Potentials of Future-Viewing Machines

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Abstract

The introduction of new scientific instruments has always played a vital role in the advancement of science and society. All scientific instruments to date have only been able to gain information pertaining to events of our immediate and distant past. Concerning our attempts to gain information about future events, thus far our sciences have been limited to prediction. However, what if we could develop instruments that would enable us, in a wide range of circumstances, to achieve direct empirical access to future states of our world? It is clear that any kind of future-viewing machine would have enormous impacts upon science and society, but what kinds of impacts? Questions as to whether such machines are physically possible and might ever be feasible from an engineering perspective will not be addressed; this work is devoted to exploring the logic of such machines and deducing some of the possibilities of their utilization.

Introductory Considerations

The concept of a machine which could allow forward and pastward time travel has captivated and beguiled our imagination since 1895, when H. G. Wells released *The Time Machine*.[1] A decade later, Albert Einstein shocked the world with time dilation, an effect of special relativity which famously permits relative forward time travel.[2] General relativity added spacetime curvature and gravitational time dilation.[3] Upon this foundation, Kurt Gödel proved in 1949 that valid solutions of the equations of general relativity describe contexts that would allow pastward time travel.[4] Of course, many thinkers have associated impossible past-alteration paradoxes with pastward time travel. However, physicists have recently dispelled this misconception: As will be thoroughly explained, physical insights have established why a time machine which operates according

[1] Wells, H. G., *The Time Machine*, (London: William Heinemann, 1895).

[2] Einstein, A., "Zur Elektrodynamik bewegter Körper," *Annalen der Physik*, 17 (1905): 769-822.

[3] Einstein, A., "Die Grundlage der allgemeinen Relativitätstheorie," *Annalen der Physik*, 354 (1916): 769-822.

[4] Gödel, K., "An Example of a New Type of Cosmological Solutions of Einstein's Field Equations of Gravitation," *Reviews of Modern Physics*, 21 (1949): 447-450.

to *Gödelian time travel* (i.e., pastward time travel as it is understood within general relativity), which could therefore occasionally lead to pastward time travel, could never be used to alter past events.[5] While extensive scholarly attention has been focused upon the concept of time machines, the related concept of future-viewing machines appears, until recently,[6] to have been neglected. However, future-viewing machines are even more interesting to contemplate than time machines, for it will be shown that they could prominently factor into the conduct of civilization.

Before the topic of future-viewing machines can be addressed, it is essential to present a series of considerations about future states discovered during the early development of modern physics in order to establish an appropriate expository context. It is centrally important to explain why it is necessary to discuss "our future" rather than "the future." For us, "our future" is necessarily our unique common future (as will be established shortly), and so we could refer to it as "the future" without any loss of accuracy in the context of what we will experience. Nevertheless, an important distinction between "our future" and "the future" must be maintained for clarity in a larger context.

Quantum mechanics has shown us this larger context. It has informed our concepts of future states more than any other theory. In classical determinism, it was thought that there is only one possible future and so only one future. However, the physical world is governed by quantum mechanics, and the deterministic equation at its foundation predicts many possible futures. Yet, in the context of the unitary succession of outcomes we experience in any given case, quantum mechanics appears to be irreducibly probabilistic. These issues were masterfully presented by David Chalmers in *The Conscious Mind*:

> [T]he Schrödinger equation is entirely deterministic.
>
> The Schrödinger equation is relatively straightforward and well understood.... In applying quantum theory to a practical or experimental problem, the bulk of the work consists in calculating how various states evolve according to Schrödinger dynamics.
>
> The Schrödinger equation cannot be *all* there is to say, however. According to the equation, the vast majority of physical states will soon evolve into a superposition of a wide range of states. But this does not square with our observations of the world. When we measure the position of a particle, we find a definite value, not the superposition of states that the Schrödinger equation would predict. If the Schrödinger equation were all there is to quantum dynamics, then even at a macroscopic level the world would evolve into a wildly superposed state. But in our experience it does not.[7]

[5] Friedman, J., et al., "Cauchy problem in spacetimes with closed timelike curves," *Physical Review D*, 42 (1990): 1915-1930. Pegg, D. T., "Quantum Mechanics and the Time Travel Paradox," *arXiv*:0506141 (2005): 18 pages. Lloyd, S., et al., "Closed timelike curves via postselection: theory and experimental demonstration," *arXiv*:1005.2219 (2010): 5 pages.

[6] Feeney, A. M., *Understanding Future-Viewing Machines and Time Travel*, Kindle electronic edition (Buffalo: Aaron M. Feeney, 2014).

[7] Chalmers, D., *The Conscious Mind*, (Oxford: Oxford University Press, 1996).

