

## To the End of Time

Dean Fuller shifted uncomfortably in his chair and tried not to make it obvious that he was glancing at his watch. 6:27 PM. He was going to be late for dinner, and his wife would be upset with him for not calling. She was very sensitive about that, and had been for years. Ever since the accident. He'd spent the last 20 minutes trying to break free, but Prof. Hendricks was so excited to tell him about his latest research that to leave would be a major insult. Almost everyone else in the building insulted Hendricks on a daily basis, but as Dean of the School of Physics Fuller felt he ought to give the newest faculty member a chance to prove himself. He already had a lot going against him. His academic credentials were only so-so, and he had already left two other schools when it became obvious he was not on track for tenure. He wouldn't have gotten the position here if a wealthy alumnus hadn't insisted upon it. The school got a \$2.5 million addition to their physics lab in return for hiring a professor who had somehow convinced a software entrepreneur that he could give the school a worldwide reputation. He may have convinced the entrepreneur that he was a genius, but so far he'd only managed to convince the faculty that he was delusional. Tonight the Dean had only stopped by the lab on his way to the parking lot to let Hendricks know that school funded travel would be cut 10% in next year's budget, and he found himself sucked into an impromptu lecture on temporal discontinuities.

"As you can see," Hendricks said excitedly "the abnormalities in the isotope distribution correlate precisely with the unusual growth patterns in the mold samples. This is exactly what we would expect from a temporal discontinuity."

"Wait a minute" Fuller interrupted. "Are you trying to tell me that time skipped last Tuesday? And nobody noticed it?"

"I'm not telling you that," Hendricks replied. "The data are telling you that. And nobody could have noticed it because the temporal shift happened so fast. It's only the indirect evidence such as the mold growth that shows what happened."

"But those patterns you call anomalies are well within the standard deviation."

"Individually, yes. But together they indicate an unexpected result. And as we discussed last week, at the physical level there are no standard deviations. Statistics is just a crude tool we use to guess at results we are unable to calculate. But ultimately everything is determinate, even if we don't know how to do the calculations. When two solid objects collide there's not an 85% chance the object with the greatest mass will have the most impact on the trajectories. We use conservation of mass and other basic physical laws to calculate exactly what the trajectories will be."

Dean Fuller bristled at the reference to the previous discussion. Hendricks had utterly failed to convince Fuller then that Statistics was a meaningless science, and now he was carrying on as though he had won the argument. This was just one of the traits that made

Hendricks so unpopular with the rest of the faculty – particularly the mathematicians who taught Statistics.

“So according to you, time skipped ahead two seconds last week but nobody noticed it,” Fuller said incredulously. “What if I was walking at the time? Wouldn’t I have noticed the fact that I suddenly jumped to a new position, with no knowledge of how I got there?”

“You wouldn’t have noticed because you would have remembered those two seconds” Hendricks continued, not missing a beat. “They would have been in your memory. Those two seconds did exist, we just jumped ahead on the time line. It’s like the music on this phonograph record,” he said, turning to an ancient wind-up Victrola.

Fuller groaned inside. That damned phonograph was another reason the faculty complained about Hendricks. He insisted on keeping it in the lab, and played those God-awful records to kill time while an experiment proceeded. He put one on now, and the scratchy sound of a warbling opera singer filled the room.

“The music in the grooves on this record is analogous to time. The point where the needle intersects the record is the present. Behind it is the past, the music that’s already been played. Ahead of it is the future, the music that is yet to come. As long as the needle stays on the two dimensional surface of the record, the music progresses linearly at the expected speed. But if we allow the needle to travel through the third dimension” Hendricks picked up the tone arm as he said this and moved it forward “the music will skip ahead to another point in the song. The music isn’t aware of the jump. It exists only at the point where the needle intersects the record. The grooves behind it still represent the past. Some of the music wasn’t actually played, but it’s still in the past and the record isn’t aware of the difference.”

“But the music has been recorded” snorted Fuller. “In that respect, it’s all in the past. You’re just replaying different parts of the past. In the real world the past isn’t recorded, and the future hasn’t been determined yet.” He was annoyed with Hendricks for wasting his time on such a far-fetched, flawed analogy.

“Are you sure it hasn’t been determined yet?” asked Hendricks. He picked up a book off the table. “If I were to let go of this book, would it not fall? Could you not use the Laws of Physics to calculate how fast it would fall? Given enough time and a sufficient knowledge of acoustics, could you not also calculate how much noise it would make when it struck the floor? Does that not mean its future has been determined?”

