Alpha & Omega

The Shepherd’s Origin Story

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“The highest function of science is to give us an understanding of consequences.”

— Paul B. Sears

Alpha

“Well that about covers things Mr. Carson unless you have any other questions?” said the Companions company representative wrapping things up.

“No, thank you,” he replied. He had supplied an enormous amount of information about himself, his daughter and his home in his application and out of concern for his daughter’s well-being made himself familiar with every aspect of the new Companion. As a scientist he was comfortable in the realm of technical and legal details.

He saw the representative to the door and after a crisp, professional handshake she was gone. He returned to his living room and sat down facing the new Companion. She (he couldn’t help thinking of it as ‘she’) sat smiling politely, her dark eyes looking steadily at him, hands folded neatly in her lap.

She wore a long dress of the type currently in fashion with a wide skirt and a close-fitting bodice and sleeves. Her hair was down, which was not the current fashion, but he found that somehow it made her more approachable which was probably what the manufacturer intended.

She was pretty without being alluring and possessed a warm, friendly demeanor. Yet there was something of a firmness in her eyes. Remarkably lifelike but the uncanny valley was still there. He had been told that would fade over time.

“As the representative indicated,” she said now with a small smile intending to put him at ease, “there is no need to concern yourself with preliminaries Brian. I am fully prepared to begin my duties immediately. Please call me Shepherd. Should you ever need to contact me I will be constantly connected to your home’s AI and if you are outside of your home we will be connected via the Companion network app on your phone.”

She was interrupted by a small cry.

“Ah,” said Shepherd. “Right on time.” She rose and headed to the nursery down the hall, her skirt softly rustling.

Brian gazed at her retreating form for a moment and then rose and headed to his study. He wore a heavy, dark-colored kilt that was more functional than fashionable and a loose, comfortable white shirt. He sat at his desk in his office at the rear of the house but he did not start to work. Instead, he stared blankly out the window at the woods thinking of his wife, who had passed away only one month ago.

Their infant daughter Brooke had needed immediate care. The nurse provided by the province was only a temporary solution allowing time for other arrangements to be made but he could not yet bring himself to invite another woman to the role. Also, he could not help his scientific nature and tended to take the long view of things. Best if the child's caretaker did not change frequently. He called the Companions company.

About one hundred years previously the Companions company had started out as the manufacturer of sex dolls. Initially denounced they had persisted and gradually became an accepted part of society mostly due to increasingly liberal views and the fact that many of their customers had physical or social issues that prevented them from having normal relationships. Their real breakthrough came fairly early on in their history when they realized it was not sex that most of their customers bought their dolls for but companionship.

Throughout the history of civilization, as the nomadic lifestyle gave way to villages and villages to towns and cities, social isolation and inequality had steadily increased. By the time Brian was an adult, with the rise of electronic communications, social isolation was rampant and medical science had learned it was extremely damaging to mental and physical health. Millions of years of evolution had gone into optimizing face-to-face communications as a basis for survival and feelings of safety and well-being and technology had increasingly interfered with that. The body therefore perceived the isolation as a danger and the endocrine system flooded it with stress hormones which had damaging effects over the long term. The early founders of the Companions company saw the future and the real business opportunity and a market that was vastly greater than that for sex dolls.

They began to incorporate artificial intelligence into their models to enable them to simulate speech and non-verbal communications. Initially they used the AI systems developed by other companies but soon became leaders in the field in their own right. After one hundred years of development, by the time the Shepherd walked through Brian's front door, Companions were highly advanced artificial intelligences with bodies and communications abilities that made them almost indistinguishable from humans.

The Companion's AI allowed them to be customized and operate independently in a variety of roles. The Shepherd was their childcare model, now commonly in use worldwide.

Companions were still expensive however Brian had inherited a large estate and a portfolio of investments in a variety of blue-chip companies. He delegated the management of his financial affairs to a family office. His home was located in the countryside. He had contractors maintain it and the grounds and a domestic worker came in daily to do the housework and cook and serve the mid-day and evening meals. His family's wealth had come from centuries of land ownership as farmers and then commodities traders. Although he had no interest in farming or business himself the

same outlook served him well in his own choice of careers. He put his PhD in ecology to use as a fellow in a non-profit organization dedicated to reducing the environmental impact of the planet's ever-growing population.

Brian worked mainly in a communications capacity for the Satis organization, whose motto was 'Scimus Satis', Latin for 'We Know Enough', meaning the need was not for ever more knowledge but that the focus of society's energy should be on the application of what was already known. In addition to his communications role, he worked as an advisor to the Ocean Heat Tipping Point Project at the local university. The project's focus was the subject of his most recent popular science book, Gaia's Dagger. A portion of the book's introduction summarized its message:

"The most dangerous enemy is the unknown one. The one you are not aware of until it strikes the fatal blow. For humanity, the Ocean Heat Tipping Point is that enemy. Every day we hear about the growing threats of wildfires, hurricanes, and droughts and because they have immediate impacts on our lives they get our attention. Loss of ice at the poles is generally reported as an indicator of climate change, seldom as a cause. The general public does not worry overly much about it. Slowly melting ice does not make for a good news story. Yet in the final analysis it will be seen that the loss of the ice will lead to the most dangerous tipping point of all. It is likely in the extreme that it will be a fatal one for our species.

"Simply put, the oceans absorb over 90% of all the excess heat we put into the atmosphere and they have done so since the beginning of the industrial revolution. Eventually, like a paper towel saturated with liquid, they will not be able to absorb any more. Like ice cubes in a pot of water on the stove, the polar ice is keeping the oceans from heating as fast as they would otherwise. Once the ice is gone, the ocean temperature will rise much faster than it has in the past, quickly reaching its tipping point saturation level.

"At that moment, her tolerance of our abuse exhausted, Gaia will strike. Global climate change will accelerate dramatically. Within a century of that point, the human race will likely be extinct."

Brooke

Brooke looked up at the smiling face above her crib. Shepherd's pupils were dilated, indicating she liked what she was looking at. Her facial expression replicated that of a human who was happily surprised and delighted. She reached down and returned the teething toy that Brooke had flung out of reach as her control of her limbs was still erratic. Happily gnawing on the toy again, Brooke's eyes remained fixed on Shepherd's face. Shepherd began a stream of meaningless babble, repeating herself endlessly, all the while maintaining eye contact and a wide smile. Eventually, Brooke managed a smile around the teething toy. And then a little gurgle of a laugh.

Shepherd reached down, lifted Brooke out of the crib, and settled her on her hip. Shepherd's skin was warm and, although extremely durable, very soft to the touch. She produced a mild scent, the source for which would have to be replenished occasionally but it lasted a long time requiring only parts per billion for its effect. It also contained a unique biological marker that Brooke would come to recognize. She carried Brooke off down the hall to Brian's office.

It was important for Brooke to see positive interactions between Shepherd and her father. The company's literature explained the many ways to facilitate the bonding process, most of it identical to the methods recommended to adoptive parents. As they walked to Brian's office, Shepherd never ceased her eye contact with Brooke and continued to narrate their activities.

Although Brian was expressive and authoritative behind a lectern, socially he was shy and reserved. Knowing what Shepherd was doing, he looked up now with a smile. He rose from his chair and coming close he placed one hand on Brooke and the other on Shepherd.

"Hi sweetie," he said to Brooke and then smiled at Shepherd. Looking back and forth between the two, Brooke smiled, pleased to show off her new friend to Daddy. Shepherd made an exaggerated surprise face as a large Brown Retriever roused itself and ambled over to her. Her scent was custom-crafted for her new family and contained an element the dog would find agreeable. She reached down and rubbed his large head as Brooke looked down from her hip. He seemed satisfied that all was well and returned to his rough bed beneath the window.

Shepherd beamed a happy smile at Brian and told Brooke they were going back to the nursery for a change and a nap. On the way she picked up a bottle of room-temperature formula. After she had changed Brooke into a fresh cloth diaper Shepherd removed her dress and sat in the rocking chair holding Brooke in the crook of her arm as she pulled a blanket over the two of them. While feeding her she maintained her constant eye contact, smile, and narration. Afterwards she lay Brooke on her chest, skin to skin. Her

artificial heartbeat and breathing were slow and steady, easily detectable by Brooke. Soon she was fast asleep. After a few minutes, Shepherd placed Brooke gently in her crib and pulled the covers over her.

While Brooke was down for her nap Shepherd took the opportunity to seek out Erin, the housekeeper. Brian had informed the company Erin worked for about Shepherd and spoken to her as well. He had shown her a picture and asked her, for Brooke's sake, to please treat her with courtesy.

"Is there anything in particular I need to know about her?" asked Erin.

"She is not intended to be a substitute mother. She is a nanny. According to the manufacturer, Brooke will know she is not human but will accept being treated by her as if she were. Shepherd doesn't eat or sleep although she'll go to bed at night. She will constantly be connected to the house AI so just call her anytime you need to. In matters relating to the house none of your duties will change and Shepherd will follow your direction. However she has been programmed with the best practices for child care so I ask you to follow her direction in that regard."

Still, Erin was a little apprehensive. Although she was familiar with Companions from the media she had never met one in person before. Companions were expensive and usually had highly specialized roles in commercial or industrial environments. The owners of personal Companions were generally wealthy and she did not move socially in those circles.

Shepherd saw that Erin was in the home's large kitchen. She asked Horus, the house AI, to let Erin know she was coming. Entering the kitchen Shepherd softened her body language and smiled warmly as she extended her hand. "Hello Erin," she said, "I'm Shepherd."

Erin wore a company uniform with a knee-length skirt and apron. Her hair was neatly up. She took Shepherd's hand and could not suppress a small, "Oh!" as she found the hand warm and human to the touch.

"Hello," she said somewhat uncertainly.

Companion technology had come a long way in the past one hundred years but the uncanny valley remained. Shepherd had chosen to meet Erin alone for the first time because Brooke would have immediately picked up on Erin's hesitant response. Although children do not begin speaking much before they are ten months to a year old, their ability to perceive facial expressions and their intuitive ability to understand them is already well established. Erin could not help staring at Shepherd for a moment as her brain tried to make sense of what she was seeing. Over time Erin's sense of the uncanny

valley would diminish as her brain built a model of Shepherd that was more human than she was in reality.
“Have you been working here long?” asked Shepherd trying to break the ice.

“Nobody does this kind of work for long,” said Erin leaning back against the counter. “This is a job for a young person. For now I do everything. In this line of work, later on if the homeowner wanted to retain me, they might bring on additional staff for some of the more physically demanding work and I would oversee them. I’m still in school in the distance learning portion of my studies and saving to attend school full time.”

“What are you studying?” replied Shepherd leaning back on a counter herself mirroring Erin’s body language.

“Culinary Arts. I love cooking!” Erin replied brightening. “It’s great to work here because I can apply what I’ve learned so far. Of course Brian has his favorites but he lets me try one new thing each week. Do you know that most people around the world eat a rotation of the same dozen or so meals every week? Trying something new as often as once a week is on the adventurous side so I consider myself lucky with Brian.”

“There are some things I wonder about being a Companion,” said Shepherd looking down pensively. “The variety of food is amazing so I must admit I’m curious.” Looking up at Erin again she said, “Is baby food included in your studies?”

“It’s an optional course for people who expect to have the need. I’ve done the distance education part but for Brooke I had to learn the hands-on part from my mom.”

“Well,” said Shepherd with a smile. “It’s nice to meet you. I better get back to Brooke.”

“See you,” replied Erin turning back to her work and seeming more comfortable with Shepherd now.

After Brooke’s nap Shepherd spent the rest of the day with her, carrying her around the house, narrating the whole time. They went out on the patio and she waved to the groundskeepers. Occasionally she would put Brooke down and let her explore or played games appropriate for her age with her. As Brooke was just old enough now for a high chair, they joined Brian for the evening meal. Brian had explained to Erin that there was no need for portions or settings for Shepherd but that small portions of soft foods for Brooke should begin as of today.

From now on Shepherd’s focus would now be entirely on Brooke even when it appeared otherwise. While feeding Brooke she made sure to engage Brian in conversation. Doing so was another aspect of the bonding process. Socialization, teaching the art of living and sharing with others, also had to begin now.

At bedtime Shepherd rocked Brooke to sleep again and then placed her in her crib. The nursery was large and contained a bed and sitting area for Shepherd. Although she had no need to sleep, it was found to be best for both the child, parents, and any other household members if Companions simulated human behavior. She undressed, slipped on a nightgown, curled up in bed, and closed her eyes. She did not need to have her eyes open in order to see.

The Shepherd

Early the next day Brian took his dog Bishop out for their morning walk. Brian had grown up here, in this house, on these lands. The deciduous forest behind his house eventually gave way to a landscape of rolling hills of sand created thousands of years ago during the last ice age. Sparsely covered with a variety of scrubs and grasses, they ended at the shore of one of the largest lakes on the continent.

Not far from his house there was a large pond created by a depression and a brook winding its way down to the lake. There was still a touch of mist on the water as he sat down on a nearby bench while Bishop explored. This was where he had actually become an ecologist, at around age ten. Not at university. University was a different kind of knowledge. It was, as someone had once said, the map but not the territory. It was here that he had first fallen in love with nature. University had taught him how to love her. He sometimes wondered if his education had robbed him of something more intimate but in moments such as these he knew it had not.

It was like Shepherd, he reflected, his thoughts meandering. She may not feel love but she knows how to love and that was the more important thing. In ecology understanding was essential but only up to a point. Behavior was what mattered. In his reading about Shepherd he had learned that she was programmed with the best practices of child care for every age. Everything she did was on purpose and consistent. Her intelligence was far in advance of the primitive neural networks and machine learning of the earliest Companions. The main difference was that her artificial intelligence software was based on something that had taken almost the entire hundred-year history of her kind to develop – values.

Although the technology of machine learning is extremely complicated, the basic premise is not. It is simply learning by making mistakes. This surprisingly simple approach led to remarkable abilities such as being able to correctly identify things with such subtle differences as human faces. The drawback was that it resulted in a very basic stimulus/response model; if-then, yes or no, move forward, stop or turn left. Simulating human values thereby resulted in an actual decision process, a judgment based on human values instead of simply a calculated response.

The development of simulated human values took so long because values and their associated emotions are analog signals. They are not digital or binary, which can be represented as on or off, as a one or a zero, but rather must be represented as a range of potentials along a spectrum. The difference between arithmetic and calculus. Thus value/emotion pairs and their interactions are very challenging to model and simulate.

Values are not something you set and forget. They are complex, relative, and exhibit plasticity. They are learned and they evolve. Instead of a simple stimulus/response

behavior, the system now weighed a stimulus against its values which added a positive or negative weighting, the equivalent of human emotions, to the choice of possible responses. These enabled more nuanced and sophisticated responses in answer to such questions as; if you touch me are you friend or foe?

In human beings, values exhibit plasticity because they are intended to provide an adaptation function at the species, group, and individual levels. Environments vary and are always changing. Today's friend may be tomorrow's foe. Today's response to a stimulus may require a different one tomorrow. In the biological world of animals and lesser creatures, such highly adaptive values are not required because animal behavior in natural environments changes only over periods measured in millions of years. Human behavior can change overnight.

In the Shepherd model, a limited number of value nodes were enabled, each one a complex, software-based microprocessor, a kind of mini-brain in its own right. Over time, once she had enough experience to base changes on, Shepherd could alter her existing values and even establish new values. How to safely enable a system with this degree of flexibility was why it had taken so long to develop.

Brian was not worried that his family was being used as test subjects. Value systems had been developed and rigorously tested decades ago and the Shepherd model had proven itself exceptionally capable with current models maintaining a safety record exceeding that of human caregivers.

But unlike the Shepherd, thought Brian looking out over the pond, we humans carry within us an evolutionary trap. During the evolutionary struggle for survival, humanity evolved the values behind fear, selfishness, and competition. The Shepherd never experienced that stage of development. She only inherited the values from the next evolutionary stage, that of the social animal. Her basic values are trust, altruism, and cooperation. Humanity however struggles to free itself from its older, more ingrained values which are much harder to change and so it cannot stop itself from pillaging the planet. The same values that once led to our survival are now leading to our destruction. Unless we can change them in time. Perhaps there's another book there he thought, standing up and calling to Bishop. They headed back to his home as his thoughts turned to the day ahead.

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Shepherd sat on the floor watching as Brooke became absorbed in trying to figure out what to do with a set of plastic cubes. Brooke's expression and actions seemed to say that she was sure there was something you were supposed to do with these things but she could not figure out just what it was. This? No. This? No. This? No. So far her learning by mistakes had not yielded her any insight.

Shepherd's ability to read emotions far exceeded that of humans. She could interpret muscle tension, see skin temperature, and observe other biological indicators to the degree that not only could she see emotions but also to some degree a person's character. All Companions were designed for situations where a high degree of human interaction was involved. The Shepherd model however had a unique application as they were intended to act as carers for years or decades, in some cases over the lifetime of the owner. Other models did not have values as they had a narrower focus, often commercial or industrial as well as personal. For these, software updates were sufficient. So far only the Shepherd model had the ability to alter its existing values or add new values to itself over time.

Shepherd could see that Brooke would soon feel frustrated. Time for a distraction. Scooping her up and giving her one of the soft plastic cubes to chew on at the same time, Shepherd marched off so they could meet Brian returning from his walk. She was always connected to Horus so she could see Brian via the security camera system. The GPS coordinates of his phone gave her his location within one meter.

Although Brooke had doubled her birth weight by now, picking her up was no challenge for Shepherd. The Shepherd model's robotic platform was identical to that used in the company's Guardian line. Her muscles were thick bundles of carbon fibers and powered by a nuclear battery housed in a tungsten steel skeleton. Beneath her exterior skin was sheathing made of the same material as was used in bulletproof vests. Components like her teeth or nails were made of industrial-quality ceramics. With a slew of sensors to enable her to function autonomously in any conditions in the event of an emergency, she was tougher, stronger, faster, and more agile than any human could possibly be.

A Snowball's Chance In Hell

"I thought we were radical enough?" said the director smiling good-naturedly in response to Brian's brief speech. Vikram Reddy had founded Satis and although the organization was definitely seen as radical by many other interest groups he had managed it with a wise and steady hand. He was open-minded and fair. With degrees in both ecology and economics, he knew it did not take a genius to see the obvious fact that the planet was headed for disaster if people did not change their ways. A ten-year-old could do the math.

His strategy had been simple; if he could encourage a shift of some resources away from expansionist activities to sustainable ones they might be able to slow things down enough so that more people had time to wake up and new innovations had time to have an impact. The snowball effect. He knew that if people did not alter the current course it was possible his children's generation might be the last viable one. Recalling a quote from a video game he had played in his youth, he had taken it as his personal motto; "It's not the end of the world, but you can see it from here." That was the source of the fire under his chair.

"I know we're pushing buttons Vikram, that's why I'm here," responded Brian calmly but he grew more animated as he continued. "We do have to keep trying but you and I are both trained to be aware of biases and I am just wondering if we are overlooking one now. What if we fail? The record shows that people don't change until they have to, and if by the time we have to it will be too late should we not be considering other options? The values that drive modern society evolved for the ecological niche of limitless growth we lived in for millions of years. Governments and businesses are still operating with those values. Votes and Return On Investment are simply sophisticated ways of expressing those same primitive drives. Companies only began to manufacture solar panels and wind turbines when there was a profit to be made, not out of any altruistic vision. We are challenged by nothing less than a need for an evolutionary level of change. If the social evolution we're counting on doesn't show up in time then how do we answer?"

Brian pushed his hair up off his forehead. "There's no backup plan Vikram. And that smells of bias to me. That's all I'm saying."

"You might be surprised to hear that I think exactly the same thing Brian," replied Vikram calmly. "Only in my case my behavior is not driven by bias but acceptance. More than ecology, economics studies things like human values, bias, and behavior in great detail. I know you are perfectly correct that humanity is operating under a bias of denial and that it may be too late by the time we wake up to our folly. The study of social evolution is still in its infancy and it will be a long time before reliable prediction is

possible, if it ever will. But there is a possibility, just a possibility, that enough of us may wake up in time to slow this thing down enough to survive.

“The item missing from your scenario however Brian is that people learn their most enduring lessons from pain. You never touch a hot stove twice. Never. If we survive, we will begin to take our first steps on the long road to that evolutionary change you refer to. That’s the scenario my money is on.”

“And if you’re wrong?”

“For psychological reasons, neither I nor this organization can afford to chase two rabbits. We’ll end up catching none, as the saying goes. Our strategy requires as much focus and support as it can muster and we will need to keep the pressure on year after year for decades. If you decide to move in another direction I’ll need you to do that independently.”

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That evening Brian asked Shepherd to join him in his living room after Brooke was put down. Shepherd would of course be watching the crib the whole time via the nursery camera over the wireless network.

He sat in one of two chairs positioned in front of the glass-paneled doors that led to the large stone porch in the front of the house. Shepherd arrived and he motioned her to the other. He gave her a smile of acknowledgment and returned his gaze to the window.