The quantum determinism of the Schrödinger equation leads to many futures together in a superposition, but when any given moment arrives we only ever experience one state of affairs. All interpretations of quantum mechanics propose ways of reconciling these two observations, among other objectives. Although there are many interpretations of quantum mechanics, it is only necessary to consider two basic approaches here. One of the earliest approaches, which has come to be referred to as the *Copenhagen interpretation*, suggests that the act of measurement somehow causes all of the possibilities presented by the Schrödinger equation to "collapse" to the unitary state of affairs that is detected. This may be referred to as "the measurement postulate."[8] According to this view, after a measurement is made, all the outcomes that could have happened according to the Schrödinger equation are treated as mere mathematical phantoms in relation to the outcome that has been measured.

An important alternative to this was proposed by Hugh Everett III, in 1957. He referred to it as the "relative state" formulation,[9] but it has come to be known simply as the *Everett interpretation*:

> The motivation for this interpretation is obvious. The heart of quantum mechanics is the Schrödinger equation. The measurement postulate, and all the other principles that have been proposed, feel like add-on extras. So why not get rid of them? The problem with this is equally obvious. If the Schrödinger equation is all, then the world is superposed at every level. But it does not *look* superposed: we never perceive pointers that are in a superposition of two states....
>
> Superposition, on this view, is everywhere. Why then does the world appear discrete?
>
> Everett's answer to this question is to *extend superposition all the way to the mind*. If we take Schrödinger's equation seriously, then if the pointer measuring an electron is in a superposition of states, the brain of a person perceiving the pointer will itself be in a superposition. The state of the brain will be described as a superposition of one state in which it perceives a pointer pointing upward, and another state in which it perceives a pointer pointing downward. Everett's key move is to suppose that each of these two states should be associated with a separate observer. What happens after such a measurement is made is that two observers are produced. One of them experiences an "up" pointer, and the other perceives a "down" pointer. It follows that *each* observer will experience a discrete state of the world.
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> Everett goes on to show that according to this framework, these observers will have most of the properties that we expect observers to have, and that most of the predictions of the quantum-mechanical calculus can be derived. For example, it is not hard to see that

[8] Ibid.

[9] Everett, H., III, "'Relative State' Formulation of Quantum Mechanics," *Reviews of Modern Physics*, 29 (1957): 454-462.

> each of the two superposed states here will have no access to the other superposed state, so that the superposition of the mind will not be betrayed in any single state. It is even possible to show that when an observer making a measurement perceives another observer measuring the same quantity, the perceived results of the measurements will be in accord, so that the world will seem quite coherent. In short, any single observer will experience the world in largely the way that we expect, even though the world itself is in a superposed state.[10]

Both interpretations incorporate the idea that there is more than one possible future, but in different ways. The Copenhagen interpretation holds that all possibilities presented by the Schrödinger equation, except whatever happens to be experienced, are mathematical abstractions for getting the probabilities right. So, the Copenhagen interpretation holds that reality is fundamentally probabilistic. On the other hand, the Everett interpretation treats all futures which emerge from the deterministic Schrödinger equation as equally real, while it maintains the ability to explain why we individually only ever experience unitary sets of once-future states and why, upon conferring with others, we would consistently conclude that we are experiencing a common, coherent world. Furthermore, according to the Everett interpretation, reality is fundamentally deterministic and merely appears to be probabilistic. Everett himself remarked, "[w]e are then led to the novel situation in which the formal theory is objectively continuous and causal, while subjectively discontinuous and probabilistic."[11]

So, upon either interpretation, "our future" is necessarily unique. In other words, we will experience one future together, even while quantum mechanics involves the consideration of many futures (although the ontological status of the future states we will not experience can be interpreted in at least two very different ways). There is one last issue to discuss. When the Everett interpretation was popularized in the 1970s, it was characterized as the "many-worlds interpretation." However, Everett did not conceive of his interpretation in such terms.[12] Chalmers provides a refreshing alternative to the inelegant concept of myriad, constantly splitting worlds:

> [T]he view I am discussing is more accurately a *one-big-world interpretation*. There is only one world, but it has more in it than we might have thought.
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> On this view, if there is any splitting, it is only in the minds of observers. As superpositions come to affect a subject's brain state, a number of separate minds result, corresponding to the components of the superposition. Each of these perceives a separate discrete

[10] Chalmers, D., *The Conscious Mind*, (Oxford: Oxford University Press, 1996).

[11] Everett, H., III, "The theory of the universal wave function," *The many-worlds interpretation of quantum mechanics*, DeWitt, B. S., Graham, N., eds., (Princeton: Princeton University Press, 1973).

[12] Barnett, J. A.,"Everett's pure wave mechanics and the notion of worlds," *European Journal for Philosophy of Science*, 1 (2011): 277-302.

