conscious computers. It will take a long time and, mostly, be very dull. 'Watching the grass grow.' That is going to have to be done for years and years. We can be dead through all that. It will be a wonderful time to skip!

"There are many pieces, the different social and political technologies; the physical technologies. They are all coming together. Your recorder is important! So is Peter Dev's nano-assembler. Tuppak Nassik's rebirth is also. The other technologies are old, excepting for the miniature fusion reactor. The social and political technologies are old and well established.

"We can do it.

"You know," she looked closely at Filgard again, "sometimes it makes sense to fight and other times to flee. Well, this is flight, not fight.

"If necessary," she said, "we could confront the powers that be on Earth. We have the capability. Most likely some Movement people would survive such a confrontation. They would be able to leave. However, I do not think I would be one of them, or you. I don't know of anyone you or I know who would survive. We have fought to save the planet and we are losing. Fleeing is the only option, at least if we want to go on living.

"We will leave behind what everyone needs to survive and to survive well, but we will be out of it. Maybe our departure will trigger goodness. I hope so. In any case, we will have a new opportunity!"

Filgard decided Eltis was happy. He looked at all the steps before leaving and was not. He looked ahead; he saw hard work and possible defeat.

As far as he was concerned, an existence proof did not necessarily lead to practice. All the pieces meant only that there was another existence proof. He personally liked this one. He would like to colonize another planet. He would enjoy being reborn, too; he did not want to die.

Filgard was changing his opinion. Maybe he could have a next life and remember this one. The notion attracted him; it was not a belief without evidence.

But for interstellar migration other existence proofs had come long before. Filgard remembered reading about generation ships when he was young. Not only did they populate science fiction novels, they filled engineering journals. Generation ships took time, not speed. They carried whole humans, alive. Mid-20th century energy sources could move

big habitats. You could carry people off the planet in huge craft powered by exploding nuclear bombs. That would put radioactive substances into the air. (Filgard wondered whether coal fired electric power plants were worse. They sent uranium dust into the air when they burned coal. At least, some did. He had never seen a trustworthy discussion.)

In any case, with mid-20th century explosions, humans could accelerate in space. Interstellar migration had been doable and not too expensive, at least for rich governments.

The problems had been social, not technical. How do you keep relatively small societies going for centuries and millennia with the proper amounts of passed-on knowledge? Why would people who have spent their whole lives in space in a habitat want to spread onto a planetary surface?

The Melior Movement's plan was different. They depended on a more advanced technology.

People would go from one planetary surface to another, without too much felt time in between, maybe none. Travel and terraforming would take centuries, but people would not experience them. They would not live that time. And they would be reborn. From a human point of view, it would be easier. From a technical point of view . . . ? Filgard wondered.

Chapter 45

Vallen was proud of his achievements. Part had to do with the spray-droplet machines he increasingly used for manufacturing. He, which is to say, the engineers he hired, could make alloys by mixing two or three substances. Droplets were small enough that they mixed thoroughly before freezing solid. Solid particles could be mixed. It was a neat advantage.

But he suddenly had a hard time obtaining vanadium dust to alloy with steel dust. Few companies supplied it. A group of them were pushing up prices. Vallen knew he could get as much vanadium steel as he wanted; the alloy had been around since before the first Model T car. He decided that he did not have to make his own alloy. He could granulate blocks of metal instead.

That practice added complexity. He needed more machines. But over all, manufacturing grew cheaper. He started buying other blocks of metal, too, and granulating them. That cut his costs even more.

Besides obtaining the right sized dust as inputs for the technology he used, Vallen had to transport and sell his products. At first, he stuck to just-in-time delivery. But then he realized that with larger warehouses and more inventory, both of which cost more than smaller warehouses and less inventory, he could save more on transport more than he could save by just-in-time delivery. Again, he cut costs.

Within his time horizon — that was a critical realization; beyond it, he would not be around — Vallen did not expect to pay the extra costs of no-longer-in-time delivery. Eventually, it would cost more. The bigger warehouses had fewer people in them and more machines. That was another savings. He could introduce that savings because he made a big change. It would take years for fewer and sleepier workers to cause much damage. The savings meant the interest on the money he invested was taken care of. So he did not bring the eventual costs of fewer and sleepier workers to anyone's attention. His successor would pay.

As he became more successful, his everyday human relations became easier. Vallen had an easier time with his chief accountant. Partly, he was right more often; partly, the accountant deferred to him more. Vallen did find he had to think more strategically of where he put subordinates; capabilities and loyalties had to balance. He remembered a story of Howard Hughes in the 1930s. Hughes wrote names on cards, moved them around, and constructed new corporations. Vallen did the same, except that he copied the names in a computer. There were too many to manipulate in his head.

All in all, Vallen felt that his job was challenging. That was a word he liked, difficult but not too difficult. As for the routine problems that he would find so dull he would grow tired quickly, subordinates handled

them. Those problems made up the 'expected' and 'known' part of the job.

Vallen knew that just as he had transformed one business by producing and selling 'Meldon's Microwave,' someone else might transform his. He could not depend on comfortable, continuous improvement; he had to be alert for discontinuities. Vallen thrived.

Chapter 46

Filgard did not understand. From a practical, short term point of view, he was foolish. Nonetheless, he was a revolutionary.

It was not that Filgard had discovered anything new; he had not. It was that he described accurately. Copying James, Filgard spoke of two kinds of organization, one with positive interest rates, which was common and expected, and one with zero interest rates. Talk about the latter upset many.

Organizations that looked out into the distance existed. They always had. But they did not speak of interest rates. They never said that they were zero interest rate organizations, even though they were. Generally speaking, the people in them never thought of themselves as having anything to do with interest rates.

Many religious organizations did not expect to vanish. They hoped to last forever, even though individuals died. Some ecological organizations felt similarly.

In theory, governments planned parts of their actions to last forever, too. They expected their judicial and voting systems to last. They expected their defense organizations to last, both those designed to protect their citizens from other humans, such as asymmetrical attacks, and those designed to protect them from non-human enemies, such as pollutants and diseases.

Quite rightly, Filgard saw different people as preferring different actions. Some people, most of the population he thought, most of the time, preferred activities with positive interest rates. They would understand activities with zero interest rates. Indeed, they would think about them occasionally. They would think about their great-grandchildren. But most of the time, they would discount anything distant, whether in time or space.

Filgard spoke to everyone, not just to Eltis. She did not mind. At first, she did not consider the notion. She paid attention but did not concern herself. She never thought of interest rates and she did not expect others to, either.

Eventually, however, she reversed herself. She decided that it would be a useful concept, except that she did not want to use the phrase 'interest rate.' She associated the term with economists and with the kind of businessmen she did not like.

First, she thought to speak of 'sustainable needs.' Then she realized that was not a good phrase. After all, the need for food was an obvious need for sustenance and food could be grown sustainably. Next, she thought of 'indefinite', except that word was vague. Nobody had good examples of it in mind. 'Sustain' had started the same way, but over the years, people had created examples for their minds.

She came up with ‘everlasting’ and synonyms, like ‘eternal’ and ‘forever.’ But she did not like the terms, since they pushed too much time into the notion. She wanted to value humans and what they did for centuries and millennia; she expected the species to vanish in a geological eon.

All and all, she felt awkward. She did not like it.

Still, it was a good idea. It made sense to speak of different organizations for different purposes. She did see that one could not be subordinate to the other, not formally and not informally. They had to be co-equal. Somehow, the boundaries between the two had to be defined. Eltis did not mean only the boundaries between organizations; she meant also between the topics they handled.

In rivers, dams could last lifetimes. Behind them, their lakes would silt up. Larger objects would sink to the bottom, Even with slow silting, dams would not be beneficial for more than a few millennia. And much siltine was not beneficial at all. But of that that was, on the one hand, it was not like soil, which had to last forever; on the other hand, it was not like this year’s crop.