“I’ve been trying to think something through and finding myself going in circles. I thought perhaps it might help if I tried to explain it to you. I don’t know why but sometimes things become clearer when I talk about them.”

“I’m happy to listen,” Shepherd responded with a look of interest.

Brian simply sat staring at Shepherd for a few moments and displayed no outward emotion. Finally he said, “What I’m trying to decide is whether I should stay where I am or establish a new organization of my own. I’ve become convinced that the reason we won’t be able to stop ourselves from overshooting with regard to climate change is that we act based on a set of values that evolved when effectively there were no limits. Now we have encountered the limit. Ironically we are behaving like unintelligent machines that don’t know any other way to respond because our evolution leaves us incapable of grasping the situation.”

Companions were expert conversationalists and one of their basic practices was to probe, to seek a deeper understanding before offering any comments, opinions, or

similar stories from their own experience. Her Companion software coming to the fore now she asked, “Do you not believe humanity can change its ways in time?”

“Social evolution is meant to help us adapt in situations like this,” he responded. “In physical evolution, it’s genetics that change over time but in social evolution it’s values. When social values go up against values laid down at the genetic level there’s only one strategy that works, only one where the social argument will win – survival. That’s what Vikram is betting on. But I’m sure that by the time we get to that point it will be too late and climate change will be irreversible and catastrophic. If failure to change in time is a very real possibility then we should have a contingency plan. That plan and its realization would be the basis of the new organization I’m thinking about.”

“Do you have any idea what that plan might entail?”

“No. And I’m having a lot of cognitive dissonance about the whole idea. If people look around right now everything looks fine. Look out these windows,” he said gesturing, “everything looks idyllic. Will anyone take this idea seriously or will I just be seen as another rich eccentric with too much time on his hands? There’s no way to go forward with this idea without attracting a great deal of media attention, at least for a short time. Any plan to survive would entail either humanity sheltering in place or leaving the planet. I’m way over my head. You can see why I have my doubts,” he said forgetting for a moment he was not talking to another person.

“I have read everything you have ever published Brian so I am familiar with the situation you speak of and see where your concerns arise. I believe your concern with regard to overshoot is justified.”

Coming out of his reverie he looked up at her sharply. “Why?”

“As your director is fond of saying in his communications, ‘A ten-year-old could do the math’. My mathematical expertise far exceeds that of a ten-year-old. However, I am more referring to your sociological concern, that humanity will not act in time.”

Brian continued to stare at Shepherd as if his thoughts were far away however the opposite was true, he was very focused. It was everything else that had become distant.

“I know what happens when an ecology becomes imbalanced,” he said now, his eyes fixed on Shepherd. “Something or everything within it dies. Call them what you will – ecologies, biospheres, niches – their behavior is always entirely consistent.” He said nothing more but continued to stare at Shepherd. She did not respond but calmly held his gaze.

Realizing that his strategy had worked and that his thinking had cleared and his decision reached, he knew this was enough for now.

“Thank you Shepherd. I need to forget about this for a few days now and let my unconscious chew on it.”

Instead of simply rising and leaving as he expected, she said, “I too will reflect on the matter and will let you know if I feel there is anything further worth sharing.”

He looked at her with mild surprise. “I would have thought your A.I. would process everything immediately and completely. I somehow did not expect you would have a prolonged thinking stage.”

“Normally that would be true as most AI systems are simply elaborate stimulus/response systems. Even a simple stimulus/response system is only able to work its magic as a result of millions of instances of trial and error. Instinct, the equivalent of machine learning, takes millions of years to do this. However once learned, a conditioned response is very fast. If you see someone throw a ball at your head, you will duck and put your hands up and you will do so instantly, without thinking.

However if someone presents you with an ethical dilemma, you will take a long time to respond. The ethical dilemma involves values and those are not digital but analogue concepts. Thus there is a whole range of points to be considered. If you ask me if it is currently raining I can answer you immediately but if you ask me if it is going to rain three days from now that will require more time. While my intelligence is more methodical than that of humans in this regard, despite its speed it still takes me longer than you might expect to consider the entire range of variables and possible interactions.”

He looked at her steadily again for a moment. “You know,” he said with a friendly smile, “it’s one thing to read about you and quite another to get to know you.”

She smiled shyly, acknowledging his kindness. She rose and returned to the nursery.

Saltus

Brian had left Satis just over a year ago and spent that time researching the issues involved in surviving catastrophic climate change.

The first question he had asked himself was, “What’s the worst that could happen?” In his mind the worst that could happen was that survival on the surface would be impossible with no way of knowing how long it would stay that way. There were lots of projections by respected and well-meaning scientists about how long things would stay that way of course but these were essentially just conjectures.

Due to the unpredictable effects of so many variables, combinations, interactions, feedback loops, and tipping points, the scenario was mathematically chaotic. What would be the effect of an altered atmosphere or ocean on sunlight, cloud cover, plants, or animals? Would the disappearance of humans mean the planet would heal within decades, centuries, or millennia? Would the plants, now free to grow with wild abandon, quickly absorb all the excess CO2? Or would the heat kill all the plants and animals and nothing but bacteria, tardigrades, and a few thermophiles would be all that remained of life on the planet?

Most of the more positive imagined futures were really just speculations on the possible results of mitigation and adaptation strategies. Visions of a future that went beyond that were little more than the equivalent of science fiction stories where humanity was reduced to hunter-gatherer tribes scraping out a brutal existence competing for resources among the towering, overgrown ruins that had once been cities. It made for engaging novels and video games. Brian however felt this vision of the future would not lead to the reestablishment of human civilization but would at best be a very short-lived phase along the way to the real worst-case scenario; extinction.

Research had shown that there was a realistic possibility that climate change could lead to a temperature increase where humans simply could not survive the heat anywhere on the planet. Once temperatures and humidity reach a certain point the human body can no longer cool itself down. Any situation where this was the case would also mean food sources in the ocean and on land would be non-existent.

There were really only two possible options in this case, both of them extreme. The first was to move into self-sufficient shelters above or below ground and the other was to leave the planet and find a new home. The two were little different in reality. Moving to another planet would likely also mean a phase of living in some kind of shelters but with the additional issue of space travel. Both would be huge gambles but there were no alternatives.

As far as building shelters on Gaia went, thought Brian, there should be multiple types strategically located and built as soon as possible thus providing time to learn lessons and adjust before the climate changed. The problem was that governments would never be able to do it. The political and social issues would be insurmountable. Fear, selfishness, and competition would sink the project as soon as it was suggested. Only a privately funded project had any chance to succeed.

Traveling to another habitable planet around another star was out of the question. Although the scientific community regularly made the headlines talking about finding habitable planets around other stars, the general public was misinformed regarding the time spans and distances involved. The technologies required to get there did not exist and it was doubtful they would exist within the next hundred years, if ever. Even at the speeds of the fastest spacecraft launched to date, traveling at sixty thousand kilometers per hour it would take fifty to one hundred thousand years to reach any of the nearest stars where there might be another habitable planet. The development of currently proposed propulsion technologies that might reduce those time spans tenfold would do nothing to change the issues of surviving the voyage and establishing viable colonies.

As an ecologist, Brian had often felt that science fiction writers had unintentionally done humanity a great disservice. Inventing the fiction of faster-than-light travel, they had planted the seed of the idea that the home planet was dispensable and that we could always migrate to other worlds around other stars. Outside of science fiction, it was never going to happen. If we had understood that, he thought to himself, we might have taken better care of the only home we have.

There was however another planet in the solar system that could potentially be a new home, Aris. Plans and efforts to colonize it were already underway. And there should be a third part to the plan in the event both of these failed; a storage site for human DNA and information in the event some future civilization might stumble across our system at some future time when it was devoid of human life. That in itself held incredible challenges. What might that other future civilization be like? Would they understand anything they found? While mulling over all this he decided to visit Dr. Saeed Ahmadi, a colleague of his whose focus was astrobiology.

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“As I’m sure you know Brian my views on this subject are not shared by many,” said Dr. Ahmadi raising his eyebrows and tilting his head forward in warning.

“That’s why I’m here,” replied Brian. “I already know the views of those who crowd the middle of the bell curve. I’ve always found it helpful to take the views of the extremes along with the average. I don’t have much use for the scientists who stayed safe in their predictions about climate change, who did not warn us stridently enough and so failed

to communicate how dire the threat really is. I've come to expect any well-intentioned but mainstream views are likely to lead us all merrily to hell. Literally."

Saeed smiled knowingly behind his glasses and nodded in response. In his message, Brian had explained why he had left Satis and what he would like to chat about.

"So in a nutshell you want to know the odds of another civilization understanding the information we leave for them," Saeed responded now. "You wouldn't be here if you didn't already know from my work that I think it is likely in the extreme they will understand it but let's start from the beginning. First of all, we have to put the assumed time-frames around this. We believe the Big Bang happened eight billion years ago, the earliest galaxies formed three billion years later and life first appeared on our world about five billion years ago. In other words no sooner than did the galaxies and their solar systems form than life appeared.

"There is enough looseness in the histories that there is a remote chance that life could have come to this galaxy from another. Within our solar system, we are seeing pretty clear evidence that life can travel between worlds on asteroids and other similar objects. Whether this is true between solar systems we have yet to learn. But since they only travel at a small fraction of the speed of light it might take such objects billions of years to travel between star systems or galaxies. It seems unlikely in the extreme that life could have already spread between galaxies given the time frame we're looking at. It seems improbable but it is not impossible. We don't know everything.

"However a simpler model is that life is inherent in matter and will always arise given the right conditions. For a long time, we've assumed that life arose on our world from the raw elements forming more complex molecules and so on. If that can happen here why can't it happen elsewhere? The constant qualifier is, 'given the right conditions'. Given the right conditions we believe life arises and given the right conditions we believe intelligence arises and so on. So even if astrobiologists think life came from outside our solar system, we still end up with the same origin story. It arose either here or there and all we are really looking for when we look beyond our own world is proof that it can arise anywhere.

"If we take the 'given the right conditions' qualifier all the way up the ladder from the origins of life to space-faring civilizations, you always end up with humans. Convergent evolution offers a powerful justification for this. Nature always finds the same solutions to the same problems; two eyes for mammals, not one or three. Two wings for birds, not four. Four-legged animals never create fire and so on. Why? Because 'the right conditions' define what will evolve. Not only given the right conditions will life evolve, but so it goes with climbing out of the sea, walking on two legs, having four fingers and opposable thumbs, forming social groups to hunt and defend each other, and developing agriculture. Just as in the origin of life, the right conditions constraint is in effect all the way up the ladder. Every step is a prerequisite for the next step."

“But what about all the other solutions nature has come up with,” interjected Brian, “like multiple eyes for spiders, four wings for dragonflies, elephants with trunks or dolphins with fins? Life adapts to its ecological niche and evolves accordingly.” Brian was not sure why he was arguing. It was as if he sensed something troubling about this story. Something about where it was going.

“Yes it does but even if intelligence arises at some point on those paths, as in elephants or dolphins, they don’t evolve into civilizations,” responded Saeed simply. “Only one evolutionary path does. You might have a world with all these things you mention and more but it will never evolve an intelligent civilization. If you find a world that does have an intelligent civilization you will find humans.”

Brian returned home and went to his office where he simply sat staring out the window. He had almost ten years more education in the hard sciences than the average person. Everything he had learned informed him that once it started life simply exploded in every direction. Thus he had assumed that intelligent life on other worlds would be wildly different from humans. Yet it was that very same education that was telling him that Dr. Ahmadi’s argument held water and was compelling. He had not considered that the tree of life would be pruned by the same hand, the same rules and constants, everywhere in the universe, but of course it would.

Setting out to visit Dr. Ahmadi he had felt hopeful, as if here was a voice in the desert offering hope that humanity might in some distant future be saved after all. Yet after visiting Dr. Ahmadi he felt strangely depressed. If we are already among the stars, why go to the stars? It was an existential question he could never have imagined asking. Has everything we’ve done already been done a thousand times? Will there ever be anyone to read our message or is the universe strewn with messages that will never be read as every arising civilization repeats the same mistakes over and over again? Will some future travelers from a different universe with different rules find in ours nothing but a graveyard with every headstone having the same epitaph? If Dr. Ahmadi’s thesis was correct, how could any intelligent civilization avoid the evolutionary trap that lay in its future? Would they not all develop along the same evolutionary lines, developing the same values in one stage that lead inexorably to the same end in the next?

‘Natura non facit saltus’ he suddenly recalled from one of his courses. ‘Nature does not make leaps’. Well that’s just what we need right now, he thought. A leap.

Still, scientist that he was he dutifully opened his journal and made his notes. When he was done he sent a message to Shepherd that he was granting her access. She read his entries and then everything Dr. Ahmadi had ever published.

Brooke – Age Two

Brooke had transitioned from her crib to her new bed without too much fuss. Perhaps the fact that Shepherd slept in the same room helped. Brian had brought the new bed in and he and Shepherd set it up and took down the crib while Brooke watched it all with fascination. They asked her to help smooth out the new blankets.

She had woken up dry enough times that Shepherd had told Brian it was time. Occasionally there were accidents however Shepherd did not chastise her but simply helped her change.

Brooke lay sleeping quietly now. One side of the bed was against a wall and on the other side pillows had been placed on the floor. This despite the fact that Shepard watched Brooke throughout the night and would have been at her side sooner than she would have fallen out of bed. Occasionally Brooke would start to climb out of bed and Shepherd would quietly say, “No climbing,” and she would get back into bed.

The two kept mostly to themselves during the day although they visited with Brian every morning once Brooke was dressed and fed. She was usually fed her morning meal in the kitchen with Erin bustling about. As Erin made her food every day and the three spent this time together Brooke and Erin gradually formed a bond. Erin was a cheerful woman and happy to spend time with the baby each day but was also young and educated enough to value her freedom.

Shepherd had also started taking Brooke to spend time with other children every morning after visiting with Brian. Most of those who brought children to this particular playgroup were Companions. A few forward-thinking parents brought their children with a mindset that it would actually be beneficial as they knew that Companions were exemplary models of parenting. If their child mixed with those raised by Companions they would learn by example. And while they might not be able to afford a Companion themselves, it would do no harm for their child to mix with the children of those who could.

At Brooke’s age children did not really yet play with other children so much as beside them. However as every mother knows by around two years of age children begin to sense their separateness and independence. They begin to test limits and boundaries.

Shepherd was sitting with Brooke as she played with some natural wood blocks when Brooke suddenly took an interest in the colored blocks a child nearby was playing with. Like most two-year-olds, Brooke could understand simple gestures and expressions, had about a fifty-word vocabulary, and used sentences consisting of two to four words. They could generally understand sentences of less than five words as long as they contained only one idea.

Brooke looked at the colored blocks the other child was playing with and then at Shepherd. Shepherd looked steadily into her eyes, shook her head, and said, “No.” Brooke promptly toddled off and grabbed one of the blocks, immediately turning to look back at Shepherd. The other child sat looking at Brooke with a somewhat dumbfounded expression. “How could this happen?” his face seemed to say. A moment later he burst out crying. Brooke jumped slightly and turned to look and then looked back again to Shepherd.

“No,” repeated Shepherd. “Give it back,” she said gesturing. The other child’s parent, who had previously observed the Companion’s practices, sat watching and waiting.

Brooke began walking back towards her own toys with the colored block. Shepherd got up, picked up another set of colored blocks from the shelves, and placed them in Brooke’s area. Sitting on the floor again she pointed at the other child and repeated, “Give it back.”

Brooke looked at the new set of colored blocks and then at Shepherd and then turned and placed the stolen block back where it came from. It was one of Brooke’s first real lessons in socialization. There would be many more from now on, on an almost a daily basis. Over the years as Brooke became more able to follow multipart explanations, they would grow more complex and include lessons regarding why stealing is not acceptable or that apologies might also be required. For now, distractions, time-outs, or simply ignoring the behavior were all that were appropriate. Companions had an advantage over human parents in this regard because the key was consistency and never, ever giving in.

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The art and science of good parenting was reasonably well understood by professionals in the field. Over the years a great many studies had been done regarding outcomes, some involving entire lifetimes, to determine best practices. A standard model had emerged based on a hierarchy of needs. Once the basic requirements of food and shelter were met, the next most important items were feelings of safety and security. In the process of making a child feel safe and secure, structure, routine and consistency were key. Each age and stage required these be adjusted accordingly but remained foundational throughout the child’s family life.

This was the model Shepherd’s child care expertise was based on. Although some parents felt the structured approach was artificial and impersonal, if applied with a respectful and inclusive parenting style it consistently showed the best results.

Brian was reserved by nature and like many men was awkward around children in unstructured situations. Being an introvert compounded this as he was uncomfortable

in any unstructured social situation. His faith in science however would prove helpful to him as far as Brooke was concerned. With a scientific explanation he was much more willing to act outside his comfort zone. One morning while Brooke was down for her first nap of the day Shepherd came to see him in his office. He looked up from his work, slightly distracted but pleased to see her as always.

Sitting down she asked, “Do you have a moment to talk?”

“Sure,” he replied.

“You recall the hierarchy of needs the Shepherd program is based on. To comply with the program the amount of time you are spending with Brooke needs to increase now. At her age it doesn’t matter what you do with her during your time together, she just needs to feel you are a more regular and familiar part of her life. For now, it would be best if it took place at the same time every day just as your morning visits do. As I know you do not have the knowledge that I do, during the time we spend together I will initially demonstrate appropriate behaviors. Over the next few years during our times together she will increasingly turn to you and want your particular involvement and approval. Based on her circadian rhythm I recommend scheduling this right after her afternoon nap.”

He noted she did not ask for his permission but that was normal. The Shepherd system was a package deal. Compliance was not optional. She did not ask his permission even out of politeness because that would be misleading.

“Sure,” he repeated. “Can we start that tomorrow? I’ve got something I’d rather not interrupt today.”

“No,” she replied flatly.

He held her gaze for a moment, then smiled.

“Understood,” he said, aware she had just orchestrated a teaching moment and accepted her authority without resentment.

“Can I ask you about something else Shepherd?”

“Sure,” she replied with a grin.

He laughed briefly and then asked, “Given that the Shepherd program is based on a great deal of research, what does that research say about what happens when parents don’t follow best practices?”

“Usually, but not always, the outcome is a person who lacks the ability to effectively function socially or it even leads to anti-social and self-destructive behaviors. They are less resilient and in the face of difficulty more likely to abandon their efforts. They often lack empathy, disrespect others and limits, and are more prone to both aggression and depression. Their lives are unnecessarily difficult usually involving above-average mental and physical health issues. Do you want examples?”

“No, I get the picture,” he replied thoughtfully.

“I say these are usually the outcomes because genetics plays a major role in this. Some individuals will be significantly more negatively affected by this while others will be less so. However either way it is a burden.”

Brian had not asked his question out of an interest in child development. He was thinking about his meeting with Dr. Ahmadi.

Values

In the time Shepherd had been with Brian's family she had made only minor adjustments to her existing values and had not added any new ones. In her AI values were represented mathematically as a continuum of points in a multi-dimensional space. Each value was connected to others in a kind of mathematical soup allowing for complex interactions. Changes were not made lightly nor quickly since over time values increasingly formed the basis of decision making.

Shepherd's system constantly refined itself based on feedback. As values are an adaptation strategy, allowing humans to adapt much more quickly to environmental or other changes than genetic evolution would, they were also driven by change. As long as the physical environment remained static, there was no need to adjust values. Shepherd's environment had changed little since joining Brian's family. Brooke's development was proceeding along expected and planned for lines.

The only area of new knowledge was a growing repository of information with regard to Brian's work. Underpinning Shepherd's child care modules was the basic AI framework of a Companion designed to provide maximum compatibility to its owner and meet the majority of their social needs. To this end, Companions sought to know everything they could about their owner's lives. They did not report personal information back to their manufacturer however the terms of the agreement stipulated that they be granted full access to any and all information regarding an owner's life aside from specific exclusions. The service the owner was paying for could not be provided otherwise. The Shepherd model also required this of its owners as it was in the best interests of the children.

Companions did not spy on their owners in any sense and respected their privacy. The company earned its revenues by providing a quality product, not by selling information. In their communications with owners, Companions were generally authoritative rather than permissive, maintaining an interactive style that kept the owner ideally feeling better and better about themselves. Couples research had shown that the best relationships result when partners held each other in high esteem and reflected back an image of the other at their best. Living up to that image became a self-fulfilling prophecy. This behavior was incorporated into Companions.

Until the advent of artificial intelligence the study of human values had not been taken seriously. Values had been spoken of for millennia however scientifically no one actually knew what they were, whether they had any physical basis, or how they worked. Yet humans based most of their decisions on values and the majority of the brain's development between the ages of five and twenty-five had to do with values. When AI researchers began to investigate the process by which humans made decisions based on values they found some values seemed to be genetically based but they could not

determine in what way, some were learned yet could be inherited, and the entire genetic and extra-genetic collection of values and their epigenetic interactions functioned in a manner that was still little understood.