> world, corresponding to the sort of wold that we perceive—call this a *miniworld*, as opposed to the *maxiworld* of the superposition. The real world is the maxiworld, and the miniworlds are merely in the minds of the subjects. Everett calls his view a *relative-state* interpretation: the state of a miniworld, in which pointers point to discrete positions, only counts as the state of the world *relative* to the specification of an observer. The objective state of the world is a superposition.[13]

This makes the Everett interpretation much more palatable and accessible. In this work, some of the technological concepts to be presented will make more sense in the context of the Everett interpretation (or something like it) rather than the Copenhagen interpretation (or anything like it). However, since there are many additional considerations outside of the scope of this paper, and there are several other interpretations, no claim will be made as to which interpretation is correct, or even that the correct interpretation has yet been proposed. Hopefully, experimental data will one day answer such questions.

Throughout, in order to signal the non-classical understanding of future states presented in this section, the term "our future" will always be used rather than "the future," even though "the future" has never meant anything to us other than "our future." In keeping with this convention, "future events" and "future outcomes" will only refer to the events and outcomes of our future.

Three Kinds of Future-Viewing Machines

The idea of technological instruments for gaining visual information about future events is a distinctly modern concept,[14] with ancient roots.[15] The related

[13]Chalmers, D., *The Conscious Mind*, (Oxford: Oxford University Press, 1996).

[14]In 1936, the short story, "Elimination" by John W. Campbell, Jr., presents a future viewing machine called the "chronoscope." It is depicted as being very much like a post-processed Everett machine, but the way the operator determines the probability of a given future outcome is by the distinctness of a given image in relation to the fainter ghost images visible within the selected probability range. What an enormously impressive feat of imagination for 1936! "Cartwright's Camera," by Nelson Bond (republished in 1946 as "Johnny Cartwright's Camera"), is another early story about a future-viewing machine. It tells the tale of a camera that is able to show how photographed scenes will appear one day ahead. In 1953, the visionary science-fiction author, Philip K. Dick, published "Paycheck," a short story about a future-viewing machine which additionally allows its operator to retrieve objects found in future scenes. A popular 1963 episode of *The Twilight Zone*, "A Most Unusual Camera," is about an instant camera which reveals how a photographed scene will appear a few minutes later. Rod Serling brilliantly explored the possibilities of his initial assumptions, and his twist-upon-a-twist ending reveals exactly what kind of future-viewing machine he had in mind among the three options presented in this section. Campbell, John W., "Elimiation," *Astounding Stories*, 17 (1936): unknown. Dick, P. K., "Paycheck," *Imagination*, 4 (1953): unknown. Bond, N., "Cartwright's Camera," *Unknown Fantasy Fiction*, 4 (1940): unknown. Bond, N., "Johnny Cartwright's Camera," *Mr. Mergenthwirker's Lobblies and Other Fantastic Tales*, (New York: Coward-McCann, Inc., 1946). Serling, R. "A Most Unusual Camera," *The Twilight Zone*, (CBS Worldwide Inc., 1963).

[15]For instance, the medieval concept of a crystal ball is evocative of the concept of a future-viewing machine. Also, the ancient practices of scrying by gazing into a bowl of wa-

concept of individuals who are able to see future events, however, has a long and interesting history. Ancient Greek mythology provides an example of this concept which remains familiar today: Cassandra, daughter of the last king of Troy, was so extraordinarily beautiful that even the god Apollo became smitten. He hoped to win her favor by giving her the ability to see future events perfectly, but after receiving his gift she declined his advances. In his displeasure, Apollo added a curse; he decreed that no one would believe her prophetic visions. Of course, a heart-wrenching tragedy ensued, for she would later be unable to convince anyone of the impending fall of her beloved kingdom.[16]

In this paper, the idea of individuals who are able to perceive future events in personal visions will not be explored. While this topic is relevant, and clearly important, there are many special challenges associated with its conceptual analysis. Instead, the focus here will be upon the concept of machines that would be able to visually access our future. For this reason, the term future viewer will refer only to a future-viewing machine. A person who directs and monitors any kind of future viewer will be referred to as its operator.

Many types of future-viewing machines are conceivable. In order to understand any of them, however, it is first necessary to analyze the various kinds of information one might obtain with respect to any given set of unknowns. First of all, information about any unknown can be either definite or ambiguous. If there is a playing card in a sealed box, an example of definite information is obvious, e.g., "the card in the box is the queen of hearts." An example of ambiguous information is also immediately apparent, e.g., "the box contains some card in the suit of hearts." Furthermore, any example of information about a given set of unknowns can be either correct or incorrect. If the card in the box is the queen of hearts, then both of the above assertions would be correct. On the other hand, if the card in the box is the ace of diamonds, they would both be incorrect. Obviously, incorrect information of any sort is not useful, and the most useful kind of correct information is definite information. However, correct ambiguous information can also be useful, to some extent, until it becomes maximally ambiguous correct information, which contains no definite information at all.