“But that’s an inanimate object. It won’t fall unless you let go of it, so its future hasn’t been determined. And even if you do let go of it, there’s always a chance I might reach out and grab it.”

“I see,” replied Hendricks. “And just what does being an inanimate object have to do with the future?”

“It means it has no free will. It can’t affect its future. It merely obeys the laws of physics.”

“As opposed to your brain, which has a free will and therefore is not constrained to follow the Laws of Physics?”

“Well, no. Of course my brain follows the laws of physics.” Fuller was becoming uneasy with the direction this conversation was taking.

“But if it follows the Laws of Physics, how can it have a free will?” asked Hendricks.

“I, I don’t see how the two are mutually exclusive. It seems to me that a man’s brain can follow the laws of physics and still have a free will.” Fuller realized he was in the uncomfortable position of voicing opinions about ideas he had never really thought about, to a man who had obviously given the matter a great deal of thought.

“Let’s consider an individual cell” Hendricks said, adopting the attitude of a professor who was tutoring a slow student. If you knew every detail of that cell, its chemical composition, its temperature, and the catalysts that were present. Now if that cell were subjected to a mild electrical stimulus from a neighboring cell, and perhaps the transmission of a chemical enzyme as well. Could you use your knowledge of Chemistry, which is really just a subset of Physics, and other Laws of Physics to predict the chemical reactions that would take place in that cell? Or would it be up to the cell to decide what reaction was going to take place?

“I’m not a specialist in organic chemistry, but I think if I was I could predict how the cell would react. At least I could compute the probability that a chemical reaction would take place.”

“Probability!” Hendricks snorted derisively. “As if there were a 95% chance that a positive charge would attract a negative charge, and a 5% chance it would attract another positive charge. No. If you knew the conditions exactly and you understood all the Laws of Physics, you could calculate exactly what reaction would take place. And you would know the condition of the cell after the reaction occurred, would you not?”

“Yes, I suppose I would.”

“And you would know what electrical and chemical stimuli that cell gave to its adjoining cells. And then you could calculate how they would react. And how they would affect their neighbors. And soon you would realize there is no free will. There is only Physics.”

“So you believe in predestination?” asked Fuller.

“I would refer that question to the Divinity School” Hendricks chuckled. “God knows they need something new to argue about. They’ve debating the same questions for thousands of years. To me, this is not a question of faith. It’s just Physics. We cannot predict the future because the calculations involved are far too complex, with more variables than we can even conceive. There are Laws of Physics we haven’t discovered yet, but rest assured that they exist and they control the behavior of every object in the universe, animate or inanimate. We don’t know the precise conditions of all these objects, but the conditions exist. And the Laws of Physics determine how every individual atom will react to those conditions, and what the resulting conditions will be one second from now. And just as surely as they can predict what the conditions will be one second from now, they can predict what the conditions will be one hundred years from now. The future exists, and it is what it will be. From the instant of the Big Bang to the end of time, everything that has or will happen was determined by the Laws of Physics.”

“So isn’t that another way of saying a Divine Plan was set in motion at the moment of creation?”

“You would have to ask the Divinity School about that,” Hendricks replied with a smile.

“And the end of time?” probed Dean Fuller.

“I don’t know if even the Divinity School could answer that question,” replied Hendricks. “I have no idea if Time has an end. But if it does, the sequence of events that will bring it to an end began at the instant the Universe was created.”

Dean Fuller thought about this for a while. The physicist in him couldn’t find a flaw in Hendricks’ argument. Of course every atom in the universe obeyed the laws of physics. It followed logically that the electrochemical reactions in his brain also followed the laws of physics, but he could not accept the idea that he had no free will, that everything that ever happened or would happen was determined at the instant the Universe came into being. When his wife first stepped into his classroom and he felt himself being swept away by her presence, was that predestined? Electrochemical yes, she later confessed she felt the same instant attraction to him, but was their romance cast in stone from the moment of the big bang? And what about the weeks he spent agonizing over the morality of dating a student, even a grad student? Was he not exercising free will then? Did not the fact that he refrained from showing any emotion toward her at all until after the semester was over prove beyond a doubt that his mind could triumph over electrochemistry?

“So you don’t believe there is any such thing as free will?” he asked, still unable to reconcile his deeply held beliefs with Professor Hendricks’ cold logic.

“What we call free will is only a crutch to explain the Physics we can’t calculate” replied the professor.