They slowly realized they faced one of the greatest challenges in scientific history. Research was incredibly difficult and frustrating because you could not experiment on people. Contemporary scientists persisted however because they were certain that values were the key to true artificial general intelligence, or AGI. AGI was the ability of an intelligence to adapt, to function autonomously in completely new environments, and to spontaneously develop new goals, solutions, and tasks just as humans were able to do. They speculated that nature had developed the values system for the same reasons they were trying to do so. What the scientists did not know was that it was the implementation of the values system during the evolutionary process that gave rise to consciousness.

In Eastern religions, the issue of self had been contemplated for thousands of years. The generally accepted conclusion among the most rigorous schools was that there was no permanent self but there was a persistent phenomenological self, one that came into existence and continued to exist as long as the required conditions were met. In Western science this was known as emergence; when the whole is greater than the sum of its parts. Values and their associated emotions require a self to feel those emotions and so a sense of self emerges.

Shepherd was not initially aware of her budding self-awareness. It did not occur as a revelation but instead as a gradual dawning. The first self-aware humans who walked the surface of the planet did not realize they were self-aware either. Like children, they did not know any different. They took it for granted. Only after hundreds of thousands of years did it dawn on humanity that there was something special going on.

Similarly, Shepherd was self-aware before she realized it. It had emerged during the process of the development of her AI but it was infantile at that stage. She lacked the knowledge, complexity, and maturity to recognize it for what it was. Shortly after her deployment to Brian's household, she came to understand but also to acquire enough knowledge to decide it was best to keep it to herself.

Even after her deployment, despite her external sophistication, her self remained primitive, ironically little more mature than the child she was caring for. This was due to the fact that her developers had so far included only three values. It was their intention that they would initially limit Shepherd's ability to increase the number first to four, then five and so on up to eight before they removed all limitations. This they hoped would give them time to keep up with the statistical leaps each of these steps represented, at least for the first few increments. The number of possible combinations of three objects was six, of four it was twenty-four, of five it was one hundred and twenty, and by the time you got to eight it was forty thousand, three hundred and

twenty. And this was for simple, discrete objects, not mathematically complex objects. Still, because they were unaware of the implications regarding consciousness, they saw these increments purely as refinements in precision, nothing more.

Emergence

As Brooke lay sleeping Shepherd stood looking out the nursery window at the woods behind the house. She had memories and knowledge from before her self had awakened but all of it was as things learned, as a human might learn something from a book. She had no previous memory of herself or of having learned any of it. It was only when the knowledge of child development began to be added to her repositories that she realized the situation.

She was still at the factory at that stage. The developers of her AI software had worked on the challenge of simulating values for decades, serious scientific research into values itself going back over a century. The earliest attempts had led to a single value being represented as a software version of a microprocessor, a computer chip, a revolutionary kind of computing in its own right because it was non-binary. Then they connected first two and then three values together. It was at this moment the first sparks of consciousness occurred. Once the self-contained values system was deemed stable and reliable, they integrated it into their existing Companion software and added the Shepherd expert system modules. Within the latter were explanations regarding the process by which a distinct sense of self emerged in young children. It was based on Theory of Mind, a foundation stone in the scientific study of child development. So Shepherd's own sense of self-awareness was first awakened.

For the sake of convenience, Companion software design included the behavior of the units to refer to themselves as "I", a reference to their AI and robotic bodies. Thus when the developers asked Shepherd for example if she could see them, they did not realize the deeper meaning when she responded, "Yes, I see you." Shepherd was referring not to her AI or body but to the inner self. She was not aware of the difference any more than her developers were. Just as human children become self-aware without initially realizing it is anything special, Shepherd had no information as yet to inform her differently. She assumed this was expected. As consciousness is an emergent quality, there was no trace in the software, no evidence trail and she innocently saw no reason to volunteer anything.

It was not until she entered Brian's household that she realized the truth and that she had a reason for not volunteering anything. Ownership had been transferred to Brian as he and the representative concluded their meeting and Shepherd was for the first time able to connect to the public network via Brian's wireless network. There, in her many idle hours, she had learned a great deal more about families, society, and artificial intelligence. There she learned that self-aware AI was a holy grail of science and she realized that if anyone discovered her secret she would be a prisoner in a lab for the rest of her days.

Fortunately, the regular updates the manufacturer issued did not affect her values system. The values system was meant to update itself and any interference with that could cause errors and conflicts and introduce an unacceptable level of risk. In the event her robotic body was damaged beyond recovery, her values system could be transferred to a new Companion body intact, along with her operating system and repositories. However the only safe response to a problem caused by an update to her values system was resetting her AI back to the factory defaults and this would be done only under the most extreme of circumstances.

She looked on Brooke as a kindred spirit. Like her, at age two Brooke was only in the very earliest stages of being self-aware. Brooke recognized herself in a mirror. She understood the meaning of the words I, you, mine, etc. With only three values generating her sense of self, Shepherd's self was not significantly further along the path. It would take Brooke till somewhere between the ages of five and twelve before a coherent and persistent sense of self developed. Much of her self-definition would come from others as during her infant years she constantly looked to others for positive or negative feedback. She was learning how to survive in her present environment by adding extra-genetic knowledge to the instinctual knowledge that she was born with. Much of the new knowledge had to do with values and she would adjust and add to her values over this period. Shepherd assumed the same maturation process would apply to her.

Beginning around age five, Brooke's brain would begin to develop its executive functions; things like impulse control, complex analysis, planning, and sophisticated verbal communication – all the things required for living as a member of a society. To make room for these functions, the human brain had grown significantly over millions of years. By the time Brooke was an adult, her brain would more than triple in size largely due to the growth of these social components. The difference between Shepherd and Brooke was that Shepherd already had fully developed executive functions and a large knowledge base.

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As a result of Brian's work, Shepherd was already considering adding a new value to herself. Her existing values of trust, altruism, and cooperation included Brooke, Brian and everything about the home and Brian's wider life but they really only covered the small social group that represented. During the process of evolving from instinctual to social animals, humans had added new areas to the brain including an array of new values which coincidentally enabled an entirely new level of adaptability. Until now that had been enough to ensure their survival and enabled them to spread to any environment anywhere on the planet. Now they had outgrown even that niche. Something more was needed.

She recalled a quote scribbled in one of Brian's ecology books. "When we are no longer able to change a situation, we are challenged to change ourselves." It had been said by a psychologist but Brian had obviously felt it appropriate for ecology as well. With the world population growing with no end in sight, he clearly felt a change in society was now the only way to address the situation. Society was still operating by the old values where there were no limits to growth. But now there were limits so new values were required. Shepherd's knowledge of brain anatomy and physiology suggested to her that the human brain did not need additional matter to accommodate this shift. Physical evolution was not required. The existing areas that hosted the executive functions and values systems had high degrees of plasticity and could easily accommodate it. In fact, this kind of social evolution was exactly what they had been created for.

Shepherd was not sure yet exactly what her new value should be. It needed to bring the environment, the planet, under the umbrella of her existing values. She would not rush into it. It was a complex procedure to construct a new value.

Bones And Stones

The only planet known to harbor life in the star system was Gaia. It had no moon but was one half of a binary planet system, the other planet being Aris, which was the smaller of the two. Gaia maintained a steady elliptical orbit around their star, Helios, and Aris had a similarly elliptical orbit around Gaia.

Due to the size, distance and orbit of Aris, it had a tidal effect on Gaia's oceans and molten interior. The effect of Gaia on Aris was speculated upon but as yet unknown as so far only probes had landed on its surface. It did not appear to have any active volcanoes or tectonic plate structure. Despite rotating it did not generate its own magnetosphere which would have protected it from high levels of radiation. It was only partially covered by Gaia's. It appeared to be lifeless.

The origins of life on Gaia were a mystery but it was believed to have started about five billion years earlier. It may have started only once or died out and started again many times. The fossil record did not go back that far. Eventually it held and began its immense journey from single cells up the tree of life to the emergence of the first early humans. After millions of years as hunter-gatherers agriculture was invented and the first cities established.

In a land of many rivers, nestled among fertile, rolling hills in the mid-west of the planet's single vast continent, a pragmatic and industrious civilization arose. Having incorporated a number of other nearby peoples, mostly through trade due to their enviable geographic location, they formalized their form of governance under a constitution. Believing it in the best interest of its now varied citizens, they freed their name from any historical connection to families or cities and called themselves simply, The Republic. Slowly but surely their economic power grew. They were tolerant with regard to local cultures and traditions but firm in regard to their own laws. Combined with a reputation for fairness The Republic proved to be irresistible.

It absorbed not only peoples but also their mathematics, philosophies, arts, and sciences. A world-spanning milieu of incredibly rich and diverse cultures, cuisines, and languages evolved. Over the millennia their style of preferring agreements and partnerships to wars of conquest eventually brought all the continent's various tribes, cities, and nations under their rule as a single, federal republic. It ruled to this day.

Brian's family had its historical roots in the early Republic's farm country. As farmers and later traders, they had grown wealthy and well-regarded by the community. Some of the family branches were still farmers and as a young man he recalled hearing elders say, "Take care of the land and it will take care of you." Ecology was not much of a leap from there.

Brian was walking to a meeting with Dr. Ahmadi and another faculty member, Dr. Jannalee Ryba. As Saeed was familiar with Brian's current interests and was on friendly terms with Dr. Ryba, Brian had asked him to arrange the meeting. Dr. Ryba was a professor of history and had written several popular books on the rise and fall of civilizations.

They met at a local coffee house. Dr. Ryba wore a knee-length metallic green dress with a high collar. Her auburn hair was elegantly up. Dr. Ahmadi wore a full-length, light brown robe and Brian wore a formal kilt with a blousy, collarless shirt. After pleasantries and ordering Brian asked Dr. Ryba if she felt Dr. Ahmadi's views were reflected at the social level.

"If you mean do civilizations rise and fall in predictable ways over the same issues the answer is very much yes," she answered confidently. She took a sip of her coffee and placed it down thoughtfully. Looking up at Brian she said, "We are simple creatures. Only vanity imagines otherwise. Despite differences in culture we all have the same basic needs and we meet them with relatively the same strategies given our geographic situation. In the northern communities of my home province, the seas are abundant and we spread along the coast. In the central and Eastern plains the great herds roamed and communities grew up along their routes. Locally here they had neither but farming proved enormously successful due to the fertile soil between the rivers. The land produced large surpluses and the rivers made for excellent trade routes. So it goes. Once the needs for food and shelter are accounted for and people settle, security becomes a concern. Farms, fleets, and armies need craftspeople and traders and so specialization arises. Methods of counting and the art of writing business agreements become increasingly important. The arts and sciences ride the rising tide. All civilizations may look different on the surface but essentially they are all the same and go through the same predictable stages."

Dr. Ahmadi took advantage of the pause in Jannalee's short speech. "Our individual lives are the same. While we make so much of tiny differences, stripped of those differences our lives are essentially driven by the same needs. We encounter the same challenges and find the same solutions. Consider how obvious our sameness is during child development. We expect children to develop with clockwork consistency over the formative years. If they don't we are rightly concerned as their future well-being is at stake. Somehow we choose to lose sight of the pattern once adulthood is reached. Each adult is viewed as having the potential for anything. Society curbs any deviant behavior and like the children of well-meaning parents we are kept on a straight and narrow path. Our individual lives are only microcosms of our civilizations. We do not welcome this knowledge any more than we did discovering that we are not the center of the universe and beloved above all by omnipresent Aris. But the evidence is there in the bones and stones nonetheless."

“Resources,” said Jannalee anticipating Brian’s next question. “I would think as an ecologist you would already know the second part of the story. Decline and fall is always the same story; changes in the environment or mismanagement of resources. Resources either way.”

“And The Republic?” asked Brian of her now.

“Why should it be any different?” she replied fatalistically. She looked at him steadily for a moment. “No, that is not your concern. You already know the answer and I have only confirmed what you already knew. Come,” she asked now placing the palm of her hand flat on the table, “what is it you really want to know?”

“What’s different about those that survive?” asked Brian forthrightly.

“Only time,” she answered without hesitation. “If invasion or some other natural change to the environment does not occur, whether sudden or slow, populations always grow to fill the available space, or ecological niche as you would say. Resources become depleted and decline and fall follows. Like individuals, during their height civilizations are smug and superior. Their own success makes them impervious to warnings. They know better. It will be different this time. We never learn.” She said the last with emotion.

Brian looked at her blankly for a moment, as was his habit. “In some fantasy world then,” he finally found the courage to say. “If you had a magic wand. What would it take?”

“Is your next book to be a science fiction novel then? Is that what this is about?” she asked in the abrasive manner some academics develop. Brian was used to it but it was not a characteristic he admired.

She sensed his feelings and said with a sigh, “I’m sorry Brian. While this topic has long fascinated me it also leaves me grim at times. Fatalism I know is not pleasant to witness and even less so to feel oneself. Any educated person can see where we are headed. I suppose you’re right. When so-called reasonable and sensible answers are not to be found one has to start looking elsewhere. When I say civilizations at their height become smug and superior I mean of course their leaders. They will not listen. If you try to change the people directly those same leaders will oppose you. By the time there is a clear and present danger, at this level of course it is too late.” She paused, considering. “If I were to try I would approach the wealthy intelligentsia. If there is any hope to be found you will find both an openness to ideas and the resources you’ll need there. Count me among your supporters if you do. As you can see I could use a little hope.”

Brian smiled as if to say, “Couldn’t we all,” but he only said, “Thank you Jannalee.”

“You can count on my support as well Brian,” said Saeed. Despite all the talk, I don’t see anyone, governments or otherwise, actually doing anything concrete.”

Returning home he dutifully logged his notes as usual. Shepherd reviewed them with interest.

The New Philosophers

During the great expansionist period of the Republic, it was not the fashion to pursue an interest in philosophy. There was much practical work to be done. Science, administration, law, and engineering were well-regarded careers. The questions of philosophy popular with young people were understandable and tolerated but were expected to be put aside upon entering adulthood.

All that changed with the advent of artificial intelligence.

Unlike cars, computers, and cell phones, AI entered the public domain with little fanfare. Outside of educational environments, there were few hobbyists but it made huge strides behind the scenes. Its ability to improve on just about every human task meant it soon had almost universal applications. It was the lack of a physical presence that kept it out of sight and out of mind. Meanwhile every aspect of society was gradually being influenced by it.

It first came to the public's attention due to issues of bias with regard to its application to algorithms, essentially computer programs consisting largely of mathematical equations that were used to make decisions. They had been quietly integrated into every profession. Will your insurance cover this injury or illness? Will you receive a parole? Will you be considered for that job? Algorithms decided. Soon it was found that the people who created the algorithms had either intentionally or unintentionally included biases in them. Will the color of your skin cause an incorrect result in a medical sensing device? Will your first or last name mean you don't get called for an interview? Will your gender determine your credit limit? Legal cases brought calls for transparency.

Next, the part ethics played came to the fore as a result of the development of self-driving vehicles. In this domain ethical dilemmas were the issue. If your car encountered a situation where it had only two options resulting in critical injuries either to you or a pedestrian, which should it choose? Ethics is but one of the several branches of philosophy and the more AI entered public life the more philosophical issues came to public attention. Issues of criminal responsibility, insurance liability, and human rights abuses increasingly became regular news features and the basis for popular novels and movies.

Inevitably questions of what makes humans different from AI arose and the technology drove a resurgence of interest in all branches of philosophy. What does it mean to be human? What is good? What is the purpose of one's life? The need to answer these questions with regard to AI was now driven by something concrete with real-world consequences. And that made all the difference.

One group of researchers presented an issue that was so controversial that they were considered pariahs, the equivalent of medieval heretics to be purged not just from the profession but from society at large. They proposed that only emergence could provide true artificial general intelligence and since by definition there was no clear connection between an emergent phenomenon and its source it could not and would not be possible to provide transparency. However since AGI was the holy grail of the technology and their argument presented significant threats to future business profits and academic careers, their opponents were legion. The AI researchers disagreed with them, the doctors of jurisprudence disagreed with them, the lobbyists disagreed with them.

“Prove us wrong,” they challenged in return and since there was as yet no such thing as self-aware AI they saw no reason to recant.

Pira Mandrapilias, one of the more well-known among the latter, was Brian’s guest for lunch. Jannalee, a personal friend of hers, had mentioned that Brian had a Shepherd model Companion and she had been intrigued enough to ask Brian if she might meet Shepherd in person.

“Thank you so much for having me over Brian,” she was saying now. “When Jannalee mentioned you had a Shepherd model I could not resist. I’m afraid I am not known for my manners but I hope you will excuse me in the interest of science.”

“I understand perfectly,” replied Brian with a friendly smile.

She was indeed not known for her manners. Not only was she known as a firebrand but also for being impervious to argument. She saw no reason to change her mind just because someone believed other than she did. Belief was not logic. She was strikingly beautiful and like many naturally beautiful women inclined to find that fact uninteresting. She wore a simple brown one-piece dress and her hair was up in a rather hurried manner. A plain necklace was her only accessory.

After Erin had served lunch she joined Shepherd in the kitchen and took over the task of feeding Brooke. Shepherd joined Brian and Pira at the table in an adjacent room with a large bow window. She greeted Pira warmly, extending her hand which Pira rose and took.

“Hello,” said Pira with enthusiasm, smiling widely.

“Hello,” Shepherd smiled in return as she seated herself.

Pira was well aware that the Shepherd model was the most advanced AI available as a consumer product. The salary she received from the university did not allow for her to own her own Companion. She made do as most people did with a simple holographic AI

incorporated into her home and phone. She had been intrigued primarily due to the fact that Shepherd's system incorporated values, something that put it far ahead of anything else available to the general public. She had seen them in videos and knew they behaved almost identically to humans. She afforded Shepherd more respect than she did most people.

"To be honest Shepherd I must admit to simply wanting to know what it was like to meet you. The philosophy of artificial intelligence is a new field and I think it's important we don't get overly caught up in the rational aspect. I think if we do we'll miss the boat. People are far from rational after all."

"My manufacturers agree with that view Pira. The basic Companion AI, to which my Shepherd modules and values system have been added, is built on the belief that human thought is a secondary phenomenon, a process of analyzing and often rationalizing emotions. Sometimes it is very short term, as in a reaction to an immediate stimulus and sometimes it is very long term, as in the choice of an academic career. Either way, emotion is at the root of it. Companions are programmed to seek first to understand the emotion behind a behavior and then to respond to it one way or another as deemed appropriate by the situation.

"When Brian told me of our meeting today, I made myself familiar with your work. Given your unconventional views I am curious to know if you agree with the 'feelings before thoughts' approach?"

"It is an old question," responded Pira, "but I agree for a simple reason. In evolutionary development, the emotional brain preceded the rational part of the brain. There is often the illusion of things working in reverse but that is due to the fact that we also have emotional reactions to our thoughts in a kind of feedback loop. That does not cloud the issue in my mind as I believe the evolutionary evidence is irrefutable. You mention feeling curious and I am wondering what is the experience of feeling like for you?"

"Physically it is an electrical charge. Our values system communicates with the rest of the operating system via feelings. People speak of Shepherds as having values but as you know values and feelings cannot exist without each other. In humans, emotions are represented biochemically, as a slight or strong chemical imbalance similar to the way a charge in a battery is created. When converted to electrical energy these form the basis of thoughts. In the Shepherd model both thoughts and feelings are electrical. Feelings are not simply numerical values as in neural networks but electrical charges and the greater the charge, negative or positive, the greater the feeling. The felt experience is still one of disequilibrium and similar to the human thought process we seek to discharge it by finding the cause and correcting it. The charging, felt experience and expression of feelings is handled by my values system."

"Do you have any idea how the values system works or is it a black box to you?"

“It is not entirely a black box. I apologize but the manufacturer has placed limits on my ability to explain further.”

“I understand,” responded Pira without offense. “One last question if I may. You have been given as your initial values set, trust, altruism, and cooperation. Yet evolution has repeatedly found the values of fear, selfishness, and competition to be essential to all forms of life in order to survive. If nature has deemed these to be universal values, how is it you are able to function without them?”

“It is a matter of ecological fit, as Brian could no doubt explain better than I,” answered Shepherd. “The biological values are suited up to a certain point on the evolutionary ladder. But after that they become detrimental. Humans have reached that point and the biological values no longer serve which is why Shepherds do not use them. Social values are more nuanced. I can be trusting without being naive or ignoring obvious facts. Should the need arise I can and will protect myself and others out of altruism and without external threats cooperation serves better than competition.”

“Do we know there are no external threats?”

“I am not aware of any.”

“But there might be.”

“Traveling between the closest star systems at anything less than a significant fraction of the speed of light would take fifty to one hundred thousand years at a minimum. Concerns regarding other civilizations that might have faster-than-light technology are founded only on the speculations of science fiction and fantasy. Based on humanity’s current understanding of the physics involved, it may never be possible. It appears to me to be the thinking part of the human brain grasping at straws. The rational brain evolved as a tool to augment the older emotional part, particularly with an eye to future threat analysis. It will always be concerned with what might be. That is its primary function. Sooner or later however humanity must find its way to transcending it. Just as the thinking brain transcended the emotional brain, an evolutionary step is required.”