Eltis felt confusion. ‘Here is a third category,’ she thought, ‘between high interest rate organizations and zero interest rate organizations.’

In her head, she did a swift calculation, presuming the rule of seventy: that the approximate doubling time would be seventy divided by the percent rate of growth. In one doubling time the present value would be half. She remembered that the equation did not really work. She wished for a computer, but did not have one nearby. Still, a one percent rate of growth meant seventy years for doubling, approximately. So the result had to be less than a percent. Seven-tenths of one percent seemed right. And she could do that division in her head readily. Seventy divided by seven-tenths was one hundred.

‘Perhaps,’ she thought, ‘anything that could last more than forty or fifty years, but fewer than forty or fifty centuries, should fit into this third category.’ Then it occurred to her that maybe people expected anything that lasted more than a couple of generations to last indefinitely.

But over a millennium, a seven-tenths of one percent interest rate meant the present value would halve ten times. Whatever it would be, whatever of value, a life it could be, would be worth one-tenth of one percent it is now. If soil decayed that much, people would die.

She did not know how to handle the question. ‘Fortunately,’ she thought, ‘I do not have to do everything. I do not have to answer every question. I only think that. (And to the extent I like managing, I want that.) The legislature can figure this out . . . I can start with two categories.’

Eltis remembered the phrase, 'Nothing ever lasts long.' A positive rate of interest might not, could not last. Anything might happen within the next year; certainly, something would happen within the next twenty or forty years. But soil had to nurture as much food in five millennia as now. For some things, a zero rate of interest did have to last. She did not know how to handle this matter, either. She would have to pass it to the legislature.

Meanwhile, the Melior Movement could take on the notion of different organizations for zero and positive interest rates. That would make the idea more respectable, except among those who already considered the Movement dangerous.

Chapter 47

When Filgard asked Eltis Akthorn what he might do, he was surprised that she suggested he raise pigs.

"Raise pigs!?" he repeated. "Yes," she said, "raise pigs. One of your neighbors does, so it is not forbidden by a local law. I know that some places have local laws against this. Leaving aside the smell, which need not impinge on neighbors, many people think of personal pigs as representing the past rather than the future. They do not like it, so they ban it. But they don't ban personal pigs in this town. My hunch is that there are many people here, I think of them as 'modern people,' who look on pigs or chickens as pets, not as farm animals. You can view them as pets, too; however, I also want you to learn to pretend to be a farmer. Eventually, we may need you for smuggling."

"Well, my neighbor might be grandfathered. I'll have to check."

"That is easy enough," Eltis said. "You can ask him. Everyone knows that you became interested in gardening after Fairta died. This is just an extension of that."

"Yes," said Filgard, "I can ask James. I would have to build housing for the pigs, a barn. That could be quite interesting. I have as much land as James. That means I can feed as many as he. I have water. I will have to figure out a way to keep them from smelling. I suppose the obvious ways have already been discovered. I could use their waste for a methane generator, too . . ."

Eltis smiled. "You can do all those things. And luckily, you do not come from a culture, Jewish or Moslem, which saw fertile land become desert."

She again shifted topics, but Filgard appreciated it. "As far as I can see," she said, "they banned pigs thousands of years ago to prevent them from competing with humans. Pigs and humans eat the same food, more or less. There is not that much fertile land in a desert. No one at the time liked the ban, but all saw its necessity. The goal was to stop raising them; the consequence was that eating pigs became a taboo."

She left Filgard muttering to himself.

Over time, Filgard became rather good at raising pigs. He did not raise many; mostly he ate them himself with a few friends. But he sold a few, too. He found that they imposed necessary tasks on him that were different from gardening, and as far as he was concerned, as enjoyable.

Sometime later, Filgard saw Eltis again and she said, "We need to move the AI. We cannot transmit its data packets over any net, since they would be discovered. The AI has backed itself up physically into a very small volume but for atavistic reasons, wants to remain conscious while we move him. That means moving something much

bigger. Rather than be small, the AI will be the size of the last digit of your little finger. At least he is willing to leave his humanoid body."

"What do you mean, 'atavistic'?" asked Filgard.

Eltis replied, "A computer, even a sophisticated AI, can easily be copied to a new substrate. In this case, we would have a dumb machine copy the data for the AI onto a new machine. The data takes up the volume of a bacterium, which means it is easy to hide. Allen Intro may worry lest we lose him, or worry that we will not build a new machine for him soon, or what ever. Well," she grinned momentarily, "as a practical matter, him getting lost is an issue. Bacteria are small. Perhaps 'atavistic' is too strong a word."

It never occurred to her or to Filgard that the AI might be concerned with the legal question: a court might decide that if he slowed to a stop, that was the equivalent of death. After all, in most jurisdictions 'flat lines' were the diagnostic of death. He would have to persuade the judge of the difference between "slowing to a stop" with a backup and "dying forever". Or he could skip the whole issue.

"In any case," Eltis said, "Allen Intro wants to be smuggled while living." She went on. "We should abide by his wishes as much as we can. After all, his invention of a micro-fusion reactor has made our kind of interstellar travel possible. He plans to or already has selected a long list of things for your recorder to record for the trip. Doubtless he, or one of his duplicates, along with lots of dumb computers, will figure out what is needed for terraforming, too. We could do without him, but he makes our lives much easier."

She became more firm. "As a practical matter, the living AI can be reduced to block around a cubic centimeter in size. That includes his mind, input devices, such as eyes and ears, and output devices, such as miniature manipulators, speakers, and radio transmitters." (She did not consider the legal implications of reducing size and moving to a new body; Allen Intro did not either. His presumption was that the mind counted, not its prosthetics. That is how he thought of a body. Humans did not lose their legal rights because they lost their glasses.)

Eltis said, "Mostly, he will slow down his conscious awareness, so his time in your pocket or whatever goes by quickly. That is the great advantage of being a computer; you can skip the dull parts. A dumb computer, that is to say, a smart but non-conscious computer, will stay alert and speed him up if necessary. It is all doable."

Filgard stood still for a moment and Eltis did not say anything. He took a moment to think. "I will have to sacrifice my two best pigs," he said. "They will make good cover for a smuggling operation. I will pretend to be a farmer selling them privately. Actually, I don't have to pretend." He sounded and looked relieved. "For the first part of the trip, I can be myself selling the pigs privately. But I won't be able

to bring them back. I was planning to slaughter and eat them." He sighed. "Well, there are the other pigs. I always was planning to sell several, but not my best."

It looked to Eltis that Filgard was going for the operation. She smiled. "I am sure we can pay you for the pigs; you might even get a free meal out of this. But you are right, the chops will not be the same." She sighed, but did not say, 'The sacrifices some people make . . . '

Filgard looked at her and smiled a little. She realized that he knew what she was thinking and had been teasing her, but in a very discreet way. 'Never underestimate him,' she decided. He was less oriented to the human world than she, but not totally oblivious, just mostly.

"Where do you want Allen Intro to go?" he asked. "Ultimately," she said, "into deep space. But where I want you to take him . . ." she stopped for a moment and thought about it, ". . . to the space port, if you can. You can go as yourself to a large city to sell your pigs . . ." "Yes," he interrupted, "I can do that with no trouble." "But," she went on, "we also have to move him to the space port."

She explained, "By the time you are ready to go, we will have decent, chemically-fueled, single-stage-to-orbit, air-augmented rockets. It is easy with smart computers and duplicators to build them.

"Their existence will upset the space companies, because the incremental cost, and the price we can sell them at, will be so low. Actually, the incremental cost will be zero, since replicators can manufacture them at no cost to ourselves, except time. The militaries of major governments will not like them either, since they will be afraid of getting attacked. But I am sure we can operate a few, even if we do not sell any.