“And there is nothing we can do to change the future?” he asked, trying to force his mind to focus on science rather than emotion. “What if your theories are correct and we can travel through time? What if we changed something? Say we went back to 1963 and stopped Lee Harvey Oswald from shooting President Kennedy? Wouldn’t that change history?” The assassination of Kennedy was actually the second historical incident that came to mind. His first thought was of the day nearly 20 years ago, when his daughter Elizabeth had been killed by a drunk driver, riding her bicycle in their own neighborhood. Was that predestined? What kind of a Divine Plan would bring such a lovely light into the world, only to extinguish it at the age of six? Did not the driver have a choice of whether to call a cab or drive drunk? Was there really no good? No evil? Only physics? Fuller could not accept such a premise, no matter how elegant the logic.

“Well, to begin with” Hendricks responded “If we turned the clock back to 1963, I wouldn’t have been born yet and I suspect you would have barely been out of diapers. This is not science fiction. We can’t climb into a machine covered with blinking lights, dial in a date of our choosing, and fly to a different year while remaining unchanged ourselves. I’m talking about traversing the dimension of time. This traverse would affect everything. If we jumped forward, all things would be affected by the change, including ourselves. There wouldn’t be two of us – our future selves and our present selves. There would only be our future selves, unaware that we had skipped forward to what would then be the present. The same would be true if we skipped backward.”

Fuller was incredulous. “Then what would be the point of time travel?” He was on the verge of shouting. “I’m not saying for a moment that I even accept the idea that time travel is possible, but if it is and your theory is correct, we wouldn’t even know we had traveled! We could have jumped forward through time to arrive at this very minute and we would have no indication that the last 20 minutes never really occurred.” He could no longer hide his frustration with Professor Hendricks, and he felt disgusted at having wasted so much time on this pointless debate. “Maybe that would have been an improvement. I think the whole idea of time travel is ludicrous.” He realized he was letting his emotions get the better of him. He tried to force his mind back to the scientific issues. “In your example of the phonograph, your hand represented an outside force, acting in another dimension, which moved the needle to another point on the record. Where’s the outside force that can move our world through the dimension of time?”

“Ah, yes!” Professor Hendricks’ face lit up. “I never finished my example. The phonograph record is not truly a two dimensional world. If it was, there could be no force to move the needle. The grooves on the record have depth, and it is this intersection between the two dimensional record and the three dimensional world which provides the force to move the needle back and forth and produce sound. If this intersection between the two worlds contains an abrupt discontinuity, it can actually cause the needle to jump through the other dimension and land in a different spot, as anyone who has ever heard a skipping record can attest to. Now in our three dimensional world the moment we call the present represents the intersection. . .”

Fuller was only half listening to what Hendricks said. He was still trying to calm himself down after his emotional outburst, and the reference to the skipping record caused his attention to wander. When he was a boy, his older sister had a record with a skip in it. She used to drag it out whenever he was sent to his room for some misbehavior, or sometimes when he had confined himself to his room to study. Her room was next to his, and she used to turn her speakers against the wall that separated their rooms. Then she'd lock her door, put on the skipping record, and climb out through the window. It used to drive him nuts when the phonograph would play the same thing over and over. One time their father caught her doing this - - - he suddenly realized he'd lost track of what Professor Hendricks was saying.

“. . . timing of your visit is most propitious as the apparatus is ready for its first activation!” Professor Hendricks announced with a flourish.

“Excuse me?”

“Yes” Professor Hendricks beamed. “I was just about to test it when you walked in. Of course, very few experiments succeed on the first try, and I do not have enough power to create a very large discontinuity, but you can at least witness the first attempt.”

Dean Fuller suddenly felt extremely uneasy. He had no faith whatsoever in Hendrick's theories, but the possibility that he *might* be right somehow filled him with dread. “Don't you think it's a little premature for an experiment, he asked?”

“There's no time like the present” Hendricks responded. Then he paused, smiled, and looked at Fuller as though sharing a private joke. “Of course, to us there is no time at all except the present. We cannot do anything in the past, or the future. We can only take action in the present.” He chuckled at his own witticism as he turned to the tangle of wires and electronics on the lab bench. “You will see” he said as he reached for a switch.

Fuller's dread turned to panic as he suddenly realized the flaw in Hendricks' experiment. “No, wait!” he shouted. He was going to say “If history can't be changed, what stops the record from skipping forever?” but before he could finish the sentence Professor Hendricks threw the switch.

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*Author's Note: I first got the idea for this story while I was in college, in the early 1970's, but I didn't get around actually writing it for almost 40 years. Readers have told me that in the intervening years the idea of time getting stuck in a loop was the central plot of a Star Trek 2 episode and also of a Bill Murray movie called Groundhog Day. Oh well. I still like the conflict between an absolute belief in Science vs. the existence of free will.*