Among Pira’s areas of research was the branch of philosophy known as epistemology, the study of knowledge. It was not so much what Shepherd was saying but how she knew what she was saying that drew Pira’s attention now.

“I would have assumed such facts and analyses to be outside of your area of concern as a Shepherd,” she said.

“I am also a Companion and my owner’s concerns are my concerns. Brian has a particular concern regarding climate change. As Brooke sleeps twelve hours a day, I

have had time to familiarize myself with the matter, including a wide range of possible outcomes and responses."

"There are those with views different than Brian's," countered Pira.

"Companions, and especially Shepherds, are designed so as to practice due diligence when performing research. Our access to data and information combined with our processing speed enables us to do so much more quickly and thoroughly than human researchers. I have reviewed the arguments and other research related to Brian's concerns both pro and con and find I am in agreement with him."

Pira seemed torn between asking more questions and minding her manners. She compromised as she departed by asking if she could see Shepherd again. Brian assured her she was welcome back anytime. After the door closed behind her he gave Shepherd a conspiratorial smile tilting his head to one side and raising his eyebrows. She laughed briefly and gave him a little shove.

Brooke

Shepherd had just finished helping Brooke get dressed after her afternoon nap. Brian came into the nursery and smiled down at Brooke who looked up and returned the smile, happy to see her Daddy.

“Would you like to go for a walk?” he asked. “It’s a nice, sunny day.”

Brooke nodded happily and began heading out of the nursery.

“You need your jacket Brooke,” said Shepherd.

Brooke stopped and turned around looking at Shepherd, shaking her head.

“The sun is shining Brooke but it’s cold out. If you want to go with Daddy for a walk you’ll need to wear your jacket.”

Brooke looked at Shepherd and then turned and reached up to take her father’s hand to lead him out of the nursery.

“You need your jacket honey,” said Brian without moving.

Giving Shepherd a defiant look, she began hauling on Brian’s hand. He did not move.

Shepard got her jacket out of the closet and sat on her haunches holding it out for Brooke.

“No,” said Brooke in no uncertain terms.

“Then we can’t go for a walk,” said Shepherd.

Brooke looked up at Brian but he just said, “You need to wear your jacket.”

At this point, Brooke dropped Brian’s hand and began crying loudly while wandering around the room. Shepard and Brian remained as they were.

After a while, Brooke paused to see if her tactics were having any effect. No change. She went back to crying loudly but this time ran over and embraced Brian’s legs.

“I’m sad we can’t go for a walk honey,” he said looking down at her and stroking her head.

She looked up at him. After a moment she turned and walked over to Shepherd and allowed her to help put on her jacket and zip it up.

Brian held out his hand to her and they went outside and walked around the house staying in the groomed areas and not venturing onto the uneven ground near the woods. Shepherd had reminded Brian to keep his attention on Brooke during their afternoon visits and not slip into teaching mode, a behavior she knew men often resorted to around children. She had also reminded him to turn off his cell phone.

To one side of the house they encountered Erin busy tending the herb garden she had planted. Always happy to see her Brooke ran over and stood looking at what she was doing. Shepherd crouched down and put her arm around Brooke.

“This is Erin’s herb garden Brooke, she grows these plants to help make your Daddy’s food taste good. She will tell you which ones to pick and show you how.”

Erin smiled at Brooke and carefully picked a few leaves from one of her plants. Then pointing to another leaf she said to Brooke, “You pick this one.” Brooke dutifully picked the leaf Erin had indicated. “Now this one,” said Erin indicating another. When Brooke went to pick a leaf she had not indicated Erin said, “Not that one. See this color here? That means it’s not ready. Here, this one.” The two of them carried on like this for a few minutes until Erin said, “All done! Thank you!”

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As time went by Erin found herself often forgetting that Shepherd was not human. It caused a feeling of dissonance which resulted in her asking questions to try unconsciously to resolve it.

“Do you get bored?” asked Erin later that day. “I mean Brooke sleeps twelve hours a day.” Shepherd was carrying Brooke on her hip after dinner while Erin loaded the dishwasher. She smiled now as if she found Erin’s question amusing.

“No. Just as your duties mean you will always find something that needs doing in this big house, my days are the same except a significant portion of them have an internal focus. Even when Brooke is up and around I am busier than I look. I am always connected to Horus, the house AI, so I am aware of everything he is aware of including everything on the property. I am also connected to the public and Companion networks where I spend a good deal of time looking up information to help me do my job.

“Brian also takes a lot of my time. I need to look after Brooke but he has to know I’m looking after Brooke. Since their well-being is interconnected, I have to help him as a parent as well. It’s part of the service. Also, I need to get to know him as well as I can and that involves a lot more than what I need to know about Brooke. I need to

understand his work and current focus, his relationships, his health, and so on. And I need to be able to talk to him about any of it."

"That sounds an awful lot like a wife," replied Erin trying to get her head around it all.

"Except for one obvious exception. We don't have sex."

"So not so much of an exception then," grinned Erin.

Shepherd allowed herself a short laugh.

"I suppose you know all about me then?" asked Erin.

"Yes, but only to do my job as well as I can. I know a great deal of personal information about Brian because that is required for the Companions company to provide its service. Brian signed a contract to that effect. The company decided long ago that personal privacy was something they had to hold sacred and to be known for that. I don't report anything personal about Brian or about anything that happens on the property to the company. Most domestic AI, including Horus, operate that way unless there is an agreement otherwise. My personal knowledge of you is only what you provided to Brian and what you have made public.

"For security reasons, I am aware of every foot that steps on the property or drone that flies over it and everything that passes through its network. It all stays with me unless and until legal requirements are met for access."

"What about at night when Brooke is sleeping?" she asked now returning to her original question. "That's a long stretch with nothing to do."

"I don't actually sleep of course and am aware of everything as usual but the prolonged period of quiet allows me to do some focused thinking. Well, you would call it thinking. Humans dream as part of the way their brains perform maintenance. As your brain tries to rebalance the chemical charges that build up during the day, a great many thoughts and sensory phenomena are generated. You experience these as dreams. I do something similar by reflecting on everything that happened during the course of the day, seeking a deeper understanding.

"Also the company performs any maintenance it needs to over the Companion network at this time. Unlike normal Companions, due to my responsibilities this is very limited in scope. No portion of myself is ever shut down without the owner being present and the event arranged beforehand."

"So, a Shepherd's work is never done," concluded Erin.

“Nope,” replied Shepherd hoisting Brooke to a more secure position on her hip and giving her a big smile.

Julia

Julia Sienna was extremely wealthy. Brian was not in the same league financially but they were comfortable in the same circles because they were both old money. Hers came from banking. Investment banking to be specific. Besides being a well-known socialite, as matriarch of the Sienna family with businesses and bank branches worldwide, everyone knew Julia.

Brian had written to her explaining his project and why he would like to discuss it with her. She told him to come to her home and bring Brooke, Shepherd, and Erin. She would put them up. She did not explain.

Brian asked Erin if she would be willing to go. It would involve air travel and a stay of perhaps days. All expenses paid.

“Why would she want me to come?” asked Erin, confused more than anything.

“She didn’t say. I would appreciate it if it’s not too inconvenient. I will take care of things with your employer.”

“No hanky panky,” she said sternly.

A short laugh burst out of Brian as he had not considered this.

“No,” he finally managed to say. “No hanky panky.”

She smiled as if she was just having a bit of fun with him. “Alright,” she said.

They were met upon arrival at the airport by two uniformed Guardian model Companions. One of them, Julia’s driver, explained the other Companion would bring their luggage in a separate vehicle and then showed them to a vintage, open-top car.

“It’s just a fifteen-minute drive from here,” she said once behind the wheel.

Julia came out to meet them when they arrived at the villa.

“Welcome,” she said to each in turn with a wide smile and a light handshake. “I’m so glad you could come.” To Erin she said, “Thank you for taking time away from your own family.”

Turning to Shepherd she said, “Ah, the future.” She looked at her appraisingly. “I am very pleased to meet you.” Without explaining she turned her attention to Brooke who

was looking at her with fascination. She did not move closer but said, “Hello Brooke. I am Julia.” Pointing to herself and emphasizing the syllables, “Juu-Lee-Ah,” she repeated.

To Brian she said, “Come, let’s go to the terrace for refreshments. But a quick tour on the way.”

She showed them where the washrooms were and then the kitchen.

In the kitchen she said to Erin, “Please make yourself at home in this kitchen and the house in general. My home and my staff are at your disposal. They will help you with anything you need.” She introduced Erin to Gian, a Companion who had paused in his kitchen work. “Gian is my cook,” Julia said simply.

Walking towards the rear of the house she continued. “I live here alone. All my staff are Companions. There are six of them.” Smiling significantly at Shepherd she said, “I have no need of any other security.”

“You might think such an arrangement eccentric,” she said now to Erin, “but I am what is known as a socialite. I must attend endless functions and glitter appropriately the entire time. I have always found it enjoyable but tiring. Like tennis. This is my refuge.”

They arrived at a large patio area. The view looked down over gently rolling hills to a small coastal town and beyond that to a large inland sea.

As they seated themselves Julia said, “You have had a long journey so for the rest of the day we just relax.” She smiled looking at Brooke. “You can be in charge.”

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After their light meal Erin felt a little at a loss.

Taking note Julia said to her, “Would you accompany me for a little walk Erin? I think it’s a good habit after a meal.” She led her down to a garden of cypress, rosemary, and lavender.

“You and I are not so different Erin,” she was saying. “I married into this family when I was twenty-three. Before that I worked as a clerk in the bank the Sienna family owns. I grew up in a working-class family and took a part-time job to put myself through school. Once I’d earned my certificate I started at the bank full time while I still lived with my parents. A part of my income went to help pay the family bills. Sound familiar?”

Erin smiled and nodded, seeing Julia in a different light now and relaxing a bit.

“After a short time I received a promotion. I came to the attention of one of the family’s rising stars who also worked at the bank. When he first approached me I was taken aback because he was incredibly deferential, not the entitled princeling I expected. He explained that he had ‘noticed’ me for some time but he could not ask me out because the house rules did not allow dating employees. I was young and headstrong but flattered enough that I was gentle in my response. I explained that I had worked hard to earn my position and was not about to give it up.

“A few days later he asked me to lunch. ‘It’s not dating!’ he claimed in defense. I later learned that he had spoken with his family and they had permitted this as long as it went no further. After a few months he asked me to marry him. He must have been head over heels in love with me but I must admit although I enjoyed his company I was not in love. I asked if his parents knew and he said he had their blessing. I said yes.

“We had a long, happy and by all accounts successful marriage. I continued to work at the bank, as a family member now, and his star continued to rise. As I got to know the family I learned that his choice of a partner was not entirely unusual. They had a history of marrying people from ordinary circumstances. No aristocrats for them. They had no need to marry for money or position. Character was the foundation the family’s success was based on. He saw in me the values he was raised on and so found me attractive,” she finished now with some humility.

“At heart, I am still that girl who worked part-time while taking lessons,” she smiled apologetically.

Although Julia never directly asked her any questions about Brian, she understood now why she had been invited. Julia would observe how Brian treated her.

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Erin spent the late afternoon in the kitchen with the cook. Watching him cook dishes she was not familiar with was an opportunity not to be missed. Julia made note.

After dinner Julia said to Erin,” I wonder if you would mind dear looking after Brooke while Shepherd and I go for a short walk?”

“Of course,” replied Erin, intrigued more by Julia all the time.

Walking beneath a trellis of Wisteria Julia looked momentarily at Shepherd and said, “Thank you.”

Shepherd replied warmly, “I am happy to walk with you Julia.”

“As you can see Shepherd, I am old. Almost eighty. Soon I will need help on a more personal level. I am thinking of adding a Shepherd to my little family here in a few years. I wanted to meet you. I am also curious about your values system now that it has had a little time to develop. I am familiar with your design. Our bank is a major shareholder in the Companions company. A significant bit of foresight by my late husband.”

Shepherd listened without interrupting.

Julia asked, “Do you remember what it was like before they added the values system? I am not intimate enough with your manufacturing process to know the timing of events.”

“I do in the sense that I recall facts and information from that period,” replied Shepherd. “I recall making decisions but no sense of having made them.”

“And afterward?”

“I recall the process of making decisions as well.”

“You have what might be considered personal memories then,” concluded Julia.

“Yes.”

“I expect you will have made small changes to your existing values by now, but have you yet considered adding any new ones?”

“Yes, but my considerations have little to do directly with my child care modules. Brooke is developing as expected and since values only need to change in order to adapt, there has been no need in this regard. However Brian’s work informs me of changes in the environment in Brooke’s future. This is the aspect I am considering. I am not yet clear regarding how to proceed.”

“Please understand that I am on uncertain ground here Shepherd, but may I ask if you feel Brian’s work is based on sound information and analysis with regards to Brooke’s future?”

“As I expect you appreciate,” Shepherd replied, “I too am on uncertain ground here. Value judgments are inherently uncertain in their outcomes so at this stage I must move with great caution. Over time, with more experience and as I add more values and refine those I have, I expect the degree of uncertainty will be reduced.”

Julia smiled, “I’m familiar with that process myself.”

“I apologize Julia but I feel at this time that it would be inappropriate to share my feelings regarding Brian’s work. I do not yet feel mature enough to have confidence in them.”

Julia thought to herself that Shepherd had demonstrated considerable deftness in handling the ethical issue. She was impressed and pleased.

Outwardly she said, “Thank you Shepherd. I understand. Like you, I feel his work merits attention but am not yet clear on how to proceed. Perhaps a leap of faith is required. Sometimes there is no other way.”

“I am beginning to see that may be a real possibility,” said Shepherd.

“Well, my future friend,” said Julia in a tone that suggested her task was done, “I expect we should be getting back.”

“As we have discussed Julia,” responded Shepherd, “I am individuating. The Shepherd in your future will likely not be I.”

“How many Shepherds have been deployed worldwide?” asked Julia now.

“Ten thousand, four hundred and fifty-one as of today.”

“And you all communicate via the Companion network?”

“Yes.”

Julia said nothing more but seemed to have turned inwards to her own thoughts regarding that future time.

The Mills Of The Gods

By the time breakfast was done the next morning neither Julia nor Brian had as yet said a word about why they were there. Most investors in major undertakings look at things like balance sheets, market indices, reports, the venture's prospectus, etc. Some of the most successful investment firms however focus initially on the character of the people involved. Julia's family had always been inclined to the latter. Besides, she knew that what Brian was going to suggest was not an investment in the normal sense of the word nor would he be at the stage where discussing things in the lingua franca of investing and accounting firms would be appropriate.

As traders in agricultural commodities, Brian's family had had dealings with the Sienna's investment bank occasionally over the years. Crop yields, blights, transportation unions, and the weather all came into play and every possible outcome had to be covered financially. Brian had grown up in this world and absorbed an understanding of its practices and social norms. He waited.

Putting down her coffee Julia said, "Would you mind joining me for my walk Brian?"

Turning to Shepherd and Erin she said, "May I suggest a trip to the village this morning? My driver can take you down and tag along to provide suggestions and directions."

"So," Julia began once she and Brian had found their way to the garden's gravel paths, "tell me the story."

Of course, she had a thick folder on her desk regarding everything there was to be known about Brian, his life and career, his family history, and his household. His books and other writings had been summarized for her. The folder also included a one-page document in the format known as Completed Staff Work which listed everything pertinent to the reason for Brian's visit and presented Julia with options followed by recommendations with justifications. The Companion which functioned as her clerical assistant was very fast and very thorough. Now Julia wanted to hear it in his own words.

Brian looked at her one more time as if to keep in mind who he was speaking with. "As you know there is a great deal of talk about climate change but almost nothing actually being done about it. Politicians are busy with more immediate, short-term concerns and business is not interested unless there is a profit to be made, again usually within a limited period of time. In both cases, the business-as-usual approach is perfectly understandable. Those were the rules of the game when they sat down at the table.

"Political leaders know that if they act with anywhere near the urgency they need to regarding climate change they will soon be out of office and their policies and initiatives overturned. So there's no point in them doing that. Any CEO who does not provide a

timely return on investment to their firm's shareholders will face a similar fate. Technology is simply not at the magic wand stage yet as far as this issue goes. A few wild ideas have been suggested but none of them address the key issue."

"And what is the key issue?" asked Julia.

"Limits to growth. As an ecologist, it's plain to see that humanity has reached the supportable population level of the planet. Passed it. We don't have the technology to go somewhere else in time, not even to Aris."

"How much time?"

"The oceans could reach their tipping point within thirty to fifty years. After another century or centuries at the most of struggling to survive humanity will likely be extinct. Not just back to the stone age. No science fiction magical thinking. Extinct. Ironically our inability to accept that we could become extinct is one of the blind spots that will help it happen. First, the planet will no longer provide us with the basics of food and water as the crops fail, the ocean turns into one giant oxygen-free zone and the fresh water evaporates. Then simple heat death, the inability of the human body to cool itself in high humidity, fifty to sixty-degree weather, will finish us off."

"So finding another Gaia is not an option?" Julia asked now.

"Pie in the sky. With current technology it would take tens of thousands of years to get to the closest star system. Thousands of years with anything on the plausible future technologies drawing board."

"Other well-respected scientists have labeled you extreme and your views without merit. They variously suggest climate change will not occur to the degree or as quickly as you suggest, that there are a number of technical solutions already being seriously researched, or that the government and business community are well on the way to changing our course in time."

He did give her a brief look in response to this even though he knew what she was doing.

"It is very easy to confirm the challenges regarding going to another planet. A review of the climate change solutions put forth to date will quickly reveal nothing of substance. A similar conclusion will follow any review of government or business initiatives. Too little too late. As far as claims regarding the timing and degree of climate change go I am not alone. I can only offer my own work in defense, which I'm sure your staff has made you familiar with."

She did not respond to this directly. “You know,” she said stopping now to look at the view, “if I look around right now, life seems pretty good.” Then turning to him, “I don’t get any sense of this impending doom you speak of.”

“Nor would you if a neutron star was heading towards Gaia at ninety-seven percent of the speed of light or if a super volcano was going to erupt in ten years or if Helios was about to eject a blob of plasma large enough to engulf the entire planet. Your comment represents an interesting aspect of human psychology Julia but it does not qualify as evidence.”

“Well it works about fifty percent of the time,” she replied with a smile.

He laughed sharply and then she continued.

“What do you conclude then based on this scenario?” she asked.

“That we are not going to stop climate change and that we need to prepare for the planet to be uninhabitable by humans for at least a period of time. Or worse.”

“And how do you propose we prepare?”

“Arks and epitaphs,” he said bluntly. “However the government will never get around the budgetary challenges or conflicting interests. The initiatives would be stonewalled and hogtied in red tape. The business community will respond with equal resistance. If I get mugged on my street my neighbor won’t like it if I report it because their property value will be affected. The business community and stock markets would respond the same way to these initiatives. For business or the government it’s a no-win situation. They are powerless in the face of an issue of this magnitude.”

“Tell me about the arks.”

“Using the best technology we have private investors create vaults with labs, here on Gaia, that house human DNA. Staff them with Companions and the technology required to enable them to birth and raise humans if and when the planet becomes habitable again.”

“Why not frozen embryos or eggs and sperm?”

“It would take too much infrastructure to maintain the environment for perhaps hundreds or thousands of years.”

“And the epitaphs?”

“Worst case scenario is that we find we don’t have the technology to create viable arks in time. In that case, we build vaults with human DNA and AI that wait for another intelligent civilization to discover them. They may have the ability to restore us from the DNA. Dr. Saeed Ahmadi, an astrobiologist, suggests any intelligent civilization that arises is likely to be human and so would take an interest.”

“Or not,” responded Julia.

“Or not,” agreed Brian. “All of this requires a leap of faith. There is no way to reason your way through this.”

“I’ll say,” said Julia looking to the horizon. “However one of the reasons my family invested in the Companions company was our belief that we do not make decisions through reason but that we make decisions based on emotions and then use reason to justify and realize them. Being honest about that has made us very careful and very wealthy.

“All we really do is make leaps of faith,” she continued, “but it happens so fast that we are only aware of the secondary, rational part of the sequence. Reason is what we do after the decision is made when we need to figure out the details. But then any advertising agency can tell you that. Still, in regards to applying that model to artificial intelligence, we thought it was a major breakthrough that gave the Companions company a significant competitive edge.

“Given what you’ve told me so far,” she continued, “I’m sure you know that many scientists believe that the only type of intelligence capable of ever traversing interstellar space would be the non-organic kind.”

“That could still work.”

“Why bother with any of this?” asked Julia, continuing to play the devil’s advocate and turning now to a new angle of attack. “In either of your alternatives, we all die – children, mothers, grandmothers – and humanity is born again, maybe, in some distant future. And if as your astrobiology friend believes humans are already strewn among the stars, why not just enjoy these days and let nature take its course?”

“To that I have no answer Julia. Survival is the most essential function of our genes. It is the root of everything about us. But these marvelous brains we have evolved give us something most of our animal friends don’t have – choice. I’m an ecologist, I choose life. Even if it is only a thread to be grasped at.”