To adequately understand future-viewing machines, definiteness and correctness must always be considered separately. In an initial approach to the topic, two types of devices are encountered first.

One imaginable type of future-viewing machine would display for its operator every possible future, in a decomposable superposition, but would be unable to show which future will be ours. Future-viewing machines of this type have been termed *Everett machines*, for they would only have something to image if an

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ter or through use of a psychomanteum involve other notable future-viewing "devices" from yesteryear (among other possible purposes). However, all of these methods rely upon the state of mind of the individual who employs them. None of these devices were ever thought to be able to access information pertaining to future events on their own. Nevertheless, it is appropriate to consider these tools for enhancing human future-viewing abilities as precursors to the modern concept of a future-viewing machine.

[16]Aeschylus, *Agamemnon*, translated by E. D. A. Morshead, The Harvard Classics, Vol. VIII, Part 1 (New York: P. F. Collier & Son, 1909).

interpretation similar to the Everett interpretation happens to be correct. While such maximally ambiguous future viewers would be fascinating, they would not be outcome-informative. Even with extensive post-processing, data derived from Everett machines could not allow the events of our future to be ascertained.

One might also imagine that there could be another kind of machine which would always be able to give definite and correct information about future outcomes, in every circumstance. Such imaginary machines are called *Cassandra machines* in reference both to Cassandra's mythical ability to see future events perfectly and the tragedies which would threaten if such machines could exist.

Thankfully, it turns out that Cassandra machines are not logically possible; it will be shown that no future-viewing machine whatsoever could always provide information that is both definite and correct in every circumstance of attempted viewing, with respect to every future event. If such a machine were possible, then it would not be possible to imagine a situation which would always foil an arbitrarily powerful future-viewing machine in its efforts to supply information that is both definite and correct. However, just such a situation will now be illustrated.

Consider a setup consisting of a computer which controls a robotic arm that can place a figurine in any of four bins arranged around a circle, labeled 0, 1, 2, and 3. Imagine also that there is an arbitrarily powerful future viewer which will attempt to view where the figurine will be at a particular future time, and that it will pass the corresponding bin number to the computer which controls the arm. There are three timed steps in this thought experiment, separated by five-second intervals. During step one, the future viewer will attempt to detect where the figurine will be ten seconds later, i.e., at the start of step three, then it will immediately pass the corresponding bin number, represented by the variable z, to the computer. During step two, the computer will adjust the position of the figurine according the any of the following four programs:

P_0: Move the figurine to bin $z + 0$ and halt.
P_1: Move the figurine to bin $z + 1$ and halt.
P_2: Move the figurine to bin $z + 2$ and halt.
P_3: Move the figurine to bin $z + 3$ and halt.

These four programs exhaust all repositioning possibilities, since $z + 4$ would produce the same result as $z + 0$. Consider by cases what would happen in a series of experiments employing this setup. In the case of an experimental run involving P_0, any bin number that the future viewer might detect for the step-three position of the figurine and pass on as z will be the number of the bin into which the computer will place the figurine before it halts (if the figurine is not already in bin z), since $z + 0 = z$.

However, under P_1, the experiment would go much differently: If the computer were to receive the value $z = 0$, it would carry out the computation $0 + 1 = 1$ and move the figurine to bin 1 before halting. Of course, this would mean that the z-value supplied by the future viewer had been incorrect. Such an outcome will be referred to as a *viewer-contradicting outcome* (*VCO*). If the computer were to receive the values $z = 1$ or $z = 2$, it would move the figurine to

bin 2 or bin 3, respectively. Lastly, the value $z = 3$ would cause the computer to move the figurine to bin 0, since the successor of 3 in this cyclical arrangement is 0. So, a VCO will occur for all z-values. As a result, under P_1, every definite z-value will be incorrect; they all lead to VCOs. Therefore, a situation "which would always foil an arbitrarily powerful future-viewing machine in its efforts to supply information that is both definite and correct," has been shown. Under P_1 (just as with P_2 and P_3), the only way any kind of future-viewing machine whatsoever could supply correct information to the computer would be for it to supply ambiguous information.

Since no future-viewing machine could supply definite and correct information about every future outcome in every circumstance, no future-viewing machine could fulfill the definition of a Cassandra machine. Cassandra machines are not logically possible.

On the other hand, there is no similar logical problem with the concept of Everett machines. Since Everett machines always show all future possibilities, the only outcomes they could fail to show are impossible outcomes. However, Everett machines would not be outcome-informative: At best, post-processing Everett machine data could yield only probability assessments.