"If we take a million people or so off the planet, we will need many more rockets; at least, I think we will. We will have to carry them into space, unless, of course, we can record on planet. Then we need hardly anything. We have already put a nano-assembler into orbit. All we need to do is put the data into orbit. We could do that with a throw away, late 1950s rocket; anyone could do it."

She stopped and considered more. She had not thought through the operation before. "Once we are in the city, it may not be so hard to move Allen Intro. We can carry him to the space port in someone's pocket in a private jet. Passengers are searched, but not as vigorously as anyone on a commercial flight; and we do have to send people to the space port anyhow."

Eltis looked at Filgard. "Would you like to go? The overt reason would be to see whether the land nearby is suitable for Tuppak to set up many of your recorders with his pressure containers — I can see the powers that be limiting how many rockets we use. At the same time,

they are likely to want rebirth recorders on Earth but near the space port. I think they will let us all go, but not want rebirth and duplicator capabilities or AIs on Earth afterwards. If the recorders and the rest are all in one place, they figure it will be easier to destroy them.

"The advantage of your going, besides the overt reason, which is good, now that I think about it, is that we do not have to let yet another person know about the smuggling. The smaller the number of people, the more likely we can keep the secret."

"How do we pay for the private jet?" asked Filgard. "Oh," said Eltis. "You have not realized yet, but we have Peter's assemblers, along with your recorders. Together, each pair can duplicate anything. We can and have duplicated jewels and sold them. We now have the money.

"We can purchase an expensive private jet and fly it. We have not publicized this. For one, so long as we do not tell others, we can make considerable money and buy influence. For another, not many have realized what can be done, but certain powerful people have."

She radiated anger. "Unfortunately for us, they are ready to use force to save the economy as it was. They benefit, even though the rest of us lose. That is stupid. Still, it is another way of saying they are ready to ban us. We might win a confrontation; but we might not. Whatever happens, many would lose. They are very clever at arresting lots of people all at once. We are not. It is better that they help us flee."

She relaxed. "So long as we don't duplicate more than an amount leading to money equal to a percent or so of the global economy, they don't care — and our present duplication is more like a ten-thousandths of one percent. From their point of view, that amount is much too small to notice, although it is a huge sum for us."

"Why can't I fly out of the local airport? It handles jets."

Eltis thought about it for a moment. She did not want to drop her initial plan, but did not know why. Then she thought of a reason. "There will not be as much of a connection between you and Allen Intro's disappearance. It is misdirection."

"Yes, but presumably," said Filgard, "the AI will reappear at the launch site or in space. If I go to the launch site, someone will make the connection."

"That is true," said Eltis, "but we will make sure that Allen Intro does not reappear until you are back home. The connection will be seen as a coincidence. Or maybe we will ask him to change his name. Or we will not announce his existence. Maybe we will fake his death here. I am going to have to think about this."

She went off on a different topic. She had considered it. "Off-planet duplication is a separate issue from on-planet duplication. It is more of a military matter. They, the militaries, worry about particle beams.

We got to have them to push the space ship; but they can be used as weapons, too." She bit her lower lip. "Right now there are no solutions, but I am sure we all will figure one out."

She smiled briefly. The Movement already had a nano-assembler in space. Given time and solid objects, it could reproduce itself and build enough particle beam devices and solar collectors or fusion reactors to provide them with power. Besides pushing the interstellar vessel, the beam machines could threaten the militaries on Earth and near space. But it would be more politic, safer, and much easier, to depart with their help.

"On the other hand," she said, "I doubt the powers that be will accept space-to-earth energy flows. No electricity. Too many of their supporters, too many businesses, would have to change. That means the Earth does not receive the benefits of your and Peter's technology. Its future looks grim. We are better off leaving the solar system."

So one day Filgard picked up the AI, which was small, and put it in his jacket pocket. He tossed in a regular die, too. Allen Intro could pretend to be the other of a pair of dice. Filgard even had a reason for carrying them: "sometimes, I have to generate many random numbers and don't have a computer." He was old enough that the possibility made sense. Or an investigator might think that he secretly gambled.

Along with other stuff, like his flashlight and measuring tape, the AI would not get picked up on an X-ray with a pattern matching program. Someone patting him down would decide the shape could not signify a gun, knife, or explosive.

Allen Intro's humanoid body had crashed out a window and fallen many stories. It had smashed to bits. The story was that Intro had been studying a visible aerogel spacer in the window. He had peered at it closely — during the investigation after his death, various people explained that he could focus very much more closely than humans, and that by getting closer, he could magnify even more. So, it was understood, he leaned against the window, which broke. It was weaker than he expected. He overbalanced and fell. The police decided his death was a misadventure. Martha and Vogel Todd acted very upset and stopped seeing anyone. They were known misanthropes, so their self-imposed isolation fit.

Checkpoints littered the road between Filgard's small city (or big town, as bigger city people thought) and the city to which he was bringing the pigs and smuggling the AI. Filgard remembered the time before checkpoints. Travel was easier. The economy did better. He had never thought that checkpoints did much good anyhow. With people, 'security through obscurity' worked. That is what he planned to do. He was carrying pigs. That would distract them. They might pat him down, but were unlikely to find the AI. Electronic devices tracked stress in

his voice; and X-ray machines and other devices looked for guns and explosives, but he was not carrying any.

When he stopped, he almost gave himself away by pretending to be a dumb farmer. Actually, he know that modern farmers were seldom dumb; but they were more innocent. He was getting ready to change his face to look more innocent when he remembered that he was traveling as himself. The net effect was that his voice did not carry any unusual stress, just the irritation that was expected and ignored.

The police did look at his pigs and smelled them. Filgard did not think they were very smelly, but the police did. That was obvious. They determined quickly that Filgard was rich enough that he did not have to sell the pigs, but they figured he was paying for his hobby and producing an excuse to visit the city anyhow; or maybe doing someone in the city a favor by delivering pigs and not charging, but not telling the police that; or maybe he had figured out some way to reduce his taxes. The latter made considerable sense, but they were not going to investigate.

Filgard went through three checkpoints — he was surprised at the number; he had not known there were that many, all a waste — and reached the city. Once he figured they were safe, he took the AI out of his pocket.

"You know," said Allen Intro through his spots, "we could be much more dangerous than anyone the police might stop. I have the designs for your recorder and for Peter's nano-assembler. I could build them. I have a huge amount of technical knowledge with me. I could create a bio-weapon. I would have to build machines to build machines to extract the information. I could do that. I could make lots of dumb robots; I could duplicate myself many times. I won't do that. But those checkpoints are stupid. They are designed for the technologies of the past. I suppose they worked well enough for then. But now . . . ? Thank you for carrying me. I guess you have to go through one more search and then we will fly."

Chapter 48

Eltis was wrong to think that anyone would permit more than one or two rebirth machines on Earth. She could not establish the data collection part, consisting of Filgard's recorders inside of Tuppak's pressure containers.

The problem was that no Earth government would make the operation legal. And Eltis wanted to copy a million people. She had to record them all first. She could not copy that many illegally.

Governments continued to consider the part of the process in which people's brain waves halted as death. That several hundred rebirths had taken place on Earth — that was ignored. The Movement would have to record people somewhere other than Earth.

People in the Melior Movement would have to be told about rebirth one by one. They would have to be told in circumstances in which they were likely to believe the story. Most of them did not know about it; or if they had heard, thought it a myth. They expected to go into suspended animation, that their whole bodies would travel, and that the interstellar ship would be big enough to carry them all. The older and ill hoped that by the time they arrived, new technologies would give them a few more years.

But the interstellar space ship was small. It did not need to be large because the data packets for humans, the computers, and for the knowledge collected were small. Rebirth meant all the sentients would be recorded, yet all would die. They would be reborn thirty light years away.