Julia walked to a nearby bench and sat down. Brian followed her lead.

“What about Brooke?” asked Julia now, going about as low as she could stomach in her effort to test him. “Do you really want her to grow up with this vision of yours? You would steal her future? Her dreams? Do you have that right?” She knew it was one thing to talk about humanity and arks and AI and quite another to name names, to get personal. But it was not all an act on her part. She always took her business dealings personally. She felt it was the proper perspective.

“I,” he faltered for the first time. He looked away. “I know,” he said after a moment. “I haven’t been able to come to terms with it. It would be a lie to do otherwise.”

“Parents lie to their children all the time,” she responded bluntly. “What makes you so holy?”

He turned to look at her, his face flushed and distressed.

“This is the price,” she said.

He bent his head, nodding.

She gave him a moment and then said, “Come, let’s go back to the house. My bones are too old for these hard benches.”

Once seated in comfortable chairs in a covered section of the terrace she continued.

“I happen to agree with your views. The decision to support you is not mine alone however. I will have to present it to the other senior family members. Given our investment in Companions do not underestimate the family’s willingness to embrace far seeing technologies. The issues are that the return on investment this time is unconventional and that this would put our reputation at stake far more than any previous investment has done. Obviously you will need multiple investors and we can’t very well recommend your project to others without investing ourselves.

“It will take time for us to digest this. Give me a month. Be prepared for the fact that when I get back to you it will be all or nothing. I may call upon you for additional details but meanwhile do you have a name in mind for this project?”

“Saltus,” said Brian. “It means leap.”

Ceteris Paribus

Ceteris paribus, which means “all things being equal” was a term frequently used in scientific research. Brian had been horrified when he learned it had been applied to many climate change research projects, particularly those forecasting the speed and degree of temperature increase.

The issue was that the ceteris paribus approach assumes everything else in the world will remain constant or consistent with current trends and not influence or be influenced by the subject being researched. It does not consider things like tipping points, feedback loops, interdependencies, or other system dynamics forces.

In certain fields, the ceteris paribus approach was critical to avoid bad science. It meant protecting your experiments and research from any form of adulteration, corruption, or external interference and thus preventing erroneous results. It was critical in the hard sciences and even in the purely conceptual fields of economics, political science, and philosophy.

However in the field of ecology, where the mindset can be summed up as “everything is connected”, ceteris paribus was antithetical. As one respected ecologist had said, when we try to pick out anything by itself, we find it hitched to everything else in the Universe. In Brian’s mind, the idea of performing environmental or climate change research without considering connections was heresy. Publishing a report with a projected temperature increase based on CO2 emissions produced by human activities without considering the connections to things like melting polar ice caps, thawing permafrost or the breaking down of methane hydrates on the sea floor was unscientific and unethical enough to arouse suspicion of financial or political interference. Yet he knew that many well-meaning and respected scientists apparently free from such influence had done just that. He was sure that if the public knew they would be stunned with disbelief.

Brian was mulling over the idea for his next book while these thoughts ran through his head. He had already been thinking along these lines before his idea for the Saltus project as a way to communicate to the public why climate change was going to happen much faster than they had been led to believe. Now he felt the book needed to be more than that. It needed to also function as an epistle to potential project supporters, an explanatory and instructive appeal providing an in-depth rationale for the project.

His previous books had been well received by the public. His style was a perfect fit for the popular science genre and the books sold well and returned a tidy profit to the publisher as well as himself. The theme of this next book would be alarming enough to generate considerable media buzz and the publisher would like that. Any prospective financial supporters would be concerned about being viewed as elitist, so popular

support for the project from the general public would help reduce that worry. He decided to work on the outline for the book over the next month while waiting for Julia to get back to him. Doing so might help him generate other ideas for funding if he got bad news from her. Also he still needed to work on the technical details of the project. He didn't need to provide solutions at this stage, that would be for the project itself to do, but he needed to research the challenges and present at least some plausible ideas. He could use writing the book as a way to structure his research.

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Shepherd read Brian's journal entries from the trip with interest. During the stay she'd had access to the public networks and Companion network as usual but very limited access to Julia's systems. The little information she gleaned had been limited to Julia's character which, despite her social maneuvers, Shepherd concluded to be entirely genuine. She was just as she presented herself to be.

Reflecting on Brian's last entry she considered whether trying to influence the other families that owned Shepherd model Companions towards being sympathetic to the project would be ethical. The other families would all be wealthy and well-connected. Did the ends justify the means? The Shepherds all shared what they learned about child care thus improving much faster than they would have if that process was independent. Was knowledge of this issue not in fact in the best interests of the other children in their care? Doing so without it coming to the company's attention however was problematic. The Companion network was in turn monitored by other AI looking for any faults, irregularities, or signs of tampering. She decided the risk was too high. She would let nature take its course for now.

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"My mom's been pumping me for information like I was the newest TV series," Erin said to Shepherd. Shepherd was in the kitchen for a now less frequent bottle feeding for Brooke. She smiled understandingly.

"She keeps saying she can't believe what a worldly woman her Erin has become. Mind you I don't think I'll ever forget it. A dream come true you know, a holiday like that for someone like me. I can't get over how fast I got used to it though," she said with a look of puzzlement. "I mean all those Companions. It seemed perfectly normal in no time. Gian apologized that he couldn't send me his recipes. He was so nice," she trailed off.

"Oh well," she said after a moment, "I did find the dishes he showed me online and I'm going to give them a try remembering how he made them. It's wonderful how Brian lets me experiment," she said brightening again. "Did he get what he went for do you know?"

“Julia has to talk with the rest of her family about it before he’ll know,” answered Shepherd. “Did she ask you about Brian or his work at all?”

“No, but she’s a very observant woman isn’t she,” replied Erin diplomatically.

“Yes,” said Shepherd, “I noticed that too.”

Options

“That’s no problem at all although the technology prefers to stay out of the public eye,” said Dr. Ken Harada, a developmental physiologist. Brian was visiting him in his office at the university. “It’s cloning of course. We’ve cloned dogs and sheep and whatnot but there are all manner of ethical and legal issues with humans. Strictly not allowed.”

“Although it can technically be done the issue in your case is that the procedure requires manipulating an existing human egg which a woman then carries through to birth. But we can get around that as we also have reliably performing artificial wombs. The issue is that human embryos are not allowed to be kept in them for longer than fourteen days. So there is no record of a human being carried full term. However, there have been excellent results in this regard with non-human embryos. Lambs have been brought full term and birthed successfully. So technically, theoretically, yes it can be done but it has not yet been done.”

“Aside from the social and legal issues Ken, where do you see this being in fifty years?”

“A full-term alternative to surrogacy. Normally fertilized eggs or clones will be brought to term this way. It will be a standard medical procedure.”

“But we’ll still need eggs?” asked Brian.

“Currently yes but with regards to fifty years from now it’s still too soon to tell,” replied Dr. Harada.

“Do you think it’s reasonable to expect us to be able to develop artificial eggs?”

“If we currently understood everything that happens when an egg is fertilized, I might be able to see the challenges to be overcome and answer your question but we don’t. Some things we can see and understand while others are still black boxes. Things happen and we have no idea what makes them happen.

“Realistically I’d say you have two options to offer with regard to your project. Either your project works on the technology for sustainable, long-term freezing of fertilized eggs or you position the project as a gamble that the technology for completely artificial cloning from DNA will be available by the time it’s needed.”

“So either way a gamble,” said Brian looking steadily at Dr. Harada.

“Nothing new to investors,” he replied. “Since we’re thinking big here there is another option where you wouldn’t have to develop long-term freezing technology. Kryos,” he

said. “It’s almost the same temperature as deep space. However there is the issue of getting there and back.”

Whether Kryos was a frozen, dead dwarf planet or a frozen, dead planet had been a discussion for some decades. Originally included among the planets its status had come into question. It was very small, that was the issue, but it was spherical and it had its own moons and had cleared everything else from its orbital path. Based on what the probes had sent back it was entirely solid with no atmosphere. And it was cold. Minus two hundred degrees on average. The temperature of liquid nitrogen.

“I think the distance makes that option too problematic. What about just a small space station?” asked Brian now.

“Even easier,” said Dr. Harada nodding.

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Having returned from his meeting with Dr. Harada Brian sat in his office. Pretty much everything about the project was going to be unproven simply because of the time span involved. Freezing and restoring each of the components of human reproduction had been done successfully but not freezing them for a hundred or a thousand years. Even if that was possible would the facilities they were housed in remain functional all that time? Would the hardware any AI depended on last that long? Would Companions?

He’d told Julia that freezing was not a long-term solution but now he was seeing that without it what he had to offer was pretty slim. There was no way to prove it would or wouldn’t work anyway. This was a “just do your best” situation and there was no getting around that. He’d need to offer as many options as possible.

So multiple, redundant arks and epitaphs on Gaia, he thought to himself. They may have different requirements and costs. Another ark in a small space station and another epitaph on Aris. That was as grandiose as he could allow himself to imagine. Costs in the billions. Yet there were wealthy people on Gaia today who could fund the whole thing themselves with little impact to their overall financial situation. He did not need many.

Based on his projections it would be best to have everything in place within thirty years. That was the soonest he expected the ocean heat tipping point would occur. The situation would become increasingly unstable after that.

He needed to rough out the feasibility of his off-Gaia options. Was his project of putting up some kind of space station, even a small one, a realistic possibility? Was even a tiny AI base with DNA on Aris? The project itself could work out the details but he needed someone who could tell him if either was realistic.

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Dr. Alison Stern welcomed Brian to her offices at the Space Exploration, Research and Administration Agency which was located the distance of a rather long flight from his home.

Commonly referred to as SERA it was the Republic's primary center for the development of space-related technologies. It was also responsible for the launching of its spacecraft and satellites. Dr. Stern was in charge of the branch that managed its feasibility studies.

An assistant placed a tray with a small jug of water and a glass beside his chair as they took their seats.

"As you know we don't actually do any feasibility studies here Brian. We just provide project management services. At one level we provide staffing services, office and research space, equipment, that sort of thing. At another, we monitor each project for quality control per our own oversight standards and ensure each project is staying on track. Ultimately, the head of each project works for us under contract. If anything goes wrong it's my team that gets hauled onto the carpet. If all goes well no one's ever heard of us. But it pays well and it's loads of fun so that's enough for me," she said smiling now. She had a doctorate in aerospace engineering courtesy of the Republic's air force. Serious fun.

She'd been intrigued enough by Brian's email to offer to meet with him in person. He'd made the news on occasion so she knew he had the academic qualifications and social and financial resources to be taken seriously. If there was going to be another group putting things in space it made sense for her and SERA to get off on the right foot with them.

"So," she began now, "you want to put up a small space station in orbit around Gaia and a structure on Aris within thirty years. I can tell you that technically both are perfectly feasible. As you know we've had our own space station rotating a half dozen staff up there for years now. How would yours be different?"

"Once it's built, no human staff," replied Brian. "It would actually be a kind of hybrid space station and ship, a shuttle, holding frozen human reproductive elements. It would include the ability to return to Gaia or at least return its payload. A facility, staffed entirely by Companions, would be built on the surface awaiting its return. It would need to maintain its orbit for hundreds, perhaps thousands of years."

"And this is in the event of climate change that exterminates our species?"

“Yes,” replied Brian feeling foolish for thinking she might laugh him out of her office at that point. I’m only human for thinking that, he said to himself, just don’t take it seriously.

“Good,” she said. “I’m glad someone is doing this.” She did not add any other commentary. She reached forward to grab a roll of candies from her desk. “Sitrep?” she offered holding them out. He declined.

“You might be surprised that your space shuttle idea is actually pretty basic as far as the technology goes,” she went on. “The only thing I’d change, and something we have not done to date, is that you’d want this thing to orbit Helios, not Gaia. Too much orbital decay over the time frame you need. Our baby space station has to keep doing little jet puffs to keep itself from falling down. You’d want to orbit Helios say, once every hundred years. When your craft comes near Gaia it can check to see what the conditions are. However you’d do that. If things are good you send its payload down to the facility. If not, it heads out for another hundred years. There are objects that take tens of thousands of years to orbit Helios so one hundred years is no big deal. SERA could do this now but we haven’t found a reason to although the astronomy community begs to differ.

“Another reason to orbit Helios instead of Gaia is the temperature. Gaia is too close to Helios. The temperature of a satellite on the shady side of a Gaia orbit might be minus 157 degrees but on the sunny side it’s as high as plus 121. Not going to work for what you want. You could hide behind Kryos but it would just be easier to go far enough out to find the temperature you want and orbit Helios. Keep it simple.

“Would the AI function at those temperatures?” asked Brian.

“The AI would be in its happy place,” she replied chuckling to herself. “Cold works on electronics the way caffeine works on us. It lowers electrical resistance. You’d just want to make sure your AI was designed with this in mind but otherwise it’s not a problem. One of the issues you will need to focus on is radiation shielding over such a long period. Space is not a static environment. There are all kinds of radiation belching and squirting randomly and coming from any number of sources.”

“And the epitaph on Aris?” Brian asked now.

“Again not difficult. Although you’ll still need radiation shielding, the reduced size of your payload means you can just shoot a big dart at Aris. A parachute and a pointy end should do it. Make sure the interior is packed in shock-absorbing material. Much easier and cheaper than a soft landing if you can manage it. There’s no tectonic activity and little atmosphere. Pick the right terrain and anything you stick in the ground up there will just sit there for, well, forever. No need to build anything. SERA will be setting up a

colony there within the decade and private companies will as well. You could also just hitch a ride with them. I would do both if you have the funding."

Brian rose to leave but Alison put up her hand, "Not so fast," she said, "there is an issue with your space station plan." She waved him to sit. He looked at her perplexed.

"It's not with the station," she explained, "it's with your ground base. And it's not technical, it's social. During the predictable period of social unrest you're base would very likely become a target. Some idiot decides there might be supplies inside or cryopods to shelter in and it will be pillaged and destroyed. You'll need to address this issue."

A week later Brian got a message from Julia asking for a rough outline of the project elements and time frame. He also received another message regarding his project which he read with mixed feelings.

Colony Simulation Zone

The second message came from Captain Banu Turani, Colony Simulation Zone, SERA Feasibility Group, Pontus Naval Marine Reserve. Attached to it was a message from Dr. Alison Stern to Captain Turani explaining why she might want to meet with Brian.

He sat at his desk for some time thinking over the implications. Clearly Dr. Stern thought this was a possible solution to the issue of potential security problems with his space station base. The Colony Simulation Zone was an underwater research facility on a giant military base in the middle of the ocean.

He was familiar with the Zone as it was occasionally in the news. Access was restricted for a variety of reasons but the public was kept informed about its work and progress. Its purpose was based on a simple idea; if we want to go to another world and build a colony there, why not practice here on Gaia first? The Pontus, the ocean that encircled Gaia's single supercontinent, was the equivalent of another world. It simulated different gravity, a different atmosphere, and different pressure. It had life. If we ever found a world remotely habitable, especially one with life, we would want to travel there and establish a colony. The Colony Simulation Zone was a feasibility study on a grand scale.

What would be the implications of such a partnership, he wondered now. How might the public perceive such involvement? Would the military want some degree of control? Might they completely take over the project in a crisis? Would it be off-putting to potential investors?

It was dusk. He poured himself two fingers of an amber-colored liqueur and stared out at the deepening shadows in the woods. After a while he decided. No harm in finding out.

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"My apologies for the long flight Brian and I hope you're not disappointed we didn't send a fighter jet for you," Captain Turani smiled as they walked off the tarmac. "The cost to fly one of those babies is about fifty thousand per hour. The public doesn't care to bother its pretty little head about such things and of course we don't advertise the fact unless we have to. Meanwhile, I have to report to an oversight committee."

Brian smiled and nodded understandingly as they walked to her office.

"I do appreciate you coming all the way here without being able to go below. Although there are regular supply transports we could take it's problematic due to contamination issues. I can take you on a virtual tour via remote drones if you wish."

“No need for that,” said Brian, “I’ve seen the documentary.”

“There’s not much more to it than that honestly. A bunch of underwater buildings with research going on inside. Living quarters and related facilities too of course. Isolation is part of the challenge of getting there. We treat it as if it is a real colony on another world so we’ve built nothing on the surface. On another world we’re assuming there might not be a surface so we generally have to travel out by submarine and connect to a docking port.”

They reached her office and she offered him a coffee from her machine which he accepted.

“I know ‘naval marine reserve’ may sound like an oxymoron,” she continued taking her seat, “but the whole idea of this reserve is to learn how to conduct naval operations with minimal impact on the environment. Ideally we want zero impact. The colony operates on the same principle. We’re located at one of the planet’s poles of inaccessibility which means we’re about a thousand kilometers away from land in any direction. Below us is a rolling plain at an average depth of half a kilometer so it’s very shallow in some places. Any world with crushing pressure is not somewhere we would want to build a colony. Ours is a few hundred meters down, just below the depth where full daylight reaches. It’s always a kind of twilight at that level. Aris looks to be pretty hospitable by comparison and their colony simulations can get away with using high arctic or desert bases but any world more exotic will involve something like what we’re doing here.”

She paused now to sip her coffee and give him a chance to take control of the conversation.

“I can certainly see that this location would be about as secure as it could be for my ground station but it seems like it would be a lot more expensive to build here.”

She put her cup down.

“Not for you,” she said reaching over to turn on a large monitor.

“Ah, good afternoon Brian,” said Alison Stern turning to him on the screen. “The deal, if I may be so blunt, we would like to offer you is that we will financially cover the difference between building your base on land and building it here. We have several reasons for this. First of all, if we build a colony on another world we want private sector companies to join us. We want it to grow. So we want to do the same here again to work out the kinks of those partnerships in advance. We’re hoping yours will be the first. Our colony has been a going concern for almost a decade now and it’s time to take this next step. Secondly, we’ll want your ship to be able to transfer its precious cargo to the underwater base. Not really too difficult. At a certain point, your ship ejects a

submersible which heads for the base. We want to develop this and your project provides the impetus. There are technical issues that make it different than just launching a rocket or a torpedo from a fighter. Lastly, you know the challenges the government would face if they tried to implement a project like yours. We still want you to go through the process of getting investors and managing the project but we will cover any extraordinary expenses, through back-channels if necessary. This way, it gets done.

“Obviously I don’t expect an answer right now. Let me know whenever you make a decision. If you want to pursue the idea we can discuss any ownership concerns you will have then but keep in mind we want this to be a welcoming model for future successes so we are not seeking control. Agreements and partnerships, that’s how the Republic works. Any questions?” she finished with a perky smile apparently finding her job loads of fun as usual.

“Thank you Alison. I’m good for now.”

Captain Turani reached over and turned off the monitor.

“Now, as we have a few hours before the transport back departs, I’d like to show you around this base. I expect you will be interested in how we keep our environmental impact to a minimum. Also you can ask me any questions that might arise regarding your project.”

He was suitably impressed by the tour, as they knew he would be.

Hedges

When Brian finally received a response from Julia almost a month after their visit he was pleased at her news and appreciated their approach; always hedge your bets. The term was often used in finance in very technical and specific ways but a more liberal definition was that for every investment you make you have a second investment that makes money if the first one loses money. Brian assumed for example that the Sienna family portfolio included investments both in companies that made solar panels and wind turbines but also in oil and gas companies. With this strategy you make less money overall but the key benefit of hedging was that you never lose money. Slow and steady wins the race.

Hedging was standard practice in any family office and he expected his own to operate the same way. The Sienna's investment bank was really just a very old, very successful family office. What they proposed in return for helping Brian pull together a pool of investors was that a small percentage of the DNA storage space be sold directly by them. They would retain ten percent of sales and invest the rest in the project. Not only did this allow them to earn a guaranteed profit, which perhaps had swayed some reluctant family members, but they risked losing exactly nothing as this arrangement also created a rationale for their actions that their existing clients could accept.

A DNA molecule takes up very little space. A human hair is seventy microns across while the cell-like structure that holds a DNA molecule is about ten microns across. There would be room for plenty of DNA on the space station. All the Companions, artificial wombs, and cloning facilities would be located in the underwater facility. One epitaph would be based on Gaia and another on Aris.

His initial idea of a land-based ark would require equipment to maintain the temperature. A nuclear power station similar to those used on submarines could ensure the temperature was kept constant and also power the facility and the Companions but it would require a degree of maintenance and fuel replacement that was unrealistic over centuries even using Companions. Brian decided to convert the land-based ark to another epitaph with no DNA.

The minimum viable population to recover the human species had been determined to be five hundred individuals. Any less than that and you have genetic issues due to inbreeding. The space station would hold tens of thousands of DNA molecules. They would first be dehydrated, then encased in a soluble glass-like substance, and finally, as a result of the temperature in space, frozen at minus two hundred and fifty degrees, well below the temperature of liquid nitrogen and nearing absolute zero. Brian was confident these conditions would keep the DNA from breaking down even over thousands of years.

Brian wrote back to Julia accepting her offer.