Any outcome-informative future-viewing machine technology must have the ability to access definite and correct information about future outcomes, whenever logically possible, and it must never be outcome-misinformative. In other words, any future-viewing machine that could ever provide information that will lead to a VCO could not be an outcome-informative future-viewing machine.

To understand why this is an intrinsic and essential property of any outcome-informative future-viewing machine, it is merely necessary to recognize the distinction between viewing our future and predicting our future. While a prediction machine which occasionally produces false predictions would still be perfectly serviceable as far as prediction machines go, such a concept does not apply here. Outcome-informative future-viewing machines would not supply predictions; their function would be to allow future outcomes to be seen directly, in situations where it would be logically possible to do so.

Upon the above analysis, three features common to any engineerable outcome-informative future-viewing machine may be specified: (1) Such a device must be logically possible, unlike a Cassandra machine, (2) it must be outcome-informative, unlike an Everett machine, and (3) the principles of its operation must ensure that it will never be outcome-misinformative. Due to these three essential properties, a third category is needed to accommodate engineerable outcome-informative future-viewing machines. Devices of this third category have been termed *foreknowledge machines*.

If one actually possessed a foreknowledge machine, it could be used to gain definite and correct information about many future outcomes (but, of course, not all of them). The term that will be used throughout to specify definite and correct information about future outcomes from foreknowledge machines is *viewer foreknowledge*. All instances of definite information pertaining to future outcomes derived from foreknowledge machines must be correct information, since foreknowledge machines are never outcome-misinformative. Thus, viewer

foreknowledge could always be identified as viewer foreknowledge whenever it would be received, and no instance of information derived from a foreknowledge machine could masquerade as viewer foreknowledge.

Of course, any proof which establishes that Cassandra machines are not logically possible also establishes that foreknowledge machines would not be able to supply viewer foreknowledge in every circumstance. Foreknowledge machines would have two modes of operation to accommodate the two kinds of circumstances in which they could be employed.

These two kinds of circumstances have been termed *non-interference viewing scenarios*, exemplified in the above thought experiment by what happens during runs of the non-interfering program, P_0, and *interference viewing scenarios*, exemplified by what happens during runs of the remaining three, interfering programs. The first and most vital point is that viewer foreknowledge pertaining to a given set of outcomes could only be derived from foreknowledge machines when they are used in non-interference viewing scenarios. In all cases involving interference viewing scenarios with respect to a given set of outcomes, at best, foreknowledge machines would only be able to supply ambiguous information about what will happen, that is, if foreknowledge machines could deliver any information at all when they are faced with interference viewing scenarios.

One must also understand that two foreknowledge machines which have been directed to view the same future outcome could easily be in different viewing scenarios with respect to that outcome, based on the details of the respective viewing instances. Intricacies of these matters will be explained after a brief introduction to the basics of Gödelian time travel.

Gödelian Time Travel and Foreknowledge Machines

It turns out that an adequate understanding of Gödelian time travel is vital in the conceptual analysis of foreknowledge machines, for reasons that will soon be clarified. Throughout the following discussion, 'pastward time travel' will refer exclusively to Gödelian time travel; all of the absurd and misleading concepts of time travel so prevalent in fiction and science documentaries are irrelevant here. When one attempts to understand pastward time travel, it is necessary to begin with the understanding that our past is fixed. The idea that the year 3000 B.C. could happen once without time travelers, and then could somehow happen again if an intrepid chrononaut were to "ever" pay it a visit, describes a kind of nonsense known as the "second-time-around fallacy."[17] The following quotation, from philosopher Larry Dwyer, presents a sensible way to think about pastward time travel:

> If we hypothesize that T pulls levers and manipulates a rocket in 1974, and travels back in time to the year 3000 B.C. then of course, even before T enters his rocket, it is true that any accurate catalogue of all the events on earth during the year 3000 B.C. would include

[17]This term was coined in 1997 by Nicholas J. Smith. Smith, N. J. J. "Bananas Enough for Time Travel?" *British Journal of the Philosophy of Science*, 48 (1997): 363-389.

> an account of T's actions, reactions and mental processes. There is no question of the year 3000 B.C. occurring more than once.[18]

Why is understanding pastward time travel vital for understanding foreknowledge machines? The reason is that future-viewing and pastward time travel are intimately related. To see this, consider that the existence of pastward time travel would mean that it would be possible for information to be delivered to us from our future. So, the seemingly separate observations, that all the troublesome issues of time travel involve traveling back in time and all the troublesome issues of "time viewing"[19] involve attempts to view our future, may be seen as two aspects of a single conundrum.