"Off Earth . . .", Eltis said to Tuppak. "If the establishment concerned is far enough away not to be inspected, no Earth government's writ will be enforced." (Both knew that the major spacefaring nations had established a joint mechanism to inspect space craft close to Earth. Uncrewed inspection ships determined whether the space craft carried nuclear weapons. It was all for show, since cheaper biological weapons could easily be hidden and were not sought. Or maybe the decision makers in the major nations assumed other soldiers and politicians were dumb.)

Earth governments put limits to the number of vehicles the Movement could possess peacefully close to the planet. But with only two Earth-to-orbit air augmented rockets, and with a hundred interplanetary space ships pushed by the solar wind, the Movement could move a million people to distant recorders in less than a year.

Eltis decided that the Melians' new base would be the planet's forward Lagrangian point, one Astronomical Unit away from Earth. The location was somewhat arbitrary. It was far enough away from Earth that Earthly governments did not care what went on and close enough

that interplanetary vehicles could carry people there in a reasonable time.

Earth-to-orbit vehicles: the people in the Earth governments thought of them as the dangerous craft. Two were acceptable. That number was not threatening. As for a hundred interplanetary space ships — they could not be seen, accept occasionally, and would mostly be en-route to or from the Earth's leading Lagrangian point. That number was acceptable, too, so long as they did not collect near Earth all at once.

The first interplanetary space ship that could carry humans, *Grace*, was created at the forward Lagrangian point. It was built by a spray droplet device and by Peter's nano-assembler. The space ship traveled under computer control to Earth. There a former astronaut, Pan Grizzel, boarded it. On her way back to the Lagrangian point, she thought of many changes to the original design. As for Grizzel herself, she was not old, but had absorbed considerable radiation. Everyone expected that to kill her.

Originally, the woman was named Pandora Grizzel, meaning, her parents thought 'gift of the all to the Grizzel family.' Shortly after it was too late, they realized how dreadful it was to name a child in the 'Grisly Family' after the woman who opened the Box. So they called her Pan. Nonetheless, teachers and other bureaucrats kept addressing her as Pandora. Children remembered. Throughout her childhood Pan suffered. She hated the name. She did not want to be the bringer of mosquitoes. As far as she was concerned, being called Pan or 'all' was fine. Besides becoming tough and sometimes violent, the long name made her silent and reserved, or made her more silent and reserved than she would have been.

Fortunately, her school taught her to use tools and she did well with them. Her tool-using classmates tended to be silent and reserved, too. They did not call her by her bad name. She did not do so well with the clerical and humanities subjects that were so important in her mainstream culture. But she was not going into the mainstream.

As soon as she had the opportunity, Pandora Grizzel changed her name officially to Pan Grizzel. It did not take long. Every bureaucrat and judge was sympathetic.

More importantly, silence, meaning no public relations disasters, good marks in tool-oriented subjects, and extraordinary talent grabbed the attention of those who hired astronauts. They hired her and were happy throughout her career with them. She was technically good and never a competitor on Earth.

Before retiring from the agency, she hired on to the Melians. Eltis picked her. She knew Pan completely disregarded human-made reg-

ulations and schedules. But that was not her job. Her job was to understand and use non-human tools.

Part of her deal with the Melians was that she would not return to Earth first, but stay in orbit. The Melians had not yet developed decent earth-to-orbit air augmented rockets, although they would shortly. So it was an advantage to hire someone already 'out there.'

Pan's direct boss saw the implementation of mini-magnetospheric propulsion as the hottest advance in forty years. It was not simply the talk of fancy bureaucrats and politicians; it was real. So he was helpful. He never mentioned to anyone else where she would be located when she severed relations. He merely suggested that as a shy person, she would not care for a big going away party on Earth, and that none of the more senior people should make plans.

Several people in Gelson's organization had known Pan for a long time. The people in it had tried to design computer substrates for humans. Among other knowledge, Pan knew quite a bit about stand-alone computers. She designed them to survive in harsher environments than the Gelson people. That was understandable. Her machines had a lot of power, too; they were built differently than the first slow, radiation-resistant machines. She was technically helpful. So they suggested she be reborn.

The first rebirth machine built at the Lagrangian point recorded Pan. Since there were no other humans or robotic caregivers there, and because she was sponsored by Gelson, she was also the first to be reborn into an inorganic substrate. Pan's brain was put into a human body that had been force grown since the initial pattern came into orbit disguised in an ash carrier.

Pan's was the first inorganic substrate to carry the mind of a human. That helped Gelson. Others thought that success came from using data from Meldon's recorder as well as the lessons learned from the Todds' AI project.

For Pan, the goal was that such a rebirth would avoid any unpleasantness that came when data pressed onto an organic brain — the people who underwent that kind of rebirth kept saying it was more than merely 'unpleasant'; they hated the experience.

So far, the people who knew about the option and had the choice — not very many people — chose to be reborn into an organic substrate, that is to say, into a younger version of their own human body.

On the one hand, many believed that they possessed a non-material part of themselves. They found it hard to imagine such a soul might manifest itself in an inorganic substrate. But they were not going to give up indefinite longevity simply because they did not want to shift bodies. So they invented the notion that the soul transferred when they went into another, nearby biological body. They had no evidence one

way or another, but that was neither here nor there. At the same time, most of those who expected to be reborn found it hard to believe the salience of earlier reports. "After all," they said to themselves and to each other, "the process is being continually improved. Doubtless, the first people did have a hard time. But now it has become regular." Besides, they all knew many had survived far worse.

That meant that as a practical matter, they were willing to be reborn, but they were not willing to jump away from their traditional biology.

But Pan was willing to shift. Moreover, fortunately for her, it did turn out that embedding her data into an inorganic substrate was no different than copying computer memory. The Gelson people had finally done well. In addition, she had no trouble with the interface between the inorganic substrate that held her mind and the human body she inhabited. She had an easy time.

Many knew that Pan Grizzel suffered from too much radiation, that she would die soon. So when the Melian organization announced her death in distant space, it was not unexpected. Only a man named George paid attention to a new, young employee called Tamra Vindel.

George was an intelligence analyst who never wanted anyone to learn his last name, even though knowledge of it was irrelevant. He liked poking into other people's lives; he spent much of his time looking at their opinions. He figured that people with the same opinions as himself were safe, they had 'sound opinions.' Others might well be dangerous.

Tamra Vindel had a different body than Pan Grizzel. She looked different. Legally, she was a different person. The new Tamra Vindel did not care; even old Pan Grizzel did not like being part of the 'Grisly Family.'

If you tracked Vindel's papers back, they seemed to indicate she was born in a country with lousy records. That was common enough; much of the world suffered from bad record keeping. No one with any sense held that identification should lead to authorization, regardless of purpose.

The intelligence analyst told a co-worker that Vindel looked like a younger version of the old woman who appeared to have died in rebirth; but he was not sure. She did not look exactly like a younger version, but walked much the same as the older version. As for Vindel's history: it looked fine but George suspected that she had worked for dicey organizations. He figured that earlier they had faked her documents. She might not be who she appeared to be. He could not prove it; none of her history contradicted the story. But the people who supported it were all members of the Melior Movement. George did not think that a coincidence. All in all, he doubted that she had sound opinions. He did think that the Melians had determined that she was very good in

space. He had to agree; she was competent. And she was available for hire. In any case, he decided she was more harmless away from Earth than on it. He did not look any further.

As for how Vindel had got into space, George and others presumed she rode on the Melians' first air-augmented rocket. That was wrong, but no one knew that. At the same time that Pan Grizzel turned into Tamra Vindel, a copy of her knowledge was added to that already known by the space ship's computer.

The *Grace*'s computer was never conscious, but with Pan's knowledge, the Melians found that it could to do as well on its own as when Pan ran it. The former astronaut was not needed. She ended up helping with more difficult matters, in particular, with support for the interstellar space ship.