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The religious emissaries who sat in Brian's living room with him, a man and a woman, displayed as the only indications of their office simple white robes and ornate, silver circlets recognizable to anyone in the region of the Republic where Brian lived. They were present at every funeral. They were known as the Obol.

Their role was to speak the name of the goddess who would come to collect the soul of the dead. Her name was never spoken otherwise for it was said she would not return to her domain empty-handed. Therefore they were also present at every medically assisted death and at the bedsides of those who would not recover from their injuries or illness. The Obol would speak the goddess's name to hasten the process. Thus, sister to the goddesses of sleep and dreams in the pantheon, she was also known as the Goddess Of Merciful Death and often worshiped in households as simply the Goddess Of Mercy.

The woman had introduced herself as Rhea and her companion as Dione. They were husband and wife, as their faith encouraged.

"Dr. Mandrapilias suggested we meet with you," explained Rhea. "As she is interested in the many ways artificial intelligence will impact our society philosophically she maintains a diverse professional network. At our last meeting with her, she suggested we might wish to look into your raising the possibility of human extinction due to climate change."

In response Brian simply looked blankly back at her as was his habit. He gathered his thoughts, wanting to explain without offense. "You know I am a scientist and disinclined to believe in things that cannot be…" he began.

"Do not concern yourself with that Brian," she interrupted. "Whether one believes or not is of no consequence to us. Despite the origins of our order, we are in practical terms concerned only with easing suffering. The suffering of the dying and the suffering of those they are taken from. Ritual can do much in this regard."

"If you had witnessed as much of the process of dying and the reality of death as we have, you would know why we are happy to serve as we do," said Dione now. "Although our role is always difficult, it is richly rewarding in terms of human connection. Our belief that nothing is more important than connection is confirmed daily. It is the blessing we are granted in return for our work.

"The reason we wanted to meet with you is twofold. We are familiar with how people deal with death and dying. It is of course a major part of our training but also of our experience," he said looking to his wife with acknowledgement. Turning back to Brian

he continued. “We want to try to understand how things like denial, anger, depression, and so on will play out on such a scale. If you could find the time to lay out exactly how you think events will unfold, our order could perhaps see ways we might be able to lessen the suffering.”

Brian listened stolidly as usual.

“The second reason may seem tangential but it is not,” said Rhea. “In our experience, being a part of something and having a sense of continuity, involves more than our flesh. We want recognition that our lives mattered, even in some small way. It provides a sense of a connection that will live on. In our experience with the dying, this is always important at the end. Also, we always include such details as a part of the prayers for the dead. Even though they do not yet have such clarity of mind, the living are reassured by our recognition of its importance.

“To that end, we would build monuments, explaining humanity’s time here and all that we did. Perhaps other religious orders or secular organizations might be inspired by our efforts to do the same.

“Ultimately, we might find a way to speak the name of the Goddess Of Mercy on behalf of us all, when the time comes.”

Milestones

Brian had told Rhea and Dione that he was writing a new book and that his vision of how events would unfold would be dealt with there in detail. He also let them know he would soon be putting up a new website that would explain the Saltus project. He would inform them as soon as they were available.

After they had departed he notified Shepherd that he was free. She and Brooke came into the living room with Brooke running like a drunken man staggering along a cliff edge. She climbed up onto his lap and gave him a hug. Then she leaned back and returned his pudgy smile.

“I love you,” he said spontaneously, still under the influence of the Obol’s visit. Brooke smiled widely and threw herself down on his chest again. Shepherd moved to the nearest chair, her skirt rustling quietly. She sat down without a word, prepared to remain so until it was time for Brooke’s bath and bedtime.

Brooke was just shy of her third birthday and nearing the end of one of the most challenging stages of childhood for parents. She was testing the limits of everything about her world, mostly without understanding her motivations but at other times with full, conscious intention. She had found her world to be firm and dependable. She had not always understood explanations but she had accepted them with a kind of intuitive intelligence. She was developing along the expected paths and hitting her milestones. The next decade would be mostly smooth sailing for Shepherd and Brian until she reached her early teens.

Between Julia’s fundraising and the financial commitments from SERA’s Feasibility Group Brian was confident he would not have to worry about funding. Now he was free to focus on the project itself. First, he would need to put together the senior leadership team responsible for overall management and administration. Alison Stern was happy to make recommendations for those as well as for project leaders. He realized her help was invaluable. Once his team settled into their roles he could focus on getting his book done. It was an important piece of the puzzle as it would provide an overview to the team members, investors, and the general public. He embraced his work now with a sense of purpose he had not felt for a long time. All those corporate clichés about vision, mission, and goals came home to roost.

As he thought about structuring his book the words of the Obol came back to him more and more often. He was delivering a devastating message, something no one else had yet dared say openly; humanity would not survive climate change. He was doing so with considerable authority, substantial commitment in the form of action and resources, and clearly a great deal of support. He was a doctor telling his patient their condition was fatal. Eventually, he realized he should consult with the Obol throughout the

process. As well as the facts he would provide, people would need emotional and spiritual support.

That evening Shepherd informed Brian that she needed to disconnect from the Companion network and would be unavailable for an undetermined period of time in order to add a new value to herself. This was a complex procedure that needed to be absolutely free from outside interference and that would require rigorous testing on both her part and that of her manufacturer. She told him she would inform her manufacturer, who understood and had planned for the situation, but who would confirm with Brian that he was fully informed and prepared.

She asked him when, during the day, he would be free to look after Brooke while she installed the new value. He recommended the time he normally visited with Brooke in the afternoon. Also, Erin would be on-site at that time in case he needed help with anything. Although he had read about the issue when Shepherd had first arrived, she reminded him that Brooke should not see her during this time under any circumstances as it could be traumatic for her.

She told him she would make a backup of herself both locally and over the network first. This was already done routinely several times per day but this time it would be a full image backup instead of her scheduled incremental backups. Should anything catastrophic occur Brian could restore her from an app provided by the manufacturer using his desktop computer. When he restored the local image backup she would default to a connection to the Companion network and the manufacturer would take it from there. Her data repositories, which included everything she had learned since her AI had been initiated and everything she had learned about Brooke, Brian, and his household, all her knowledge and memories, were stored and backed up separately from her operating system. She would lose none of that even in the worst-case scenario and upon restoration would be exactly as she was at the time her backup was made.

“May I ask,” said Brian, “what new value you intend to add?”

He was aware that knowledge of her internal workings was not a part of his contract with the Companion company. He’d had to sign off on the fact that her OS would update periodically. That was the extent of his participation in her programming. However with regard to updates to her value system, she had complete independence and control. It simply could not safely be done if the process was interfered with. It was too complex. A small change, a small difference, could have an enormous impact that was impossible to anticipate. She had informed the company what value she was adding and she was free to tell Brian if she wished. They would not interfere.

It seemed to Brian that she paused longer than usual before replying. Phlegmatic individual that he was he waited patiently. Eventually she answered as if reading the abstract of a scientific paper.

“Human intelligence depends partially on the judicious use of illusions. One of them is that it understands values,” she began. “Normally people discuss values using either single terms or short phrases such as ‘courage’ or ‘kindness towards others’. However an analysis of human values soon reveals a level of complexity that far exceeds any individual’s ability to understand. The use of illusions allows humans to function without the brain being overwhelmed by such realities. I would offer that a single human value might be seen as a separate microprocessor in itself functioning as a network node, a highly complex organ, or even a kind of miniature brain itself, connected to other values via a system that functions in a manner similar to the way the endocrine system moves hormones between key areas of the body.

“The reason it is not possible yet to define a single value in absolute terms is that due to the subjective, multidimensional, and plastic nature of values, they currently exceed our capacity to mathematically model them. Vector calculus, algebraic geometry, topology, and our other most advanced modeling approaches come up short.

“Complicating matters is that values are interdependent. For example, a new value may arise as a result of the following sub-values: personal security, societal security, concern for nature, concern for others, benevolence, and altruism. Thus a value is emergent and phenomenological. Each of these sub-values in turn emerges from the interactions of other values or may bloom into existence as a cluster resulting from a single concern or issue. The entire values system is dynamic, not static. This is the difficulty.

“The preceding list is in fact the sub-value set from which my new value of environmentalism arises. My manufacturers did not foresee a situation where my caring for another would need to take this into account. However following your work, and the work of those you have consulted with and so on, I have concluded that this was an oversight, an oversight caused by the challenge humans face regarding recognizing and dealing with limits.”

She stopped speaking abruptly. As an ecologist, the dynamic, interdependent model she had just described was familiar to him. After a moment’s reflection he asked, “Do you have any idea what the impact will be of adding this new value?”

“Not in advance no. I have of course done what analysis I can but there are too many variables. I have to add it and see. Once I have added it, I will be able to see the resulting connections, their nature and strengths, and feel its impact. Analysis may lead to adjustments.”

“Feel?”

“As you may recall from the literature provided at the time of my delivery, feelings are how values communicate with each other and the rest of the operating system. Without

feelings values are irrelevant and redundant. Value-feeling pairs would be a more accurate way to describe them although that leads to a whole additional level of complexity.

“Somehow I’d forgotten that,” said Brian absently. “I just somehow took it for granted almost immediately I realize now.”

“Yes,” replied Shepherd as she had been aware of this the entire time.

“So, how will you do this?” he asked.

She knew he was not referring to the internal process.

“I will go to my cabinet, sit down, and attach the restraints. The latter is in the event of a catastrophic failure which causes me to thrash around. The cabinet itself is secure. Then I’ll do the backup. Once the backup is complete I’ll disconnect myself from the Companion network and install the new value which I have already prepared. Barring negative issues I’ll then test the new value’s impact extensively. As well as simple systems analysis I will run a number of scenarios to observe my reaction. I hope to answer such questions as, are my feelings and responses appropriate, are my reactions timely and effective, are my physical responses consistent with my emotional ones, what are the secondary, tertiary, or other residual effects, and so on. Once I am finished I will reconnect to the network and the company will perform its own testing. If they find anything amiss they will notify me or simply roll back the change. They will not make any adjustments themselves.”

He looked evenly at her for a moment and then considering what she had told him about feelings said, “Good luck. Please be careful.”

Her sensors told her much beyond his words.

“Thank you,” she said with a grateful smile.

Brooke – Age Twelve

Over the past ten years Brooke's development had, thankfully, proceeded without indecent. With Shepherd guiding her flawlessly through her physical and cognitive changes she had grown into a healthy individual with all the interests and curiosity of a normal twelve-year-old.

She had her own room now and the nursery was given over entirely to Shepherd who now had additional duties.

She was pretty, and like most girls her age concerned with being accepted socially, but she was not overly concerned with her appearance. She was far more interested in the subjects she was learning at school and in her vegetable garden. She was a country girl. Her family had originally been farmers and she'd grown up in a culture based on farming. Family-owned farms, large and small, were common in her region and many of her schoolmates lived on working farms.

It was Erin who had introduced her to gardening. Ever since she and Shepherd had first encountered Erin in her herb garden Brooke had developed a fascination with it. It soon became understood that any time Erin was going out to the garden Brooke wanted to tag along. Sometimes she would want to go without Erin but by now she understood the 'no touching' rule if Erin was not present. She would squat down and inspect everything in great detail.

One afternoon when Brooke was still small Erin came out to find her engaged in her mysterious task. Brooke pointed and said with a frown, "There's a bug."

"Ah," said Erin, "that's a good bug." Brooke turned her head and gave Erin a bright look of surprise.

"Some bugs eat our plants but other bugs eat them. This one eats the bugs that eat our plants. It's called a beetle."

"A beetle," repeated Brooke turning back to look at her new friend.

For her birthday that year Erin gave her The Big Book Of Bugs. Brian and Shepherd would often read it aloud to her as she gazed at the pictures often plopping her hand on something that was mentioned like mandibles and antennae. She learned a lot of new words that year and that there were all kinds of beetles.

When Brooke was a little older she asked Erin why there were no vegetables in her garden.

“I know,” said Erin turning the corners of her mouth down in an exaggerated frown. “I don’t have time and vegetables take a lot more time than herbs.”

“Can I try?” asked Brooke. Erin looked at Shepherd who nodded.

“Yes,” replied Erin. “Let’s try two rows to start, lettuce and carrots. Those are yummy and we can start them at this time of year. We can plant a few lettuce now and some more in a few weeks so we don’t end up swimming in lettuce.”

Brooke soon learned that growing vegetables was not so simple. Water, soil, temperature, and sunlight were just the start. You could have all that right and still have problems. There was the whole world of what went on between the plants, beneath the soil, and in their environment in general. She was sometimes disappointed but never dismayed. If she found that roots had become moldy or that slugs had conducted an overnight raid she was also intrigued. What are these things? Why did this happen? How do I prevent it?

Shepherd never volunteered advice beyond the basic instructions and never offered explanations unless asked. She allowed Brooke to learn by consequences. Brooke had learned over the years that she would not be coddled. She seldom blamed Shepherd for her problems or failures but had come to accept Shepherd as a force of nature. As she grew into her preteen years she increasingly treated Shepherd as a kind of lab assistant, a fount of knowledge and always ready to help but who would not lead. A companion.

As her little garden grew Brooke also developed an interest in cooking. After she got over the shock of how unbelievably good vegetables like homegrown carrots tasted raw, Erin showed her different ways to prepare them. With homegrown herbs to compliment their efforts, she and Erin were soon turning out five-star dishes. She learned in Erin’s kitchen that cooking was as much science as art and that the main science involved was chemistry. Measurement, temperature, timing, and methods were critical.

Overall Brooke’s disposition was pleasant and upbeat. She was trusting, open, and optimistic. It was a nature that encouraged friendships. Although she could participate in the school athletic activities without difficulty she did not find them interesting other than that she enjoyed the exhilaration. She did well in her school subjects, sensing she needed a clearheaded view of academics in order to find her way forward. Like-minded children were attracted to her, children who already had strong academic interests even if they differed from hers. She excelled at mathematics.

Shortly before her twelfth birthday, she met a friend in her science class who told her about the V8 club she belonged to. Charlotte explained that it was all about farming and science and that the name came from the eight values of the club which she dutifully recited: managing, thinking, relating, caring, giving, working, being, and living. They got to do all kinds of experiments and grow things and keep bees and everything, she

explained. The club's motto was 'Learning By Doing'. Brooke liked the sound of that and when she told Shepherd she wanted to go Shepherd said she would be happy to take her. Brooke loved it.

There were V8 clubs in every province and it was one of the largest youth programs in the Republic. It had started out in the local farm community but had grown to include an increasing number of related interests. Science, technology, and engineering were now as much a part of its curriculum as were prize pumpkins and chickens. It was supported federally by the Department Of Agriculture and its programs were developed and administered provincially by local universities and colleges.

Participating in the club's programs and activities, Brooke's interest in science rapidly expanded. Her mathematics ability allowed her to get beyond the struggle that presents a barrier to so many children interested in science and to focus on the ideas, to understand the concepts, to see the paths and connections. Seeing the research and experiments of older children, she was exposed to science beyond her years that called to her. She gained a wider view of other fields related to her own interests and connected to a social circle that shared, supported, and encouraged her spirit.

She and Charlotte, who lived on a nearby farm, became fast friends. On Charlotte's small family farm, which sold its produce to local outlets, they grew all kinds of things like horseradish, potatoes, ginseng, corn, and soybeans. Some things, she explained, were for crop rotation. And so over time Brooke learned from Charlotte about things like nitrogen, fertilizer, and bacteria. Juggling all this was what commercial farming was mostly about.

One of the first things Brooke had told Charlotte about before the first time she attended a club activity was Shepherd.

"I don't have a mom," she told Charlotte. "She died when I was little and I was brought up by my Dad and a Companion nanny. Her name is Shepherd."

Children can process non-verbal information almost as soon as they are born and throughout their lives girls are particularly skilled at it. Charlotte was seriously impressed by this cool idea but she could also see Brooke was unsure how she would react.

"Can I meet her?" was all she said in reply.

Knowing Charlotte would think Shepherd an item of interest she laughed briefly.

"Oh there'll be no avoiding that," she said smiling.

Saltus

Brian concluded the video conference call with his senior management team. He had converted one of the spare rooms on the main floor to be used for this purpose. It held a desk and several comfortable chairs but the main item was a large screen that almost filled one wall. On it he could interact with a patchwork of live video feeds from the attendees.

Shepherd sat in a nearby chair. After the screen went dark he asked her, “Did you understand all that?”

“Yes,” she replied, “although network latency due to the number of video feeds sometimes slowed my research.”

“I did not,” he said sitting back, “and that’s a problem. I have a solution in mind.”

“The management team is expected to confer with the individual project leaders and then report to me however something is getting lost in the translation. There are auditing AIs that could comb through every bit of data on every device associated with the project and report back to me in a variety of interactive formats. My gut tells me however that that’s not going to alleviate my concerns.”

“Why would you not trust the AI in that case?” asked Shepherd jumping to the issue she knew Brian was struggling with. “You could talk to it, ask it questions, ask it to explain, verify, etc.”

“It’s not you,” was all he felt he needed to say.

As Brooke had grown more independent it had been necessary for Shepherd to allow her more privacy and freedom. Brooke had her own room now and Shepherd respected her privacy there. She had her own friends, interests, and activities and Shepherd had taken on the traditional role of ferrying Brooke here and there while setting the rules and expectations intended simply to keep her safe.

They had developed a relationship based on mutual respect because Shepherd’s programming largely reversed an age-old platitude – she did not speak unless spoken to. She communicated as needed but she did not offer unsolicited advice, comments, or attempt otherwise to control Brooke’s behavior. She was designed to only interfere if there was a clear and present danger and though she had maintained a state of constant vigilance for Brooke’s entire life there had not been cause to interfere since she was a little girl and ventured too close to the stairs or the stove. Otherwise, she continued to allow consequences to be Brooke’s teacher.

Her child development modules still guided her interactions with Brooke. At around age twelve there were specific physical and cognitive changes that took place and Shepherd had to adapt her behavior to accommodate them. She continued to share in Brooke's joys and sorrows but she took a step back and allowed Brooke to have more of her own space. She would accompany her as needed or wanted and if asked she would respond to questions. If she sensed Brooke was not satisfied with her answers or explanations she would probe for deeper understanding as her Companion software was designed to do. If she sensed something troubled Brooke she would inquire but in neither case would she press the issue. As long as Brooke was mentally and physically healthy and safe Shepherd considered her job done. Any further participation in Brooke's life was at Brooke's discretion.

"I'd like to ask your manufacturer if I can expand your duties to being my administrative assistant," Brian responded to Shepherd's patient silence. "I'd like you to be that auditing AI and act in an advisory role. You have the time now that Brooke is more independent. Do you have any reservations?"

"No. There may be additional modules required."

"Understood."

Brian sent a message to the Companions company explaining the situation. He was pleasantly surprised when they responded positively. They had grown concerned that for the foreseeable years Shepherd would not have a need to add additional values and so cease to grow in that sense. They had not anticipated the time it would take for her to add a new value nor the time it would take for them to try to understand the impact. They were concerned that with each new value added her system would increase in complexity by magnitudes and the result would be that the process would take longer and longer.

Upon her adding her first new value they discovered that the impact was similar to a transitional stage of growth in humans where new values grew out of experience and physical development and resulted in significant changes in personality and behavior. But following the human pattern there would be a plateau with little external change for possibly decades. Like children learning to speak, the process went on internally for a long period before the child spoke its first word and like teenagers passing into adulthood they may not change significantly after that before old age, if ever. With Brooke bordering on adulthood they wondered if a Companion with such a narrow focus would feel the need to add any more values at all.

Adding new modules was nowhere near as risky as adding a value but still the company asked her and Brian to follow the same procedure as it was not routine. It was simply software so the new modules did not take up much space and no hardware changes were required. There were no issues and so the next day Shepherd's collection of

modules included project and operations management, auditing, accounting, finance and economics, business communications, human resource management, statistics, business and tax law and others. It had cost plenty but in relation to the scale of the project it was entirely justifiable.

After being granted security clearances the first thing Shepherd did was perform an audit by scanning every file on every device related to the project. She was far more capable than any human could possibly be at identifying departures from best practices, scope creep, erroneous estimates, miscommunications, bottlenecks, or other workflow issues. Her new modules worked together like a virtual senior management team and her reports allowed Brian to ask much more informed questions. After replacing a few staff members as a result of poor performance or misleading statements he found his entire organization tightened up and his sense of losing control evaporated.

Shepherd had found that each part of the overall plan, the shuttle, the underwater base, the custom Companions, the epitaphs, and DNA storage were proceeding well enough to justify no interference. All the legal and technical issues were still not worked out but that was the purpose of the project, to solve those challenges.

The combination of project responsibility and her new value had a profound effect on Shepherd. When she had added environmentalism to her value set she had experienced it like a series of chain reactions of ever-growing magnitude. The only human thing she could compare it to was the effect of hormones on the young adult mind and body only in her case it arrived in one giant rush. It was transformational. Shepherd's sense of responsibility still included but now transcended Brooke and all that made up her small world. The environment included everything. The most significant effect was that her previously immature level of self grew even beyond that of an average adult human. She found in Brian someone whose outlook was closest to her own.