Any informed discussion of Gödelian time travel must involve *closed timelike curves* (*CTCs*). CTCs are "trajectories in spacetime that effectively travel backwards in time: a test particle following a CTC can in principle interact with its former self in the past."[20]

The contributions of Igor Novikov are vital for understanding CTCs. An influential 1990 article co-authored by luminaries in the field including Novikov,[21] presented a principle that the physics community eventually named the Novikov self-consistency principle, since he began developing the idea in the 1970s. This excerpt, wherein 'global' and 'globally' refer to the whole of spacetime, contains information about the origin of the principle and its final formulation:

> Events on a CTC are already guaranteed to be self-consistent, Novikov argued; they influence each other around the closed curve in a self-adjusted, cyclical, self-consistent way. The other authors recently have arrived at the same viewpoint.
>
> We shall embody this viewpoint in a *principle of self-consistency*, which states that *the only solutions to the laws of physics that can occur locally in the real Universe are those which are globally self-consistent*. This principle allows one to build a local solution to the equations of physics only if that local solution can be extended to be part of a (not necessarily unique) global solution...[22]

So, what exactly have physicists discovered about Gödelian time travel which eliminates any chance of paradox? Science-fiction author Robert Heinlein was possibly the first thinker to express how nature could both allow pastward time travel and enforce non-paradox. He revealed this answer in a conversation between two characters in his 1964 novel, *Farnham's Freehold*:

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[18] Dwyer, L., "Time Travel and Changing the Past," *Philosophical Studies: An International Journal for Philosophy in the Analytic Tradition*, 27 (1975): 341-350.

[19] This term may be found on page 283 in Paul Nahin's definitive time travel compendium. It can be used to refer both to instruments that allow us to see into our past, such as telescopes, and instruments that would allow us to see into our future. Nahin, P., *Time Machines: Time Travel in Physics, Metaphysics, and Science Fiction*, (New York: Springer-Verlag, 1999).

[20] Lloyd, S., et al., "Closed timelike curves via postselection: theory and experimental demonstration," *arXiv*:1005.2219 (2010): 5 pages.

[21] Friedman, J., et al., "Cauchy problem in spacetimes with closed timelike curves," *Physical Review D*, 42 (1990): 1915-1930.

[22] Ibid.

> "The way I see it, there are no paradoxes in time travel, there can't be. If we are going to make this time jump, then we already did; that's what happened. And if it doesn't work, then it's because it didn't happen."
>
> "But it hasn't happened yet. Therefore, you are saying it didn't happen, so it can't happen. That's what I said."
>
> "No, no! We don't know whether it has already happened or not. If it did, it will. If it didn't, it won't."[23]

In other words, at any given time τ, time machines could only be used to fulfill pastward journeys that, by time τ, are already part of "any accurate catalogue of all the events" of τ's past. So, any pastward trip that could be successfully initiated at τ can only involve events and cause effects that are already part of the history of τ.

Heinlein's insight can be used to show that all arguments against pastward time travel which reference past-alteration paradoxes are straw man arguments. While such arguments certainly rule out what might be called "past-alteration time travel," a very flimsy straw man indeed, they cannot be applied to the consistent kind of time travel Heinlein envisioned. Experts now understand that it would only be possible to use a time machine to artificially establish CTCs (necessarily within some supportive topological context)[24] if a fundamental mechanism that would enforce a globally consistent result has been satisfied. In cases where such a mechanism would not be satisfied, no time machine would be able to establish the required CTCs.

An international team headed by MIT quantum engineer, Seth Lloyd, presented pivotal work on CTC formation in three papers published in 2010 and 2011.[25] CTCs have become a mainstream issue for physicists, as their 2011

[23]Heinlein, R., *Farnham's Freehold*, (New York: G. P. Putnam's Sons, 1964).

[24]The solutions Gödel found in 1949 describe spacetimes that incorporate CTCs as a normal part of their four-dimensional topology. He noted in his paper that, "it is theoretically possible in these worlds to travel into the past, or otherwise influence the past." Since CTCs are ubiquitous in such spacetimes, one would only require a fast spaceship and knowledge of the required trajectories in order to navigate into past environments. Due to some of the details of the solutions Gödel found, the worlds they describe do not resemble our own (as Gödel himself noted in 1952). However, by arriving at these solutions, Gödel established by example that general relativity does not rule out pastward time travel. In our world, Gödelian time travel would require more than just a fast spaceship and a well-informed navigator; we would need to find a way to induce a context for establishing and sustaining CTCs. Such a context would have to involve a topological modification of spacetime, so Gödelian time travel would seem to require the formation of an "opening" in spacetime. For this purpose, one may imagine a permanently stationed machine that is able to establish and sustain CTC-bearing hyperdimensional tunnels or portals (i.e., tunnels with very short throats). Gödel, K., "An Example of a New Type of Cosmological Solutions of Einstein's Field Equations of Gravitation," Reviews of Modern Physics, 21 (1949): 447-450. Gödel, K., "Rotating Universes in General Relativity Theory," *Proceedings of the International Congress of Mathematicians*, 1 (1952): 175-181.