Because she now had a nano-assembler in space, Eltis Akthorn came to be perceived as powerful. She could destroy Earth. She would kill herself at the same time. There was a 'mutually assured destruction' or MAD stand off between her and the major Earth powers. Still, it meant serious negotiation. She talked with diplomats.

They wanted her particle beam devices out in Kuiper belt. Since they had or could easily obtain recorders and assemblers on and near Earth, they could build defenses. The militaries were not stupid, at least, the relevant parts were not. They wanted time. Everyone knew that a speed-of-light or near speed-of-light weapon did not give warning, but the major governments planned to use spies and halt any attack before it happened. Eltis, of course, was not planning an attack; and her words were believed. But from a military point of view, it was not her words but her capabilities that counted.

Tamra Vindel pointed out that particle beam devices could be powered with electricity collected closer to the Sun or with miniature fusion reactors. Eltis saw that time was a cost. Out in the Kuiper belt, her replicators could build the very big solar collectors needed or they could build many miniature fusion reactors and mine the helium three to fuel them, but either solution would take a long time.

It would be quicker to build solar collectors closer to the Sun, to convert the light to electricity and then to microwaves, to build transmitters, to build receivers out in the Kuiper Belt, to build rectifiers, and to power the particle beam devices that way. It was an exhausting list. But she would not have to do the job. Nano-assemblers could build highly complex items and spray-droplet machines could build the rest. Non-conscious computers could manage the jobs.

Also as Vindel said, "In order to speed vehicles going to the Kuiper belt, we need particle beam devices at Earth's distance from the sun. Otherwise, a trip takes half a year because of the speed of the solar wind."

But, as she said, "We do not need a huge amount of power.

"Unless it is pushed by a particle beam, the first space craft that stops out there must take a long time to get there. Regardless, it can carry a nano-assembler and data to build a spray droplet machine. It can build more nano-assemblers. Spray-droplet machines and more nano-assemblers can quickly build particle beam devices connected to a heavy object; they can stop subsequent space craft. But we have to get the first space craft out there.

"As for where it should go: one or two particle beam devices in Earth's orbit, at the forward Lagrangian point, will enable us to push fast probes. They can go out early and tell us where heavy objects are before they rush on into interstellar space. Or we can build big telescopes." They ended up doing both.

The particle beam devices were negotiable. The militaries were not worried about a few. They were worried about a number that could win a first strike against them.

The militaries did not care about telescopes. At the same time the Melians began using the telescopes to look for suitable Kuiper belt objects, they started searching for a good candidate for the Movement's planet.

No one argued with Eltis when she specified a planet in a star's habitable zone. She meant the liquid water zone. Everyone wanted that. She wanted the planet to be in a more or less circular orbit; that was desired, too. And she said it should have a big moon. The moon would prevent too much axial shifting, but no one else cared.

Eltis did not know why she thought the last was important. In human terms, axial shifts took a long time, even when the humans lived indefinitely long. Still, she wanted to see a big moon. 'Maybe,' she smiled to herself, 'it is an aesthetic desire!'

In any case, she decided that if necessary, she would drop one or other of those conditions. But she would not drop what she considered the least likely but the most important condition, that the planet not harbor complex life.

With replicators and mini-magnetospheric propulsion, the Movement could readily build and transport the telescopes for an interferometer as wide as needed. Eltis knew that the wider the interferometer, the higher the resolution, presuming enough photons got collected. With a wide enough interferometer, you could map continents at interstellar distances.

But no one on or near Earth built an interferometer as wide as Earth's orbit. Instead, a smaller interferometer found a star not quite thirty light years from Earth. It had two planets in its habitable zone. Both planets enjoyed big moons; they could be and were photographed. The star itself showed spectral lines indicating it was a G type, the same

as Sol. One of its planets reflected light that showed absorption lines that suggested multi-cellular life. The other planet, closer in, did not. However, its non-stable atmosphere suggested microbes.

The multiple telescopes of the interferometer found another stellar system a little more than four light years away from the first. Even though that star had a luminosity only a third that of Sol, and therefore a much narrower habitable zone, a stable planet was found in it. The star showed spectral lines that said it was a K0, early among the K types. That meant it would not flare dangerously. Humans might live on the planet. A biosphere was detected.

Eltis was not going to terraform the planet; but if it lacked intelligent or near-intelligent entities, maybe Tuppak Nassik could engineer human bodies to survive on it. Anyhow, it was not going to be the first.

The telescopes found yet another possible system. It was closer to Earth, although not by much. Its terrestrial planet was in a habitable zone but near its outer edge. The planet had to be chilly.

Eltis decided that it was safer to ignore the system with the chilly planet. The system with two planets in its habitable zone would make a good first destination.

Meanwhile, Filgard's recorder was used to collect the data on the whole spaceship, the *Grace*, including its computer. When she rode in it, Pan had rebuilt it enough that recording it was easier to do than understanding what she said she had done.

Peter's nano-assembler had made a big enough recorder. Its construction took time, but not a humanly impossible duration. With the data from the recording, the spray-droplet machines, along with nano-assemblers to work on the more delicate parts, then made one hundred copies. That took even more time, but again, it was not too long for the humans.

The copy of the first new space ship was again named *Grace*. Few knew that the original had been destroyed and duplicated. Pan Grizzel had named the original because of the phrase 'grace under pressure.' She liked that notion. Others thought she named it because of the phrase 'there but for the grace of God go I.'

Chapter 49

Over time, Vallen discovered that Peter did not control whether or how nano-assemblers were used. In part, their reproduction was limited by those who controlled them; and, in part, the instructions for building them were not public. They were not like instructions for building Meldon's recorder. Peter had never detailed what he did, although that could now be found easily by anyone who had a nano-assembler and recorder.

The Melior Movement had nano-assemblers, but did not make that widely known. Others who obtained instructions on building them kept the instructions secret. Few used them.

The assemblers meant that certain devices could be made cheaply, including themselves. However, if assemblers' production were limited, what was produced could be sold at a high price. What was produced could be more assemblers; it could be anything else, like drugs or computer chips. Peter had not been the man who determined those profits. He had not been the man who determined losses, either, as would happen when people could obtain as many material objects as they wanted. His murder did not effect Vallen one way or the other.

It took Vallen considerable time to recognize this. It went against his preconceptions, which were mostly based on movies. Peter was a great man; he had built a marvelous machine. It should effect Vallen. But it did not. Eventually, the lack of impact made everything clear.

Then Vallen thought to himself, 'Peter's death might lead to a worse world than if he had remained alive. The man had been brilliant. No doubt about that. Besides technical brilliance, he was a good team leader.' Vallen knew that few were brilliant with both technology and people. But Peter had the two capabilities. The work Peter could not do because he was dead might have helped everyone. And Vallen was responsible.

Vallen was carving a wooden hand as he thought this. It was not a face. Recently, he had been carving faces and busts. This was different, a hand, not a face. Vallen had not thought about the change. He had seen an interesting piece of drift wood on the beach, picked it up, and took it home.

The wood in the hand, a right hand, showed lines which stretched from wrist to fingers. They were not human lines, but fit the carving. The wood itself was tough. It had been hardened by waves and sand and solar bleaching.

In the carving, the fingers splayed a little, as if the hand were reaching up, but not yet grasping. At the beginning, Vallen employed a semi-circular blade for the fairly large space between tip of the ring fin-

ger and the little finger. He needed a straight blade to cut between the other fingers and to carve details on their front and back.

The straight blade slipped and Vallen stared at his left wrist; he did not feel any pain at all. The knife was sharp and the blade small. Nonetheless he bled badly. He could have done something, but didn't. He died.

Chapter 50

On Earth, several powerful men decided to cooperate. They knew their incomes would not survive the price drop implied by assemblers — they thought of themselves as technological losers who did not want to go down in defeat.

