

Intents and Purposes
(Penn State University, Astro 120: Spring 1998)
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Author's Note: Written for my senior year Astronomy class. Here's what I told my professor:

One of the main hurdles I faced in writing this story -- at least from a scientific standpoint -- is that wormholes simply do not make for very interesting, much less practical time machines. They are, as Trevor says here, of very limited immediate use. If I create a time machine following the steps followed in the story (and suggested by Kip Thorne in *Black Holes and Time Warps*), I will not be able to use it until the spacecraft returns to Earth -- ten years later. I would have a time machine that would only allow me to travel back to the beginning of a decade I just lived through.

This could very well explain, as I also tried to briefly touch upon in my narrative, why the world has not been overrun by visitors from the future. In *A Brief History of Time*, Hawking cites this as further evidence that time machines do not -- cannot -- exist, but isn't it just as likely that, since you can't travel to a time before the wormhole became a time machine, that a time machine simply hasn't been built yet? That we will see visitors from the future when and if such a device is created? I honestly could not say; I understand the laws of quantum gravity even less than either Thorne or Hawking and so hesitate to make even a vaguely educated guess.

My main thesis here, if there is one, runs somewhat counter to Hawking's arguments. Hawking envisions a Universe which abhors paradox and so will not allow a time machine to be built. But if vacuum fluctuations would cycle through a wormhole, going back in time to destroy it before it becomes a time machine...isn't that just as paradoxical? Perhaps the Universe does abhor paradox, though, but not time travel; everything is merely a loop, another cycle, reiteration. Possibility is gone. Time travel does not necessarily indicate paradox, I have tried to argue, although we might actually prefer if it did.

I have focused primarily on the wormhole theories discussed by Kip Thorne in *Black Holes and Time Warps*, where the wormhole is threaded with "exotic material" (which Thorne mentions might be found in the form of vacuum fluctuations distorted by gravity, of the sort found in horizon of a black hole). If such threading were possible, wormholes might provide an excellent means of transport between the stars (assuming, of course, that time is hooked up normally between the two mouths, as I have assumed in my story and as Thorne assumes for his thought experiments). But further steps to turn that transport into a time machine seem, to me, problematic. Even if the vacuum fluctuations did not destroy it, and even if we could overcome its limited immediate use, would we really want a working time machine?

If nothing else, this story has introduced me to Kip Thorne's excellent book and encouraged me to think further on the subject. I am, however, glad that I chose not to include tachyons as another element -- although I am surprised that neither Thorne or Hawking even mention their possibility, if only to dismiss it.

Here's what I tell you: I am just a writer. I am not a scientist, and I do not understand the principles that govern the universe. Take this for what it is: an experiment, an exploration of an idea.

"...unexpected dangers await any maker of time machines."
- Kip S. Thorne, Ph.D., *Black Holes and Time Warps: Einstein's Outrageous Legacy*

History, Janie would remember three days too late, was bunk. None of it mattered. Time was an illusion. The truth, if it even existed (and she had her doubts), was elusive, enigmatic and fragmentary, as substantial as ghosts or a dream. It would not be found in any of the books she had forced herself to read as a child, in the thick volumes that had lined the dusty shelves in her grandfather's study, or even in the notes she sometimes found scribbled in their margins. These all were lies, the half truths or whole-cloth fabrications of posterity, the reinvention of the past by its heirs, the stories of conquering armies and empires. Not the truth, Janie thought-not hardly.

More like Darwinian thinking at work: the strong survived; their tales were told. The weak, though, were forgotten. Memories buried, their dead unlamented, they were erased, excised from antiquity-forgotten, neglected, ignored. Nothing endured but shadows of the past, faint echoes, like ripples in a pond whose true size and span one could only begin to guess, whose shores one would never map, nor depths ever fathom. History occluded the past; it did not reveal. History obscured. History lied. And the lies of history, Janie would finally understand, were traps into which it was all too easy to fall.

By then, of course, the Machine had already been built, had been redesigned and recalibrated, dismantled, inspected and rebuilt, and Trevor had walked off into the darkness of the void and disappeared. The Project had been heralded a success. A new era had begun. A last minute epiphany or attack of conscience would not change that, or shut tight the Pandora's box their work had sprung open. The damage had been done. May you live in interesting times, Trevor had scrawled in the back pages of his notes, but may you never possess your heart's desire. Even then, Janie suspected, he had known. Even then he'd been at least dimly aware of the demons that his equations would set loose, the thread of events that had originated with Lachesis and Trevor's dreams and that now bound her inexorably to this path. Long before they'd had any reason to worry-before the meetings, the petitions and government grants, the military advisors-Trevor had known.