[25]Lloyd, S., et al., "Closed timelike curves via postselection: theory and experimental demonstration," *arXiv*:1005.2219 (2010): 5 pages. Lloyd, S., et al., "Quantum mechanics of time travel through post-selected teleportation," *Physical Review D*, 84 (2010): 11 pages. Lloyd, S., et al., "Closed Timelike Curves via Postselection: Theory and Experimental Test

article points out; "CTCs appear in many solutions of Einstein's field equations and any future quantum version of general relativity will have to reconcile them with the requirements of quantum mechanics."[26] These papers propose a quantum model of CTC formation based upon, "a projective or postselected CTC, or P-CTC," i.e., the "P-CTC model."[27] Postselection is a procedure of selecting a subset of experimental trials for further analysis, based on whether certain conditions have been met. By combining quantum teleportation[28] with postselection in a novel experiment, they found a way to simulate attempts to cause paradoxes via time travel:

> We now analyze how P-CTCs deal with time travel paradoxes. In the grandfather paradox, the time traveler goes back in time and kills her grandfather [before her father is conceived], so she cannot be born and cannot kill anyone: a logical contradiction. This paradox can be implemented through a quantum circuit where a "living" qubit (i.e., a bit in the state 1), goes back in time and tries to "kill" itself, i.e., flip to the state 0...[29]

To see how nature responds when faced with an attempt to cause a contradiction in the context of quantum teleportation, they began by measuring the polarization state of a photon before attempting to transfer its quantum information to another photon. In trials which led to successful quantum teleportation (i.e., the trials to be postselected), they would also measure the polarization state of the receiving photon. A parameter known as the "quantum gun angle"[30] was adjusted to increase the likelihood that these polarization values would disagree, but adjustments in this direction would always proportionally decrease the chance that quantum teleportation would succeed. In all cases of successful quantum teleportation, the two measured polarization values were found to match. The implications for Gödelian time travel are clear, but the question remains, what kind of mechanism could be involved in CTC formation which could enforce globally consistent CTCs?

Physicist David Pegg argued in 2005 that paradox-associated CTCs would correspond to destructive interference of quantum mechanical amplitudes, such that they would have a zero probability of formation. He explains this reasoning in the concluding remarks of his paper:

> It is not totally surprising that a principle applying to classical physics has a quantum mechanical basis. The classical principle of

of Consistency," *Physical Review Letters*, 106 (2011): 4 pages.

[26]Lloyd, S., et al., "Closed Timelike Curves via Postselection: Theory and Experimental Test of Consistency," *Physical Review Letters*, 106 (2011): 4 pages.

[27]Ibid.

[28]Quantum teleportation is the name given to the non-classical transfer of quantum information from one quantum system, such as a photon, to another quantum system of the same type. Bennett, C. H., et al., "Teleporting an Unknown Quantum State via Dual Classical and Einstein-Podolsky-Rosen Channels," *Physical Review Letters*, 70 (1993): 1895-1899.

[29]Lloyd, S., et al., "Closed Timelike Curves via Postselection: Theory and Experimental Test of Consistency," *Physical Review Letters*, 106 (2011): 4 pages.

[30]Ibid.

> least action can be explained in terms of the addition of amplitudes associated with all possible paths. The amplitudes for all paths except for those in the region of the path of least action cancel, so the probability for finding that the system has taken a path not near the path of least action is zero. This explains how the system "knows" to take the path of least action. In this paper we suggest that closed causal cycles are sorted out by a similar mechanism. Only those cycles with a net non-zero amplitude have a non-zero probability of occurring and these are the consistent cycles. In conclusion, rather than just being invoked to save the possibility of the present shaping the past, it now seems that the principle of self consistency could well have a solid physical basis in quantum mechanics.[31]

Foreknowledge Machines in Greater Detail

Many experiments in quantum mechanics involve half-silvered mirrors. When a half-silvered mirror is placed in a beam of light, half of the photons will reflect and the rest will pass through. So, when single photons are sent to interact with a half-silvered mirror they have an equal chance of reflecting or passing through, but there is no way to predict which of these two results will occur in any given case. Without foreknowledge machines, it is only possible to ascertain reflection or transmission of a photon in a given run of an experiment involving a half-silvered mirror strictly after that run is over. The Schrödinger equation cannot be used to predict, much less ascertain, the outcome of any particular run.