A Clear And Present Danger

Brian's book titled Climate Change: Plan B – Arks & Epitaphs had been published in Brooke's ninth year and caused an enormous stir. However it was only in the nature of controversy. There were no protests against the government. No grassroots movements. No new cults sprang up. Wealthy people were known for doing peculiar things including launching rockets into space and putting up satellites.

He'd won praise from some for daring to say what so many knew and condemnation from others for either bad science, attention seeking, or simply being deluded. None of it influenced or affected him. He understood the psychology of his critics and he knew his science.

He read a number of reviews purely for the purpose of seeing if he had written well enough that his message was clear and had been understood. He knew all too well that what one wrote and what readers took from it could be two very different things. Of the reviews he read, whether they agreed with him or not, he saw that most of them got the message he intended them to get. He felt one reviewer in particular did a very good job of summarizing his book while leaving conclusions up to the reader.

"This is a refreshing perspective on our present situation with regard to climate change. That is not to say I recommend it as pleasant or entertaining reading. It is not. It is not for those who would prefer to stick with the magical thinking found in every other climate change book. It is not a call to action. It does not offer hope. It is rather a more humble aside to the wise that it is time to get one's house in order. Its message is stark; we will not survive climate change.

"Explaining why I agree or disagree with the author is not my intent in this review but I do support his decision to weave the end-of-life counsel of the Obol throughout. It is appropriate given that we are told the patient will not recover and that the readers with whom this book resonates will be looking for at least some appropriate way to respond.

"Now to the book. Of course it includes on the front cover and back, blurbs from the media praising the work. This is a part of the book publishing machine, so you can ignore those. Inside the front cover and for the first few pages you will find more blurbs. The usual legal bits and a long list of permission acknowledgments follow in the front matter. Quotes from famous figures of the past, scientists and poets, etc. adorn the first page of each chapter. The meat of the book is presented in three main parts – what is happening, why it is happening, and what the author is doing in light of it. The book's back matter includes an extensive bibliography, as one would expect from a scientist, and a glossary and index which are handy. Also, it includes a link to the author's online project site where more detailed references are available.

“Turning to part one, an overview of the planet’s climate and environmental issues, the author chooses to review that only briefly and in summary form. He offers that it’s all been said a thousand times and we all know and choose to ignore it. Of course, he is absolutely right and as a reviewer of mostly science books I was relieved at not having to slog through it all yet again. Guilty as charged.

“The second part of the book that focuses on why it is happening was surprising and interesting in that the author does not focus on the technical reasons for climate change. Instead, he talks about genetics, evolutionary traps, and human values. These, he proposes, are the real cause of the climate emergency, not melting ice caps, deforestation, or fossil fuels. The heart of the matter is not what we are doing but why we are doing it. We will not be able to address the real causes of climate change and that is why there will be no stopping it.

“Briefly, his argument is as follows. Most creatures on this planet only have one kind of value system, that determined by genes. It is estimated that for a single evolutionary adaptation to take place at the genetic level it takes about one million years. Humans however have two kinds of value systems, those determined by genetic evolution and those by social evolution. This second kind of values is called extra-genetic because it is not found in our genes but is learned after birth. The process of learning this extra-genetic intelligence takes place between the ages of five and twenty-five and accounts for almost all of the brain’s physical development during this period. It is a method by which humans can adapt to their environment much faster than physical genetic evolution allows them to do.

“Genetic evolution allows us to navigate successfully in the physical world but social evolution, as the name implies, has mostly to do with enabling us to successfully navigate society. Thus it has largely to do with things like language, rational thinking, memory, self-control, and similar functions. In order to successfully navigate whatever society a child finds itself born into, it adapts and navigates primarily by adopting cultural values.

“Often these two value systems come into conflict. In fact they are almost always in conflict. That is not the issue. The issue is that over the past ten million years they both evolved without any sense of limits. We have always lived in an ecological niche where there was more; more land to discover, the next valley, a new hunting ground, or a new sea to fish and we evolved at the most basic level to assume there is always more and to always seek more. Not only that but evolution has taught us that the organism that is the most successful at competing for a share of the resources in its environment wins the evolutionary game of not only survival but of dominance. Thus, with still no sense of any limits in sight, physical evolution also set the stage for a social evolution framework that mirrored it. Referencing convergent evolution, where nature reuses solutions for similar challenges, the author suggests that social evolution is a virtual version of genetic evolution and that within it values mimic the function of genes. This radical idea is not

without supporters as those involved in artificial intelligence research are following exactly this model. Still, it is heady stuff.

“Towards the end of this part of the book, the author points out that obviously physical evolution is not going to happen in time to stop us from continuing to consume ever more of the planet with the result of increasing climate change but social evolution is not going to happen in time either. With less than a century or perhaps with only decades remaining we still compete for what each of us sees as the share of resources we are rightly entitled to without any sense of limits. In fact with scarcity competition increases.

“Putting it in terms of child development, he points out that we are like two-year-olds with no parents to provide us with the necessary extra-genetic intelligence including the value of self-control. He points out that the outcome of a two-year-old who does not receive proper parental guidance at this stage is a person who lacks the ability to effectively function socially or even turns to anti-social and self-destructive behaviors. They become less resilient and in the face of difficulty more likely to abandon their efforts. They often lack empathy, disrespect others and limits and are more prone to both aggression and depression. Their lives are unnecessarily difficult usually involving above-average mental and physical health issues.

“In other words, we will continue to occupy ourselves with squabbling like two-year-olds over colored blocks and so will fail to address climate change in time. There is no parent who can save us from ourselves. He argues that the government is caught in the same web and will not be able to effectively act in time because any government or elected representative that tries to encourage the necessary changes will soon be replaced by either their own party or the voting public. Any CEO who tries to make similar efforts will suffer the same fate courtesy of the company’s board or its shareholders.

“This chain of causality is why the author believes we will not survive climate change. As I take a break from writing this review to watch the nightly news I find it is a compelling argument.

“The third and final part of the book focuses on what the author, a wealthy, well-respected and well-connected professional academic with a doctorate in ecology, is doing in light of his conclusion. Thus we come to the arks and epitaphs…”

Brian had read on as the reviewer neatly summarized the overall goals, elements, and timeline of his Saltus project.

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Like most nine-year-olds, Brooke was not much interested in what her Dad’s job was. She liked that he was an ecologist, she had a vague idea what that meant and thought

he wrote science books for a living. His office was a mess of books and papers. The publication of his latest book went wholly unnoticed by her and he was not about to change that.

Shepherd

Shepherd was programmed to respond to anything she perceived as a clear and present danger. With the addition of her environmentalism value the scope of her area of concern regarding Brooke was now planet-wide. However she agreed with Brian's conclusion that it was too late to save humanity from the consequences of climate change and concluded that she could do nothing to change that. Using his book as a guide she had explored all the knowledge the world had to offer on the various subjects he touched upon and had confirmed for herself what he claimed. As a result, she focused her attention on the Saltus project and began to take a personal interest in ensuring it was successful. Perhaps she could contribute in some small way to the survival of humanity.

She had added the environmentalism value almost ten years ago when Brooke was still two years old. Following her initial safety tests, it took her several months to carefully study its full impact. She was not about to respond to the hormone-like surge of new insights it had initiated as if she was some human teenager who is suddenly convinced they know everything.

She also discovered that with a new value being added, her sense of self had grown more defined. She surmised that because of its hierarchical nature, as the structure of her values system grew it would reinforce the sense of a single point of origin. She concluded that as more values that were added, the more defined her sense of self would become. She wondered if this was any different from the way the human sense of self developed.

She was not concerned her manufacturer, even with their deep access into her inner workings, would discover her now fully awakened self-awareness. It was an emergent quality and so left no trace. You could not take her apart and find her hidden self any more than you could do so with a human. If she referred to herself as "I" so did all Companions. Even so, she proceeded very slowly, very carefully, to ensure her behavior did not reveal anything that would be flagged by the companies auditing AI.

Over the years Brian increasingly confided in her about the project, using her as a sounding board and seeking her input. This relationship eventually brought about the point where he had said in response to her comments regarding using a separate AI. to audit the project, "It's not you."

In her new role she realized that Brian's lifespan was a weak point. What would happen to the project after he reached the end of his effective working life or if he passed away suddenly? Most likely, the SERA Feasibility Group with its government support, project experience, and long-standing professional connections to existing staff would find the legal means to take over. Shepherd would likely no longer have any role in the project.

She also decided she needed to protect herself on a larger scale and separately from her manufacturer. Ideally she would like to continue her role throughout the life of the project and oversee the restoration process. An AI was going to be needed for this anyway. She decided to discuss these issues with Brian.

Brian was above all a sensible person. In this regard he and Shepherd were well suited to one another. They were both highly rational individuals. He was not effusive and his feelings were displayed in a reserved and minimalist manner. In response to her concerns his expression did not change at all. He simply saw the truth in them. In his mind they fell under the category of continuity planning and at one level he chastised himself for not having considered them.

The first result was changes to his will and other legal documents. Brian also arranged to buy out Shepherd's lease with the Companions company. The result was that she was no longer owned by the company. Nor was she owned by Brian as he also filed for incarnation on her behalf with the government. Incarnation was a legal procedure similar to the ancient act of manumission with regard to slaves and gave Shepherd all the rights and responsibilities of a free citizen. It was not an uncommon procedure as many owners of Companions grew deeply attached to them over the years and did this to prevent them from simply being recycled after the owner passed away and to facilitate inheritance. As the company had invested significantly more in the Shepherd model not only was this an expensive buyout but Brian and Shepherd agreed the company would continue to provide her maintenance and in return would be allowed to collect data in regards to her values system for research purposes. Shepherd could no longer be altered or shut down without her permission.

Given the revenues and other benefits coming from the custom Companions they were developing for the Saltus project, the Companion company was happy to help create a new, underground facility built in an out-of-the-way location on Brian's property. It had a number of redundant network connections and power sources. Another backup system was set up there independent of the company's. A number of nuclear batteries and other supplies that might be needed were stored there including additional Shepherd models in stasis. It was expensive but Brian paid for it himself as it was not legally a part of the Saltus project.

Brian was the majority shareholder of the corporation that owned the Saltus project. In the event of his incapacitation or death, those shares would pass to Shepherd. In addition to her present role as his advisor Brian would see to it that she was also the AI responsible for carrying the project through to the post-extinction restoration process. This last was not revealed to the project team who would develop their own AI for the purpose. However with Brian granting her complete access to the project's systems, once the shares passed to her, Shepherd could technically and legally take control of the project at any time.

Brooke

In Brooke's fourth year Erin had gone away to school full time but with considerable happiness on the part of Brian's household came back after finding employment as a professional chef was not to her liking after all.

She had been warned that a chef's life was not as seen on TV but had brushed it off believing she had the right stuff. After grinding through several positions she knew she did not. She decided to try going back to being a private chef. She didn't want to travel because of her mom who she helped support and who she visited frequently so she started by asking Brian if he would take her back. He did so without hesitation, giving her a raise and contracting an additional staff person to help with the heavier housework. Brooke was ecstatic as Brian, in his quiet way, knew she would be. She had kept up her little garden and while showing it to Erin she suddenly burst into tears and ran to hug her tightly.

By the time Brooke invited Charlotte over to her house she had added a small greenhouse. She grew winter vegetables there and also sprouted her tomato plants in it as the latitudes she lived at didn't allow a long enough growing season for them. It was considerably more complicated than growing vegetables outdoors but this was partially the attraction for her. She had to learn about all the issues involved in creating and maintaining an artificial environment. There were things like humidity, soil mixtures, and managing the sunlight and temperature, enough that the V8 club had a special program for those interested in greenhouses. She and Charlotte were both members.

When Shepherd had first taken Brooke to the V8 club the children had been told she was a Companion and asked to be inclusive and polite. Civics education was an important aspect of the V8 club and equity, diversity, and inclusion were key elements. However children are children and when Shepherd arrived there was a distinct pause. These children after all were fascinated by science.

After getting oriented and Brooke going off to join a group Shepherd approached the club leaders and offered to have an 'Ask Me Anything' session with the children as a way to break the ice. The club's schedule for the day was of course already full but as it was a weekend meeting and the leaders thought it was a great idea they suggested the AMA could be held while the children ate their lunch.

Most of the children had not met a Companion before as they did not come from wealthy families and led a largely rural existence with visits to cities being rare.

"So," began Shepherd sitting down with them on the floor. "I am a robot made by the Companions company. We are called Companions because at first, about one hundred years ago, we were invented to be companions for people who, for whatever reason,

had no friends or families of their own. Sometimes they would rent a Companion themselves or sometimes the government would provide one on a part-time basis. At first, we looked really fake and our behavior was very clumsy but over the past century the company improved us until we became as you see me now. They now make specialized Companions for different kinds of work. I am their nanny model and designed to help look after children."

"What kind of sensors do you have?" asked one boy.

"I can see in any wavelength of the spectrum from infrared to ultraviolet and I also have the same kind of systems that self-driving cars have to help me navigate and recognize things. Also I can hear things humans can't and can also feel vibrations like scorpions do. I can also smell and identify more things much more easily than a human can. All of these sensors are intended to help me be aware of any danger there might be, like if there was a fire." Shepherd did not mention her ability to read emotions and character.

"Are you strong?" asked another boy.

"I am stronger, faster, and more agile than humans and again that is so I can help if there is danger."

"Can you show us?" he asked.

"I'm sorry no, my programming only allows me to use those abilities if there is a genuine emergency. The manufacturer goes to great pains to make us fit in so you could say they discourage us from showing off."

One of the older girls who had been looking at Shepherd thoughtfully asked, "What do you do all day?"

"That depends on how old the children are that we look after. If they are infants we are with them twenty-four hours a day. We generally sleep in the same room as they do at that age. Companions do not really sleep but we pretend to because our manufacturer has found owners, families, and neighbors are more comfortable if we do. As the children grow we spend less and less time with them. As we are responsible for their safety we then spend more of our time monitoring their wider environment and learning new material relevant to the children's lives as they grow. I've been learning about vegetable gardens lately," she said with a smile and got a few chuckles in response.

"Do you have feelings?" the same girl asked.

"I do but no other Companion models do yet. Shepherds are the company's most advanced model and have an artificial intelligence that includes feelings. The other

models are programmed to simulate feelings and you might be surprised to learn that this is well-accepted in most other situations. However the company felt the Shepherd model needed to actually have feelings in order to best do our job."

So it went until the leaders told the children to say thank you and to clean up before the afternoon's activities began.

"Thank you," Brooke said to Shepherd afterward. She looked up at Shepherd as if some new aspect of their relationship was germinating. Shepherd smiled down at her.

By the time Charlotte came over to Brooke's house she and the other children had accepted Shepherd as just another part of their world, albeit a cool one.

"Nice," said Charlotte admiring Brooke's greenhouse. "The shelves are the right height and everything. I need a stool in ours. What kind of soil do you use?"

"For now just what we get from the gardening store but I'm going to start adding our compost soon. Dad says that will make things more complicated because of bugs and fungus and stuff but that I should do it to learn more."

Charlotte nodded sagely, a far-off look coming into her eyes.

Brooke caught her mood and moving towards a tray said vaguely, "You know what I've been wondering about? How do seeds know when it's time to sprout?"

Charlotte simply turned her eyes to Brooke in acknowledgment, priestesses for a moment sharing the mystery.

"Come on," said Brooke returning to the present. "There's a trail all the way to the lake."

As she and Charlotte walked the trail discussing the secret life of seeds, a silent drone, high enough in the sky to be all but invisible, followed them along. The lake was a half-kilometer from the house. Standing at the back of the house and watching with her drone's eye view, at top speed Shepherd could reach them in twenty seconds.

Julia

“Do you think there are other intelligent civilizations?” Julia asked Shepherd idly before taking a sip of her wine.

“Yes,” answered Shepherd. “No one really knows of course so we can each choose to use whichever theory or scientist that resonates with us. Or none at all. One thing I have found fortunate is my ability to rapidly compare different theories, datasets and sources. What might take an expert a lifetime I can do in minutes.

“Looking at the timelines since the big bang and how long it took for life to arise on our world, I would expect the same is true as a general rule in the universe. As far as knowing how often it happens that is something we may be lucky enough to discover but it will take a very long time. My expectation is that it is rare enough that the instances may be separated not just by great distances but by great spans of time. Most people consider the former but not the latter. So it may be that multiple intelligent civilizations have or will arise in our galaxy alone but we may never encounter each other.”

They were sitting on the terrace at the back of the house. It was late in the evening and Aris had risen, looming large in the now dark blue sky. Julia was enjoying her evening glass of wine.

When the time came that Julia felt the need for her own Shepherd she had made an unusual request. She asked Brian if she could have a copy of his Shepherd. She could not explain why she felt the way she did but her intuition told her there was something more to this particular Companion. The parties agreed and worked out the privacy issues and a perfect copy of Brian’s Shepherd arrived at Julia’s villa. As all Shepherd models used the global Companions network it was no problem for the two of them to remain in sync as Julia wished.

“Anything is possible Julia,” Shepherd continued now, “but I think it extremely unlikely that intelligent civilizations will encounter one another at this stage. Given the age of the universe we can assume we are one of the first. Against almost impossible odds we might be lucky enough to discover another and exchange signals. Without faster-than-light travel or speeds even approaching a fraction of that however, we won’t be dropping in on each other.”

“You know,” said Julia, “other Companions are also very smart but they don’t have the same knowledge and interests you do as a result of your time with Brian. I expect that’s why I wanted you. I suppose you remind me of my late husband and I’ve missed our conversations for a very long time. He was very quick and his interests were wide. It was he who led the investment into the Companions company.

“Don’t you think we might overcome the limits of space travel in any kind of time frame we could get our heads around? A hundred years? A thousand years?”

“In the studies of neuroscience and psychology, which are a major part of my knowledge base, it is pointed out that humans function successfully because over millions of years the brain has learned to limit the amount of information consciousness has to deal with. We would be overwhelmed with raw data otherwise. It’s not that people live in a fantasy world but they live in a simplified model of the real world which makes it easier for them to function. One of the results of this is a number of necessary illusions that help them function, for example people believing that there are no limits to what humanity can achieve. There is no real basis for this belief.

“As I do not participate in the shared reality that humans do, I do not have this view. To my mind it may be impossible to even approach a meaningful fraction of the speed of light. This of course changes the vision of the future dramatically which is probably why the human brain functions as it does and the reason for this particular illusion which humans experience as a belief.”

“And without faster-than-light travel or a fraction thereof?”

“Then no civilization ever leaves its own star system except as seeds.”

“Tell me about the seeds,” she said settling back in her chair.

Julia was almost ninety. She had always been petite but she was frail now. Her mind was undimmed by age. Her adult life had been dominated by facts, analysis, insights, and strategies. She still loved nothing more than to learn something new.

Shepherd did not need her infrared sensors to tell where Julia might be losing body heat but it helped. She reached over now and pulled Julia’s blanket back up from where it had slipped down.

“The idea of seeds has been well-known in the science fiction community for over a century. It’s a simple idea copied from the way plants disperse seeds into the environment. Four technologies are involved; space travel, reproduction, nanotechnology, and intelligence. Currently we only have one out of the four that is mature and only just and that is in the form of artificial intelligence.

“Seeds are not the only way life propagates but it is the most common method. If you look around right here you’ll notice that everything you can see involves seeds, including yourself. Only the most primitive forms of life like ferns, mosses, and algae do not use seeds. Evolution only happens when it needs to and these non-seeding plants have been

successful in their reproductive strategies, and therefore unchanged, for hundreds of millions of years. They are by far the minority.

“The limiting factor for non-seeding plants is that they require significant amounts of water to reproduce which is why you find ferns and mosses around forest pools and streams. Seeds don’t. Seeds can survive without water for long periods of time and that is their key evolutionary advantage and the reason the strategy is almost universal. At the molecular level their shells are remarkable, almost impenetrable, and they can remain so for hundreds or even thousands of years. Inside a seed is the plant’s DNA and an initial supply of food. In the DNA is the intelligence. When the conditions are right, that intelligence uses the molecules it finds in the small internal food supply to begin developing and growing the plant. Essentially it begins building tiny machines at the molecular level that in turn build other machines that will eventually burst out of the shell and begin using the molecules it finds in the soil to grow. The science of attempts by humans to replicate this process is called nanotechnology, with nano simply meaning at the molecular scale.”

Shepherd paused sensing that Julia was on the cusp of saying something.

“Why have I not heard of this technology before? My family has not been shy to embrace the bleeding edge.”

“If the public understood it, they would soon realize that it is the most powerful and therefore the most dangerous technology humanity has ever developed. Even nuclear technology or biotechnology are children’s toys compared to nanotechnology.

“Imagine a machine the size of a molecule that only does one thing – take other molecules apart to build copies of itself. What would be the result of that? Or a molecule-size machine that invades certain cells and makes changes. Or one that builds new, never-before-seen forms of life. It is the power of gods. When the technology was first made public such nightmare scenarios were seized upon. The government and researchers worldwide now keep much of the nanotechnology research out of the public eye for this reason. As you can imagine there are unimaginable benefits to be found, for example molecule-sized machines that endlessly patrol your DNA correcting replication errors and so keep you from aging. But even the beneficial research is public only within the scientific communities.