But now Trevor was gone. History had swallowed him whole. Sic transit gloria. Tempus fugit. Janie did not know where-or when-he now could be. She was no longer part of the team, they had informed her; her services were no longer required. Her husband's vanishing act had made Janie redundant, expendable, and they could attend to Lachesis without her. She was not even allowed to enter the building where the Machine was now housed. Trevor had been the physicist; she was just the bookworm, the tagalong, the loose end. They didn't need her anymore. They had what they wanted. They had the strands of history in the palms of their hands.

So all Janie wanted-the only real option still left to her, she knew-was to pretend that none of it had ever happened, to forget Trevor Milligan and that she had ever listened to what he'd had to say. Selective amnesia. Reacquired ignorance. It was as simple-as impossible-as that. To forget, take refuge in oblivion, and let history wash her away as it had everything else. The past would still be safe, then, tucked inside her notes and the books on her grandfather's shelves. The past would still have meaning. History would be more than a collection of lies, a compendium of lost or misremembered dreams. If she had never heard the name Lachesis, she thought, or had laughed at Trevor's talk of time machines and paradox, of vacuum fluctuations, exotic matter, and the holes poked between two centuries-if she had just laughed and turned away, ignored him, dismissed him as a fool-then she wouldn't have to know. Anything. True awareness, which Lachesis now offered, was too immense for any one mind. It was like one of Trevor's strange singularities, a black hole or the emptiness of a collapsed wormhole-an encapsulated heart of infinity, where everything broke down and human comprehension became impossible. Ultimate knowledge had its price. Uncertainty was precious, and ignorance was bliss. Omniscience was the death of all hope.

"You can't change the future," Trevor had told her only the week before, "and you can't rewrite the past. The universe won't allow that, protects itself from paradox, plain and simple. I don't think you can alter the timeline; you can't affect change. Change just becomes inevitability. Whatever you do becomes what you've always done. If you go back in time, it's because you've always gone back in time. It's inescapable, Janie, like gravity. It's like . . . like predestination on a quantum level. You might think you're free to act, that you have choice. But you're not. You don't.

"If I go back, and I tell myself how to build a time machine-if I show myself what Lachesis is capable of-then the machine has to be built. There's no choice involved. Do you understand? There's no free will, no other possible outcome or avenues to explore. But then there's also no paradox. It's just . . . what happened, what will always happen. It's a loop. It perpetuates itself, ad

infinitum. Sort of like what Hawking calls chronology protection, you know? The preservation of logic, of continuity, consistent cause and effect. A safety mechanism. There's no getting around it. It can't be outwitted, circumvented, or undone. It's just there."

Change, now, was impossible. The universe denied it to survive, necessarily narrowed a line of probability into one prescribed outcome, one finite string of events, and thus eliminated paradox, incongruities in the timeline, flies in the ointment. Confronted with the reality of time travel, free will ceased to exist, even as an idea. Doors were closed; roads could not be traveled; revisions could not be made. All action became merely reiteration, an endless loop of Lachesis' thread. Science was a search for constants, Janie understood—for verities, eternal truths and quantifiable meaning—but, at its heart, it was mainly conjecture, theory disguised as law, supposition masquerading as fact. The human mind ached for clarity amidst the chaos, for structure and design, recognizable patterns in the universe that could be transcribed into equations and histories, translated into comprehensible human terms—calculated, studied, accepted as fact, applied to everyday life. But it was incomprehension that kept man reaching for the stars, doubt that kept him reaching for the gods. Time travel negated that uncertainty, isolated possibility, removed all need for doubt, and, thus, allowed for ultimate, infinite knowledge.

The knowledge that there was nothing left worth knowing, that her every action was now fated, scripted by the very cosmos they had tried to tinker with, to comprehend, to chart—to control. That there could be no variation, no possibility, no uncertainty or hope. The past could not be altered, so it would, instead, be ignored, buried beneath history and its false narrative of time. The military had Lachesis now, had unrestricted access to the Machine and the countless wormholes at its core. They would use it. They would step through a small mouth at one end and emerge five, then perhaps ten or twenty years in the past from another. They would attempt to change the course of time, the tide of history—to prevent the advent of a war, divert an assassin's bullet, forestall the inevitable rise of a dictator—anything they had failed to foresee since Trevor had activated Lachesis and the time machine had begun to exist. But the past could not be changed, and the loop, once threaded, could not be severed or reknotted. The allotment of fate was not negotiable. The universe abhorred paradox. Their attempts would meet with failure, Janie knew, or would, perhaps, even provoke the very events they had tried to avert.