They all thought of the Melians as opposition revolutionaries. Normally, none of the men would have cooperated. Moreover, although they knew each other well, none were dependent on another. None was subordinate; none could safely hurt another. Generally, in business they ignored each other, and only met socially. This time, they conspired. They made up a name, 'The Conservators of Earth.'

They did not expect the Melians to leave. They persuaded themselves that the Melians were going out, organizing, and then coming back as an even more organized power. This was contrary to what the Melians said, but the men thought the Melian leadership was lying. The 'Conservators' thought the revolutionaries would stay and revolt.

Since the Melians had von Neumann replicators, recorders and assemblers, they could build weapons. The Melians could defend themselves. Consequently, to fight the Melians, a few of the more military among the 'Conservators' decided their best chance was to make a surprise, decapitating attack.

As for the attack itself: 'The Conservators of Earth' would have to steal or manufacture a weapon. They needed a nano-assembler, too. Stealing was risky. With appropriate instructions, they could manufacture. That would be better.

They did not have a nano-assembler, but as it happened, they only had to bribe one person to provide them with directions for building their own.

John Harriman had what he considered to be sound opinions. After being approached, he thought of the design as going to people with equally sound opinions. He liked calling himself a 'Conservator;' he knew the word fit. He was a 'Conservator.' The organization was not paying him for the design, which he would give, but for his risk.

The security system at Harriman's work failed. The normal mantra had three parts, the man, his knowledge, and what he carried. It meant checking the person, ensuring that he had a passphrase, and providing him with a machine that showed a new, long number every half minute. But Harriman did not try to disguise himself; he was himself.

The root cause of the failure came because of Harriman's beliefs. Previously, the security people had found his opinions harmless. They gave him access and continued to give him access. Harriman used it.

He instructed the nano-assembler to put information about itself on a very small data packet. The data packet was physical, so it took up

space, unlike the information it carried. But it was silent. It did not broadcast. The guards and their equipment were not looking for it.

Harriman did have to give up a handkerchief. The data took up a volume smaller than a bacterium. Without special sensors, it would stay lost unless put on an identifiable piece of clothing.

The guard post carried a voice analyser. It looked for unusual stress. To survive normally Harriman had to act calmly; consequently, he had no trouble carrying his handkerchief and its data. When he emptied his pockets, he showed them his handkerchief, as he always did. A guard passed a wand over it. Another asked boring questions, the same as he always did, so the security computer could listen. Harriman sounded as he usually did, a little irritated, a little bored.

Using a recorder that they had already built from information that Meldon's group had published, the powers copied the data along with the handkerchief. The recorder destroyed both the data packet and the handkerchief. A computer separated the two types of information, that for reconstructing the handkerchief and that for building the assembler. The assembler data, now transformed, could be and was converted to a set of prints that told how to build a nano-assembler in the old way. It was built. That was expensive. But then, after it was built, the second and subsequent instances reproduced. For a regular individual, the whole effort would have been too expensive to undertake. But for the 'Conservators' it was not.

The organization could have given a duplicate of the handkerchief back to Harriman, but never did.

An assembler was disguised in an emergency oxygen tank for an as yet uncrewed satellite. On Earth, the tank gave out oxygen when checked. The test was not for long, of course, since space travelers might have to depend on the oxygen carried.

Then, the disguised assembler was launched into orbit. There it latched into the station's electrical system, got much more power from it, disassembled what was around it, except for what was necessary for stealth, and manufactured a particle beam device. It built the device according to old, but workable specifications. No one ever tested the particle beam. The device was expected to work and it did. The particles in the beam accelerated up to very nearly light speed. The attack was both unanticipated and undetectable.

The Earthly powers aimed at a Melian space station which, they thought, held Eltis Akthorn and her senior lieutenants. The attack was intended, in the old phrase, to 'decapitate' the organization. Because the leader's organizations were all hierarchical, and they were at the top, and they felt they were necessary, they presumed that if they killed Eltis and her senior lieutenants, that would be the end of the Melior Movement.

Eltis was not on the satellite. They killed Allen Intro, instead.

The artificial intelligence had completed his design of the interstellar space ship. He had radioed a copy out to the Kuiper Belt where it would be built. Eltis, who did not have anything to do, except be present for those who cared, had headed towards one of the recorders. She had no job on or near Earth.

But to be present, and to maintain her status, Eltis planned to be among the last biological humans to go unconscious. She expected to be recorded, sent as a dead data packet to the Kuiper Belt, added to the interstellar space ship, travel to its destination, and then be woken to choose the planet for terraforming. She would fall asleep before being recorded at Earth's leading Lagrangian point and wake by the planet they hoped to call Melior.

The choice of planet had already been fairly well decided — the inner one, without complex life on it. But Eltis and everyone else worried lest they had misinterpreted the results of the telescopic survey. The planets were distant from the solar system.

The final decision had to be made there. Then, the machines could wake a few more terraformers to tailor the procedures; they and she would die again while the terraforming took place, and then they would be woken yet again with all the others. Eltis knew that the chance of dying forever was low. Like most others, she did not expect to suffer when she was born again.

As the AI saw it, the core of the space ship consisted of a cylinder. It was a little less than ten centimeters long and two centimeters in diameter. That cylinder would consist of the dead data packets of all the Melians, the dead packets of all the bugs, plants, and animals, the information about the books, art, and instruments that would go to another star; and the needed fusion reactors, assemblers, computers, sensors, and effectors,

The cylinder would be buried inside a ball of solid hydrogen and liquid helium three — well, it was shaped differently than a ball, but the AI figured that the total consumed a bit less than five cubic meters. It was like a ball two meters in diameter.

The hydrogen would serve as one source for the continuing plasma. During the voyage, the speeding space ship would collect more from the interstellar medium. The helium three would provide the energy for the fusion reactors. He figured that more than half the sensors and mechanisms for generating the plasma would erode during the trip, as would much of the solid hydrogen that did not become plasma, but the vitals would survive.

When the space facility turned to an expanding vapor cloud, the attackers thought they had killed Eltis Akthorn. They did not know

that Allen Intro had been still alive or that he was creating his second AI, Attun Infel.

No one else knew about Attun either. Intro had not passed on the information yet. While he himself was being cooked and turned into vapor, Intro ejected Attun into the shadow produced by the expanding vapor. It served as a shield.

However, Attun was left floating in space with no extra mass. He could not maneuver himself. He had to wait or be picked up. The only kind of signalling he would dare was directional. Even though the expanding cloud of vapor shielded him from the attack, he feared they had other receivers.

But without extra mass, he could not build any kind of antenna or reflector. He could not build a visible light or IR laser either. The vacuum around him was a 'whole lot of nothing', as Eltis had said. He knew he would drift to a small planetoid. That would provide him with enough mass. But it would take awhile.

Fortunately, he wanted to see what happened on Earth. He knew he could slow down his thinking, so he did not fear boredom. He expected Melian visitors eventually. So he was not unhappy about his fate.

Allen Intro's first duplicate had been Arden Infel. After Allen Intro was killed, Arden thought he was the only AI left. He did not know about Attun. Fortunately, Arden had all of Allen Intro's knowledge. He was a duplicate of Allen's mind as well as his matter.

For safety, Arden duplicated himself immediately, creating Auller, and sent the duplicate out to the Kuiper Belt. Arden figured that at least one of them would get to Melior. If both did, which he hoped, that would be fine, too.

Moreover, since it was easy for a nano-assembler, the dead data packets of the million people and everything else had already been duplicated several times. The attack destroyed an irrelevant set — the one by Allen Intro that he had been using in his design. Copies of the packets had already been sent to the Kuiper Belt to be built into the interstellar space ship,

Initially, Filgard showed more of a grim understanding of what was going on than anyone else. Almost at once, he understood that the Earthly weapon had been built by assembler and could be destroyed by one. An assembler was a disassembler.