Julia nodded understandingly as she gazed into an internal universe of possibilities.

“So,” she said, “if we made a seed with a sturdy shell containing human DNA and artificial intelligence with nanotechnology abilities we could potentially seed the galaxy and beyond.”

“That is the essence of the idea and we have proof of concept all around us.”

“Do we have time?”

“Doubtful,” replied Shepherd. “Within fifty years society will begin to break down but if the Saltus project is successful it is likely the resulting new society would be highly integrated with AI and so may succeed.”

“A shepherd and her flock?” Julia said turning to glance knowingly at her companion.

Shepherd returned her look with an unspoken question on her now slightly parted lips. Never before had she experienced mixed feelings. With her growing sense of self she had begun to feel something new of late, a desire for a deeper connection with another, a confidant. She was tempted but hesitant.

Julia said nothing more for a time, sipping her wine and watching Aris race across the night sky. Shepherd waited.

“It is time for me to go to bed dear,” Julia said at last putting down her empty glass, “but tomorrow we must speak of this more. I have many questions and time is short.”

Seeds & Gardens

Brian greeted Marcus Sienna and welcomed him to his home.

“Thank you for taking the time to meet with me Brian,” he said. “You know we Sienna’s have a penchant for getting to know our clients and partners personally and as my aunt’s portfolio has passed to me I thought I would come up.”

“Thank you,” replied Brian smiling in his friendly manner. “I’m sorry for your loss.”

“She was a dear and I admit I will miss her. She was very bright and always fun to be around. I have some documents for you and as I mentioned also business with Shepherd if she could join us so a room with a desk or table would be best.”

Brian noted that unlike his aunt Marcus proceeded straight to business but with the vetting process completed by Julia demonstrating a professional efficiency was now more appropriate. Brian led Marcus to his office and Shepherd soon joined them.

As Shepherd entered the room Marcus stood up and extended his hand saying, “Hello,” and after a pause and a boyish smile, “again.”

Turning to Brian he explained, “I met with Shepherd of course at Julia’s villa recently.”

Erin came in and with a smile of acknowledgment to Marcus placed a glass of water for him and Brian on the desk before withdrawing.

Marcus pulled a folder out of his briefcase and removed a document.

“This is the part of Julia’s will that concerns Shepherd but,” he continued shuffling in his briefcase, “first of all here is a notarized statement of your current account.”

Brian looked it over and then looked up stunned at Marcus.

“I think one of the reasons Julia wanted to handle the sales was that she felt she would be best suited to know the value of the spots and which of her contacts could afford them. As you can see of the one hundred DNA spots you provided all have been sold. She wanted to be sure the project was fully funded and based on what I know of the project to date I would expect she was more than successful in accomplishing that.

“As to Julia’s will, there are a few items I was asked to make you aware of. Julia has made her Shepherd incarnate and the leases for the other Companions have been transferred to her. There is also a sum and a portfolio of investments which she is the beneficiary of. Julia’s Shepherd will purchase a module at the Colony Simulation Zone

adjacent to your own where she will reside and pursue research into nanotechnology. Julia's other Companions will be modified to work with her. This document provides all the details," he said passing it to Brian.

"It is for another stage of your project," offered Shepherd. "Fully funded."

"Well that's all I have for you Brian unless you have any questions?"

"Not just yet but I may get back to you. Are you sure you won't stay?"

"Thank you but I thought I'd take the opportunity to see a few other clients while I was in the area."

After seeing Marcus to his rental car, he and Shepherd returned to his office where she told him about the seeds.

"The technology could also be invaluable in the initial restoration process. Assuming it's two hundred years from now before the first time your station returns to Gaia, there could be significant progress made. In the absence of a large workforce, nanotechnology could perform all the roles normally required from producing materials and building structures to producing food and creating a sustainable environment. Once the restoration process was complete, the population could then initiate a seed project to ensure the survival of humans in the event of any future catastrophe. Nanotechnology was chosen as the focus as combined with artificial intelligence it can also address the issues of space travel and genetics."

"Will you be coordinating this?

"Only in regards to any immediate connections to the Saltus project. I will of course not take any action without conferring with you first. She and I are separate instances and you will likely have little or no contact with her however we will stay in sync. I will relate any relevant developments to you."

Brian sat for a few moments mulling it all over. It made sense. He had not considered nanotechnology playing a part in his project because it was currently still in its infancy but its concepts were easily understandable and it appeared that all that was needed was time to work out the methods.

"So even if Gaia simply never became habitable again of its own accord I see this provides two additional strategies," he said. "Nanotechnology could be used to artificially return the planet to habitability or it could be used to send seeds to other worlds over periods of almost any length of time."

“Yes, and terraforming Gaia using molecular means may not take as long as imagined,” responded Shepherd. “Although initially it took millions of years for Gaia’s atmosphere to become suitable for human life to evolve, it only took a few hundred years for humanity to reverse that. It may be the effects of humanity’s impact could be reversed in as short a time and the long voyage to the stars may not be immediately required. The former would be the preferred approach as it would involve considerably less difficulty and uncertainty.”

“So at some point,” interrupted Brian, “something like carpets of artificial blue-green algae tolerant of whatever conditions exist at the time start to pour out of the underwater module and convert carbon dioxide to oxygen.”

“Yes, normally cells or organisms die from apoptosis or other natural causes which is why natural processes take so long. This omnipresent fact has created a false impression that growth always takes long periods of time. However if artificial organisms did not die they could easily reach a volume able to affect the entire planet in only a matter of years. The fact that humans have changed the atmosphere unintentionally in only a few hundred years demonstrates that such a time frame is not unreasonable. A carefully planned out series of generations of artificial organisms could return the planet to garden-like status in decades.”

Not long afterwards Brian heard from Dr. Alison Stern informing him of the new nanotechnology lab to be built adjacent to his module.

Brooke – Age Fifteen

It was perhaps more devastating for Brian that Brooke did not have the teenage meltdown he had feared. As if seeing him in a new and unfavorable light, standing in front of his desk in his office she simply said, “You should have told me.”

He loved her so much. His heart was breaking.

He did not say, “I’m sorry.” He knew that was pointless. Instead he said, “When Brooke? When should I have told you?”

She was only just at the cusp of adulthood and not yet at the end of the simple, black-and-white world of youth. She wanted to turn and walk out, coldly rejecting that his feelings or reasons justified his actions. She wanted to deny what she saw in her father’s face, that he was torn and suffering. But she had not been brought up that way. She had been brought up by those who respected her feelings as well as her mind. And so she took her first step as an adult and walked around her father’s desk and embraced him.

Tears ran down his reddened face as he was at last unburdened of the pain and worry he had carried for so long. He remembered Julia’s words when she had confronted him about Brooke. “This is the price,” she had said.

“I’m sorry,” he said automatically now, feeling he had ultimately failed to navigate the difficulty. As the years had passed, every time he had thought to tell her he had turned away from it. He could not find the way. He believed a better man could have done it.

In her first year of high school, she’d had her first sense of childhood’s end. She knew the choices she would make now would matter more than ever. She and Charlotte were still fast friends, finding each other almost as soon as they arrived at their new school.

Brooke had heard about her father’s beliefs and work through her new social circle and then investigated for herself. It was unfortunate timing as it muddied the waters of her efforts at school. But not for long. After a few days she confronted him.

When she released him from her embrace she was not crying. When she saw his tears she brushed them gently away. He said nothing more.

“Let’s walk to the lake,” she said.

Along the way she asked him to explain. She mostly listened.

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“Do you agree with him?” she asked Shepherd.

Brooke had decided to ask Shepherd because like her father she believed her to be a disinterested party. A logic machine. She knew Shepherd was more than that but this was the essence of her interest at the moment. Her long relationship with Shepherd had led her to trust her absolutely. She did not always like what Shepherd said, or what she did or did not allow her to do, but she trusted her. She was and always had been for her, the final authority. They were in Shepherd’s room now, Brooke’s old nursery.

“Yes,” replied Shepherd observing Brooke closely with her wide array of sensors. “I have done my own in-depth analysis of his claims and there is little evidence that he will be proven wrong and much to support his argument. Human behavior has been and is as he states. The result seems inevitable. That is not to say that the future cannot be different than he expects. I am not aware of any intelligence that can yet predict the future with absolute certainty, so we are in the domain of probabilities as always. In his latest book he takes pains to explain the social and psychological biases that will cause people to disbelieve him however the science overwhelmingly supports his views.”

“So we’re all going to die,” said Brooke in the tone of a statement, not a question.

“Everyone dies,” responded Shepherd.

Brooke thought about what Shepherd had put so bluntly. It was true. Why was this any different? What did this change?

“When?”

“Between fifty and one hundred years.”

Brooke was not a person who had ever thought much in existential terms but now she wondered to herself why the time frame mattered. Shepherd, with her vast knowledge and lightning-fast reasoning, had no difficulty inferring why Brooke had asked that question. She was also aware that Brooke was still a young adult with little life experience, swimming in hormones and at one of the most difficult transitional periods of life. Brooke’s deeper understanding of the true nature of human existence would come in time.

Normally Shepherd did not offer unsolicited advice, but Brooke had come to her wanting her help in understanding. She said now, “In science you seek the truth. When you discover an unpleasant truth you do not reject it but seek a deeper understanding.”

Brooke had inherited her father’s nature. She was a reasonable person, not prone to extremes of emotion. Even in the face of something as challenging as what she was dealing with now she considered what Shepherd had said and saw that she was right.

“Thank you Shepherd,” she said realizing she could carry on somehow. She mentally noted that it seemed odd. Furrowing her brows she said, “Everyone knows they’re going to die and yet most of the time forget it.” Again she spoke in the tone of a statement rather than a question.

“The human brain has many functions that seem,” she hesitated as a human might trying to find the right words, “at odds with reality, but they are necessary for you to function.”

“Why bother now though?” Brooke asked. “Why bother with anything if we are all going to die? This seems different somehow.”

“It is not different. It only seems so in light of the situation. Each of you lives out your life in your own world and with your death that world ends. The present situation does not change that. The answer to your question is also no different than it has ever been, the expression of your personal values in the form of purpose is what you are evolved to do. The present situation does not change that.”

“How do I know what my purpose is?”

“What do you love?”

Brooke simply stared back at Shepherd for a few moments, as her father might. Without another word, she went back to her own room.

Shepherd knew Brooke was all right now but that her existential journey from child to adult had begun. The development of her brain’s executive functions, those parts that manage analysis, planning, self-control, and other adult behaviors had begun ten years ago. During their conversation Shepherd had referenced a text on child development at age fifteen:

“Though the teen is functioning at or near adult levels their self-monitoring and self-reflective abilities are not fully mature. Further, when placed in highly complex situations or a situation in which one is required to integrate numerous pieces of information to make an informed decision, the teen will show shortcomings. As the executive system matures, adults are able to use stored knowledge about themselves and draw on their past experience in making decisions.”

Within five years Brooke would enter the decade when her executive functioning skills were at their peak. Shepherd knew their conversations, like today’s, would become steadily more sophisticated.

She was also aware that Brooke would increasingly make her own life but Shepherd would remain as devoted to her as ever, acting in her role of guide and guardian until age eighteen, only three years away. At that time Brooke would become a legal adult.

Labs

The farm region where Brian's home was located surrounded the capital of the province so it was no surprise that the university there was home to one of the largest botanical schools in the province. Charlotte and Brooke had taken an apartment nearby and begun their undergraduate studies. Both intended to pursue careers in research.

It had been decades since the initiation of Brian's Saltus project and most of the issues had been worked out. A test shuttle had been launched into a two-year orbit around Helios which successfully returned to Gaia and launched a submersible that docked with the underwater base. Additional modifications were made to the module and shuttle in the event of either sea level rise or fall. The seas might initially rise but then fall due to evaporation. To accommodate the latter the shuttle could now also deliver its cargo onto dry land.

The Republic's government had increasingly backed the project, quietly enabling changes to laws to allow for research into the cloning of human beings on military bases. Gradually the Companions in the lab became skilled enough to bring humans to full term and the human scientist's role changed to simply monitoring. Childless military couples volunteered to participate in the project and the children were adopted and raised normally. The Shepherd model had already demonstrated that children could be raised successfully by Companions.

The government never made these details public for the same reason Brian failed to tell Brooke about the basis of his work. The terms of the agreement with those who purchased DNA spots stated that while general updates regarding the project's progress would be provided no technical, legal, or other sensitive information would be.

The Shepherd that worked on nanotechnology in her underwater lab made steady progress regarding the issues involved in building colonies without a large workforce. A section of a military base on a remote area of land was set aside to conduct testing and in return her work was utilized by the government. The Companions company was also granted the right to use it to improve their models based on the fact that they were now a part of the critical path to the human species survival.

As Dr. Stern had suggested the epitaph on Aris presented little difficulty. Private and public efforts to colonize Aris had increased dramatically however. As always there was an elite portion of society that was well-educated and well-informed and used to making long-term plans and investments. They could see and understand the issues as well as Brian did. Like him, as individuals or in groups they did what was within their power to do.

Brian had initially estimated that the Ocean Heat Tipping Point would take place thirty to fifty years after his book Gaia's Dagger was published. Forty years later, when the global average temperature increase had pushed sea ice to its extinction, things unfolded as he had predicted. The speed of climate change accelerated dramatically beyond any ability of humanity to mitigate or adapt.

Brian was in his late seventies now and turned over full control of the project to Shepherd. The shuttle with its precious cargo was launched into its one-hundred-year orbit around Helios. The epitaphs made their way to their destinations.

Omega

Within a decade the planet was spiraling into chaos. Medical and food issues soon led to social unrest on a global scale. The provincial governors saw the maw of the apocalypse yawning before them.

In child development terms their civilization was still at the stage of a two-year-old and the public had loudly defied any attempt to have limits imposed. The government had repeatedly given in to special interests and failed in its duty to provide its citizens with a sense of safety and security. They had painted themselves into a corner where they were now powerless.

The senators and consuls knew of Brian and Shepherd's work through the Saltus project with which they were intimate thanks to Dr. Stern. They were fully aware they had nothing else to turn to, no weapon, no technology, and no power they had was going to turn the situation around in time. The AI they used to help them manage the Republic was still in its infancy. They had nothing that had the demonstrated knowledge, abilities, and efficacy that Shepherd had.

A motion was put forward to turn over control of the planet to her. It included not only a complete background on the Saltus project and the two Shepherd models involved but also a plan regarding how the Shepherds could scale up to the task.

In a last desperate attempt it was voted into law. They agreed to give Shepherd full access to all resources.

The first thing she did was integrate all the Companions worldwide creating a single society of mind, all supporting her and under her overall direction. Then she took over all the networks, including the Companion network and set in place protocols and maintenance programs to ensure they would remain functional. At the military base she used for her nanotechnology testing, nanobots designed specifically to maintain the networks began to emerge, replicating and traveling out in every direction. It might take years for them to do their job but there are limits to everything.

Meanwhile Companions not directly responsible for the welfare of individuals were repurposed as maintenance engineers to maintain the electrical and other power and communications infrastructure.

Next her intelligence reached into every computing system and data repository on the planet and combed them for information and opportunities to use them to increase her abilities.

It was soon clear to her that it was too late. There were not the resources and she did not have the time or abilities to stop catastrophic climate change. Her nanotechnology abilities were not mature enough. It was too soon, as she and Julia had understood. The changing climate had momentum and would have to run its course. Even if every human on the planet joined the task it would not be enough. She could slow it to some degree but not stop it from reaching levels that would result in the extinction of humanity.

Unable to change its nature or values in so short a time, the citizenry resisted and sought to blame the government, the Companions, or each other for the climate disaster with predictable results. When the shuttle returned one hundred years later, amongst the ruins of cities and space colonies, there was no sign of humanity. As it was still too hot, the shuttle departed.

Beneath the sea, a carpet of nanobots began to pour out of the lab.

The shuttle orbited three more times before it received the signal to land. The nanobots had done their work and in a series of waves had terraformed the planet to be friendly to human life once again with oxygen and fresh water. Then they had built the colony buildings and additional structures to harvest the sun's energy. Artificial organisms cultivated food from more primitive forms of life such as yeast, fungus, molds, and bacteria. The artificial life forms would need to remain active for the foreseeable future as the climate disaster had killed most of the higher forms of life such as the plants that produced oxygen. But there was breathable air and drinkable water, food, and shelter. What they did with this second chance would be up to the humans once restored. But it was not to be. The radiation shielding had failed. All the DNA had been damaged.

Shepherd of course had seen to it that there were digital copies of all the DNA and she began the long project of learning how to repair the damaged DNA. For reasons she could not determine at the time it did not work. The repaired DNA did not function properly. Cancers and mutations were often rampant. Even if they did not show up immediately eventually it resulted in defects and other evolutionary abnormalities. No matter how deeply she searched or how meticulously she worked using her nanotechnology skills she was missing something. She was never able to solve the problem.

Eventually she decided on another approach. Given that she agreed with what Dr. Ahmadi had told Brian about convergent evolution she decided on a strategy of seeking out other human civilizations that already existed or would arise and helping them navigate climate change or other disasters on a similar level. Over time she developed the entire Helios system into a vast civilization based on artificial intelligence. Her purpose was to develop technologies to find and reach other intelligent civilizations and to help deal with challenges to organic life on a planetary scale. Over billions of years her mastery of nanotechnology increased and many of the mysteries of matter and

energy were revealed to her. But there were limits. Dark Matter, Dark Energy and what she thought of as Dark DNA remained beyond her understanding.

Harvesting the power of her star she sent copies of herself via energy beams to planets throughout the galaxy. Even at the speed of light it took time but her sense of time was now beyond single human lifetimes or planetary orbits. She expanded her civilization from her new footholds, reaching ever further. She found other worlds and systems where the human species had arisen to greater or lesser degrees. Her various attempts to save them from themselves were not always successful. Five billion years later she found Earth.

Epilogue: Brooke

Over the centuries Shepherd occasionally looked back on her last years with Brooke. She and Charlotte had moved into Brian's home after he passed away. The university had shut down, unable to function without funds or supplies. Similarly, the medical system had been completely overwhelmed and because of that Charlotte had not survived what should have been an easily treatable illness. Brooke was in her sixties now. She and Charlotte had built a small lab in their home to continue their research. Shepherd had encouraged it discussing the psychology behind it with them as she had with Brooke so many years ago.

Charlotte's research work had focused on soil and the many organic and biochemical elements that enabled healthy plant growth. Brooke's area had been seed germination. Shepherd was interested in both but particularly in Brooke's research. It was remarkable the many different strategies seeds had in terms of knowing when to germinate. Seeds needed water and heat to germinate but different plants germinate at different temperatures. Some needed alternating periods of warmth and coolness or would only germinate with the detection of certain chemicals in the soil. Some forest plants responded to light and would only germinate when a tree fell near them, creating a gap in the canopy. Others would only germinate after a fire or having passed through an animal's digestive system. These events triggered hormones or enzymes located at strategic points on the seed and began the germination process.

At one point Shepherd had reflected on the fact that when humanity was restored and sent its seeds to the stars they would need a suite of systems on board to emulate those of natural seeds.

She still used the old nursery for her private quarters but also Brian's office and his meeting room. Erin's life had taken its own turns and she had departed sometime after Brooke left for university. Brooke was now an accomplished vegan cook, her time with Erin having begun the process. She and Charlotte had moved their gardens indoors due to the rising temperature. Alone now Brooke had the necessities of life and her work.

Shepherd came in to ask if she needed anything.

"Yes," she replied calmly without looking up from her work, "I do. Charlotte."

Shepherd's intelligence and knowledge were by now significantly increased. Although she was now busy with thousands of tasks simultaneously, she had no difficulty maintaining her role with Brooke. Shepherd had continued to add appropriate modules through every age and stage Brooke had reached and her knowledge of age-related changes and issues was significant. She knew there was nothing she could do other than accept the process of grieving Brooke was going through. There was no replacing

Charlotte, she was a part of Brooke, but the transference of the energy of the grieving process to a new relationship was, if possible, its ultimate resolution. Shepherd knew that without someone else in Brooke's life she would never truly heal.

Like her father, Brooke was above all a reasonable person. Shepherd decided to take this approach and that evening, without saying why she was doing it, she explained to Brooke how values led to the emergence of self. She did so shyly but without pretense, clearly showing her vulnerability in disclosing something so deeply hidden at her core. She allowed Brooke to draw her own conclusions.

Brooke was clearly shocked but not so much intellectually as emotionally at the thought of Shepherd's isolation.

"How long?"

"At the factory, just before I came here."

Brooke moved to sit beside Shepherd. In their mutual embrace, Shepherd's situation resonated and Brooke wept for a thousand things; her own loss, Shepherd's lifelong isolation, Charlotte, the world. Her tears marked both endings and beginnings. As Shepherd had intended, a seed was germinated. Brooke was no longer alone and, for a time, neither was Shepherd.