"We might live in a much better world," Trevor had once joked (although it didn't seem funny now), "if we could just convince ourselves to leave it the hell alone."

It had been history, though, and her misplaced faith in it, that had initially drawn her to Trevor. He was charming certainly, fascinating, attractive; she could not pretend that sex had not played a role, that she had not been flattered or aroused by his interest. But it was more the promise of history itself that had seduced her, the opportunity to witness all of yesterday firsthand—not as it was recounted in her books or taught by her professors, but as it had truly unfolded, moment by moment. Trevor had offered that, in a way, had said that he was building a window to the past, a bridge between here and there, between now and then. He was building a time machine.

"You ought to call it Lachesis," she had told him. "After the Greek myth. The three sisters, the Fates? Clotho spins the thread, Atropos cuts it, but Lachesis decides how much any one person gets. She sings of the past, of things that were, decides the span of your life. Plato called her the maiden daughter of Necessity, that which leads to what must be.

"And besides," Janie had added, "I'm sure Chronos is taken."

And so they had built it, Lachesis, the time machine. When the University would no longer fund his research, Trevor turned (perhaps not all that reluctantly) to the military and its much deeper pockets. Within six months, sooner than anyone had expected, he had produced results—localized exotic matter, vacuum fluctuations so distorted by gravitational tides as to have a negative average energy density, so curved that their own gravity would defocus the light traveling through

a wormhole and push the walls apart. The distance between two points ceased to exist. Here and there became one and the same.

"Normally," Trevor said, "a wormhole will collapse into a singularity even before a photon can pass through it. It's an instantaneous rip in space and time, the tear of a single thread. Unless you hold it open, it's there and gone, of no practical value. Weave exotic matter through it, though, use the gravity that would ordinarily collapse it to prop it open instead and . . . well, you've got yourself a working walkway to the stars."

Or a time machine-provided, of course, that a few further steps were taken.

"A wormhole has two mouths, twin pockets connected in spacetime's fabric. You can have one here, one there-anywhere-and the in between doesn't matter. Distance doesn't matter. If you accelerate one of those mouths-say, aboard a spacecraft traveling near the speed of light-leave another here on Earth, and just . . . wait, you find that suddenly time doesn't matter either. It's all relative, all about context. A trip that seems to take only twelve hours into space and back could last as long as ten years. Because each mouth experiences a different flow of time, a different frame of reference. For the mouth on the spacecraft, the trip does last only twelve hours, while a decade passes by here on Earth. So when the ship returns and you poke your head through the wormhole, you'll find yourself on Earth, ten years earlier, rewitnessing history."

Just like that, Janie thought. You stepped from one reference frame into another, from one moment . . . well, not to next, but to the previous. They had feared that normal, everyday vacuum fluctuations, which were not immediately defocused by the exotic matter holding the walls apart, might destroy the Machine, loop themselves around in time, building in strength, until they collapsed the wormhole.

"That's what everyone thought would happen," Trevor said. "That was the theory. Inevitable destruction as soon as it became a time machine."

A particle would arrive at the moment that it first went through the wormhole and decide to go through it again, building a continuous loop. So where there had at first been only one particle, now there were two, then three-then twenty-piling atop each other and building in strength, exponentially, until the beam they produced was infinitely strong and able to collapse the wormhole upon itself. In becoming a time machine (or so the theory seemed to claim), a wormhole prevented itself from becoming a time machine.

"Seems paradoxical to me," Trevor said. "Can it both be and not be a time machine simultaneously? How does the universe decide that this paradox is okay, that the impossible can happen here? If it insulates itself from paradox to maintain consistent cause and effect . . . well, why doesn't it do so here? How can we have it both ways?"

These questions were moot once the Project began. Lachesis had worked. The theory was wrong. And the only reason the world had not yet been overrun by time travelers was because a time machine had only just been built.

"We can't go back to a moment before the wormhole," Trevor had said, addressing the assembled Project team. "Before it turned itself into a time machine. And we would have to wait those ten years, wait for the ship to return. If it relanded on Earth in the year 2010, for instance, we wouldn't be able to go back to a point before the millenium. It's of limited immediate use. But a little patience and all of history from then on can be yours."

But history, as Janie had discovered, was meaningless, a chimera that could not be captured, bottled, or understood. You could not own history or change the past. You could merely step

through a wormhole-as thousands now would-and attempt to remold time in your own image, to recast your lot or retie your thread. But the universe would not allow that. The universe protected itself from such attempts. And the price that it exacted for this folly-this belief that man's record of time meant anything-was the end of ignorance, the beginning of knowledge, and the death of hope.