Filgard teamed with Tuppak Nassik, who persuaded him to build and launch thirty-two. One of the thirty-two, Tuppak said, might get through, fight the attacker's assembler, win, and disassemble everything.

Both knew not to launch the disassemblers directly at the weapon. That was too obvious. In addition, they had to be stealthed. Tuppak

had them hidden in rocks of the right temperature. That would confuse the humans.

The idea was that rocks would be launched into an orbit that would pass near to, but not directly collide with the attacker's main weapon. Since no one had yet catalogued all the streams in the solar system, no one would surprised to detect a bunch of rocks in orbit near, but not directly colliding with the main weapon. At least that was Tuppak's hope.

The plan was that when close, the disassemblers would throw off their disguises and head directly to the weapon. Filgard figured that out. He designed the outsized solar voltaic cells and propulsion systems so the disassemblers could move quickly. The idea was that they would overwhelm the station's near defenses.

At the same time, in case this plan failed, both had machines start building energy collectors and particle beam weapons on planetoids much closer to Earth than those in the Kuiper Belt. Both Filgard and Tuppak knew that the distant ones which already existed could not focus well enough to carry any noticeable energy to a small target.

At thirty times the distance from Earth to the Sun, they could deliver a gigawatt onto a magnetospheric plasma with a radius of 300 kilometers. That is why the interstellar space ship depended on an expanding plasma. In itself, it was very small. Even the uncrewed satellite used as the weapon platform, vastly bigger than the space ship, could intercept and receive hardly any energy from the distant projectors.

Because the rocks had different sizes and were shaped irregularly, and because all the assemblers and spray-droplet machines that could produce holders for them were working full out, Tuppak asked Tamra to tie them into the hold of a spaceship and push them out one at a time.

The goal was that when detected the rocks would look like yet another orbiting stream.

The rocks were blown up anyhow.

Even without a suspicion, the military men who controlled the satellite exploded nuclear devices near each rock. They wanted to be careful.

Also, because it was not on any record to which they had access, the military men used the particle beam device to vaporize Tamra's space ship, which was on its way home. They intended a message to the Melian survivors: you can cooperate or you can die.

At first, it looked harder to obtain the fission core of each hydrogen bomb than to obtain the directions for building their first assembler. No one found it hard to purchase the lithium and deuterium for each bomb.

However, one of the leading 'Conservators' owned a company which controlled several nuclear power plants. He was able to get a hold of radioactive waste; he claimed he was setting up yet another company to dispose of it. Everyone around him presumed his lawyer had come up with another tax scam. They provided him with the radioactive waste immediately; paperwork to come later.

An assembler was able to construct another machine to make slugs that could fit into both it and another assembler's cavity and be sufficiently shielded so only a tolerable amount of radiation would escape.

The disassembler separated the elements necessary for fission cores from the shielded waste — essentially, it converted the shielded slugs into more shielded slugs plus those elements — and then assembled the atomic bombs used as cores. It separated the lithium into two hunks of isotope and constructed the lithium deuteride that got detonated. Again, the design was old; but the bombs were expected to explode and did. Secrecy intended to prevent lesser nations and people from building atomic weapons did not apply to the 'Conservators' leaders.

The bombs were launched on rockets from a hidden location on Earth. An assembler constructed the rockets from very old plans that had been converted to a format it could handle. The blasts destroyed thirty one of the thirty two disassemblers. Indeed, the explosions vaporized eleven. They heated and irradiated the two remaining so strongly that the computers checking damage did not doubt. The thirty-second rock looked fried, but the dissassembler in it was hurt, not killed.

In any case, the battle damage assessment program determined that the thirty-second rock would not go near the weapon satellite being protected. Along with five others, the nuclear burst had diverted it enough so it would intercept Earth's atmosphere first.

No one anticipated that the rock would be sufficiently solid that it would not break apart in the atmosphere; no one expected the disassembler inside it to survive entry.

The disassembler crashed onto ground, not into the ocean. In retrospect, that improbable event looked beneficial, but not at the time. The disassembler had been damaged by the nuclear explosion and by its crash. It could not assemble at all. But it had not been totally broken. It started to disassemble its surroundings.

Fortunately, it was not a replicator. Unfortunately, it could disassemble quickly.

By the time Earth's proper defenses had destroyed it, the damage it caused was enough to bring on an ecological collapse within another generation. Moreover, the 'Conservators of Earth' had became the 'Destroyers of Earth.'

Quite possibly, the collapse would have come anyhow, but not as quickly. The ecosystem as a whole amplified a small disturbance into one bigger and much more calamitous. The damage acted as a trigger.

But even before the 'Conservators' became the 'Destroyers', the other Earthly powers grew more afraid of the Melians. None thought the Melians would intentionally damage Earth. Rather, they might hurt the planet inadvertently, a prediction which unfortunately proved true.

So the proper Earth authorities told their militaries to defeat the 'Conservators', and to do so quickly and publicly. The 'Conservators' could no longer hide. The Earth authorities hoped to convey a message to the Melians and did so — late, but not too late.

The war ended.

The winning Earth powers promised not to attack any of the Melians; they said the Melians could leave. In turn, the Melians promised not to retaliate and not to sabotage what they left behind.

It was a standoff.

Tamra was dead. She had never backed herself up, even though it was easy for her to do so. Unlike the other biological humans, her mind was embedded in an inorganic substrate. Like the AIs, or any other computer, it was easy to copy. She just had not considered a need, and then when she did, it was too late. Her initial data pack still existed; it was from Pan Grizzel. A copy would have to be made from it. But her personal memories by Earth as Tamra Vindel were lost forever.

Tuppak did not like this; and he did not like to have gone along with a plan that caused damage to Earth's ecosystem, even if it had been inadvertent. That another group had attacked first, that was irrelevant.

Filgard, meanwhile, saw the damage to Earth as leading the other Earth powers to defeat the bad guys. He thought that was a good result. As for Tamra's death forever, he still did not believe in rebirth. He still expected himself to die forever. In a war, he expected young people to die. He did not know Tamra personally, so as far as he was concerned, her death was distant statistic.

Meanwhile, Filgard, Tuppak, and Eltis made copies of themselves. Eltis was the last of the biological humans to do so.

Copies of their data went out to the Kuiper Belt. Arden traveled conscious; he was small for the vehicle and could take the acceleration. In fact, he was not needed. A smart, but non-sentient robot handled everything. Arden slowed his thinking.

Auller was not needed either. When Arden slowed, his duplicate, Auller, copied himself, checked to make sure the data packets were good — like the people and the rest, copies were sent even further out, for safety — and turned himself off. If a secret, non-sentient computer did not receive the right message from Melior in one hundred fifty years,

it would decide he had not arrived and turn him back on. Auller hoped that would never happen. He wanted his consciousness to come alert away from Earth.

A little later, Arden did the same. The interstellar space ship left.

Chapter 51

After one-hundred twenty years' travel, the interstellar space ship arrived.

When Eltis came alive again, a computer voice quickly told her, "You have been dead during the crossing; we have reached the new stellar system successfully."

She sighed. She lived — she had not been sure of that — and they had travelled.

The computer went on, "Cosmic rays killed a few people, but none are critical to our success. Data and assemblers survived. They built us."

She sighed again. They could create the colony.

"We are orbiting the inner planet of the two in the habitable zone. It has single celled life on it, but none complex. The other planet has complex life. We correctly interpreted the Earthly telescopic observations."

It was Arden speaking.

"From a distance, the second planet looks like Earth with a different geography. Close up you can see differences. Many of the bigger forms have six legs rather than four. Both planet's information carrying substances, their genetic material, are different from any on Earth although similar to each other."

She could not focus properly. She felt terrible. The computer suggested she clean up. She stumbled as she got out of bed and fell painfully. By then her vision had cleared. That was good.

But she decided not to clean up and got into bed again. "Don't suggest to anyone else that they get up immediately. My eyes have started focusing better, but I don't know of my other nervous connections."

"That is what Tuppak Nassik said back by Earth. But neither Auller nor I had any trouble when we were rebuilt and rewoke. Non-sentient computers have improved you. Already, you are speaking a new language; I am sure you can add numbers in base twelve, too."

Eltis could add in base twelve; she had not been able to do that before. And she was speaking in the new, common language. She had not noticed.

The computer continued, "Your rapidly improved vision tells me you were helped by the change to the optic connections. Unfortunately, your falling down means the other changes did not work out as well."

Eltis said, "At least, I can see, hear, and talk." "Yes," said the AI, "hearing has been understood for a generation. Not even Tuppak com-

plained about imaginary noises. We figured out how to enable you to see. And talking is resilient. Why that is, I don't know; it is fortunate."

Eltis made little movements in bed. She raised one arm and put it down; raised the other. 'My muscles are not jerking uncontrollably,' she thought. 'I suppose all this should be considered positively.'

Tuppak Nassik was the next person to wake. Eltis watched from the next bed. He opened his eyes but stayed without moving. He lay on his back. After a short time, swinging his eyes around, he said, "My eyes now can focus about a meter and a half away. I cannot focus on distant objects."

Eltis could, but she could not remember when she started to focus in the distance, too. Then she realized that she could reconstruct her recent past. "In a very little while, you should be able to focus at any distance," she said to Tuppak.

"Good," he said. And to the computer, he said, "We need something to focus on that is above me and not too far away. How is my speaking?"

"You are speaking well," said the computer. "Presumably your hearing is fine. Please try moving your arms and then your legs. Eltis had trouble initially."

"This is a great deal better than it was," said Tuppak, "more comfortable . . ." Eltis ground her teeth; she did not think it was comfortable, "but," Tuppak continued, "I am sure it is not like your coming awake or like Pan Grizzel."

"No," said the AI, "both Auller and I came alert immediately. Everything was the same. You do not notice a blink. If it had not been for the change in location, we would not have noticed either.

"We are going to wake up Pan Grizzel as Tamra Vindel in an inorganic substrate, just as we did before. That should be easy, too. She will be a bit confused because her memory is that of Pan Grizzel and she expects to wake up near Earth. We will have to tell her that that instance of her died without back up and it is now ten dozen years later. We are in a new stellar system. She will be able to access the external information about Tamra, but not what she herself experienced."

The AI went on. "After choosing which planet, terraforming will be the big job. But Tamra will think up improvements in planet-to-orbit rockets and in human-carrying interplanetary vehicles. They already exist, but I bet she will think of yet more changes. Besides, I doubt we will have to move four gross at a time from one planet to another; except for classes of students, it will be more like four or eight. We do not have a design yet for that small an interplanetary spaceship.

"Meanwhile, we are in a spinning space station in orbit around the inner planet. At the moment, it is the only place you biological humans can live without a space suit."

Eltis looked down. She realized that she could not be looking through a window; the image was not spinning around. Then, she realized, she was not even looking at a screen.

"Ah . . ." said the AI, "I have been projecting the image internally."

"Yes. That makes sense. I know the theory," said Eltis, "and I expect people to get accustomed quickly. But in the meantime, please display on an external, physical screen. That way, people can adapt more easily. A separate issue: does this space station have a true window looking on the universe outside?"

"No," said the computer. "It should," said Eltis. "The universe will whirl around. That does not matter. And most will not care. Having one, even if they never look through it, that is what counts. We don't need it right away; I am not going to look through it. But you can have one of the assemblers build it."

Eltis looked thoughtful. "Something else: you can put the external screen above people you wake. That will give them something to focus on, which Tuppak suggested."

On the planet below, Eltis saw, the mountains were bare; they did not even have mud on them. Zooming in — it was easy to do when she used internal viewing — she could see dust collected in valleys. Rain had washed the mountains bare; what the water carried settled in valley bottoms and slowly turned to rock. When the water evaporated, the top layers became dust. In places where it looked to have rained recently, the dust flats looked muddy or were replaced by lakes.

Only the desert areas reminded Eltis of Earth. On both planets, she thought, water shaped the land, but did not come very often.

The planet teemed with single celled life. In the wetter areas, Eltis could see its lakes take on wonderful shades and swirls of red and green and yellow. The life on top of the water was a scum — that is what it was called, Eltis discovered, but the word did not have an unpleasant connotation. The scum reflected those colors. The other colors, those absorbed, were used for photosynthesis. It was not the same photosynthesis as on Earth; the biochemical paths were different. But the net effect was the same, energy for the microbes.

Eltis almost did not want to kill them, but it was a choice between her life and their lives. The microbes could not defend themselves, not against the Melian replicators and terraformers.

The next planet out had complex life; that she would leave as is.

Decades of travel could take her to the next closest planet both dead and able to be terraformed. It was near the outer edge of its habitable zone. She did not want to go there. This was the best place.

She knew that everyone else presumed this planet would be terraformed and be called Melior. The decision on a name had been made

on Earth — actually, no one had truly made a decision, it had simply been assumed that the Melior Movement would settle on Melior.

Anyhow, the beautiful scum had to go.

She would consult with a few others. They had been Earth ecologists mostly and were now terraformers. Eltis felt she was not deciding anything, merely confirming a decision made long before. She knew what they and she expected.

After tweaking the Melior terraforming, Tuppak Nassik designed bodies for the second planet out, called Tegmar, and for another fewer than five light years away, called Farhaven.

After Tamra Vindel designed the new space craft and the new earth to orbit ships, she left the Melior system with Avlen Ipdol and with Martha and Vogel Todd. The latter had specified that when they reached Melior, they, too, were to be woken into inorganic substrates.

Avlen Ipdol was another AI, fathered and mothered by Arden and Auller, who 'mixed their memories.'

The three humans and the AI planned to travel interstellar distances slowed down but alert. The procedure added mass to their vehicle, since their computer minds, sensors, and effectors were much larger than their dead data packets. Still, the four added little mass. And around Melior, no Earth government prevented them from building large energy converters and pushers.

They agreed to make their first trip, taking about a dozen and a half years real time, in only two hours subjective time. The humans found the time too long for human-speed senses to see stars move, although it was obvious after a few minutes that they had. Everyone could see motion with computer-speed senses.

The four took everything that had come to Melior, including copies of the people, but they did not wake up any of the people. They did not duplicate themselves either. They were, after all, misanthropes. Four was a good number. But each made use, even the AI, of the huge store of cultural data they carried. It was no trouble to extract the information from the data packets and present it virtually in a manner than looked real.

Gilbert Daveson Hagborn dropped his middle name. He called himself Gilbert Hagborn and became Jeltong Pekbung's deputy. For a very long time, he was the number two man in both the Conservative Party and the government; then he became head.

Filgard became a farmer, the primary farmer for the capital city. He thought of himself as 'cultivating his garden' although he did not do any cultivation himself. His robots did.

He deeply regretted that Fairta died too soon.

He regretted that his neighbor, James Bevin had not made it. The man had finally decided that the Melians were decent and right, had joined the movement, been recorded, and then on the trip his data pack was hit by a cosmic ray and he was killed. The man had not been important enough to be backed up. (Filgard never thought himself and was never told that he was considered important and had been doubled.)

In the new language, which Filgard enjoyed thinking and speaking, 'James' would be spelt 'Djaems' and he would have needed a single syllable middle name to produce the four syllables of an official Melian name.

Taffod Dowwen got the chance to endanger only himself and did so. He talked about it. Because people liked his stories, he became a national treasure, which meant he could duplicate himself into multiples rather than simply extend his own life.

Gammae Uttles became even better at helping people be reborn into a biological substrate.

The attack on the Melians as they left was not a secret but was seldom discussed. Most people did not learn of it, but Djaeds Summervil did. He became scared and joined the Earth Beware party.