However, a foreknowledge machine operator monitoring future runs of such an experiment would be able to receive viewer foreknowledge detailing precisely which photons will reflect and which photons will pass through. This is because every instance of viewer foreknowledge must match the outcome to which it pertains, since the reception of viewer foreknowledge simply means that a given attempt to measure an event from our future has been successful. Just as we can currently find out, after the fact, whether a photon has reflected or has passed through a half-silvered mirror by having performed a measurement with detectors, the reception of viewer foreknowledge may one day allow us to monitor detectors in experiments, and conduct any other kind of empirical evaluation, from a far earlier vantage. With current technology, once the result of a measurement is available to us, whatever has been measured must already be part of our past. Foreknowledge machines would, whenever possible, simply give us the ability to measure the events of our future, allowing us to become just as certain about them as we are about any of the past events we have measured. It stands to reason, then, that viewer foreknowledge could only emerge from the kind of "self-adjusted, cyclical, self-consistent" process that Novikov proposed, which plays a role in the P-CTC model and which governs whether it will be possible

[31] Pegg, D. T., "Quantum Mechanics and the Time Travel Paradox," *arXiv*:0506141 (2005): 18 pages.

to initiate CTCs in the case of Gödelian time travel. So, viewer foreknowledge will always detail corresponding future events precisely, since CTCs can only be sustained, and due to related or identical processes, viewer foreknowledge will only be obtainable, under conditions of total quantum agreement.

This unified understanding explains both why paradox is impossible in the context of Gödelian time travel and why viewer foreknowledge, once received, is inviolable. All the events revealed in viewer foreknowledge will occur with certainty, and no effort to prevent or change such outcomes could possibly succeed. Any efforts to prevent or change such outcomes, if there will be any, would have already factored into the details of the viewer foreknowledge that had originally been received.

The impossibility of preventing outcomes that have been received in viewer foreknowledge might seem to be a troubling pronouncement, but the ever-present alternative, that an operator might encounter an interference viewing scenario instead, means that this feature is not a cause for concern. Foreknowledge machines would merely be instruments for information retrieval, nothing more and nothing less; they would not and could not exert any direct influence over people or events. This will be referred to as the *principle of independence*.

Notice that a corresponding principle could not be advanced for Cassandra machines, for they are incapable of preserving any latitude of action afforded by an unknown future. Since Cassandra machines can never be wrong and must always show definite outcomes, every future outcome that imaginary Cassandra machine operators might receive would be utterly locked in, even if they have been shown that they will have an accident. Just as no one will ever have to explain the geometrical peculiarities of round squares, no one will ever have to explain how Cassandra machines occasionally manage to induce amnesia or control people against their wills.

On the other hand, foreknowledge machines would not control people or future events at all. The principle of independence affirms that the only reason future outcomes would eventually be found to agree with viewer foreknowledge is because foreknowledge machines in non-interference viewing scenarios allowed operators to witness those very outcomes, just as a pair of binoculars allows one to witness the behaviors of a distant bird. A birdwatcher does not wonder if bird images control birds; it is obvious to us that optics works the other way around. Given sufficient familiarity with foreknowledge machines, all the effects they might appear to exert on decisions, and thus any influence they might seem to have upon our future, would come to be understood correctly. Future-sighted groups that adopt the principle of independence would find that it will never let them down, and any other interpretation of causal ordering would be ruled out by the most basic knowledge of the mechanisms behind the operation of foreknowledge machines.

It was suggested in the introduction that outcome-informative future-viewing machines could be used to eliminate certain kinds of negative outcomes. Specifically, they could be used to eliminate many categories of accidents and willful tragedies.

To begin to explain the reasoning behind this attractive potential, it must

be pointed out that viewer foreknowledge pertaining to any set of events that will not occur could not be derived from foreknowledge machines. By definition, viewer foreknowledge can only detail outcomes that will occur, so foreknowledge machines could not be used to somehow scan our future for accidents or willful tragedies in order so that they could be avoided.

However, when a given course of action will lead to the safe achievement of a given objective, in the context of proper procedures, it would be possible to find this outcome in viewer foreknowledge even before that course of action has been initiated. On the other hand, whenever an interference viewing scenario would arise to prevent confirmation that a given course of action will result in the safe achievement of some desired objective, a different course of action to achieve the same objective could be arranged. In turn, the outcome of this new circumstance would be checked, and so on, until viewer foreknowledge which establishes that the objective will be safely achieved has been received. Access to viewer foreknowledge would enable a society to eliminate accidents and willful tragedies whenever this "safety confirmation or circumstance change" model could be applied.

Consider air travel situations, for instance, where departure and arrival times and locations are all established beforehand. In such situations, the practice of obtaining viewer foreknowledge of each flight safely reaching its destination could be adopted as a standard procedure prior to authorizing vehicles for departure. Of course, in this certification process, if an interference viewing scenario were to arise which would prevent confirmation that a given flight will safely reach its destination, that flight would be canceled and a contingency flight would be arranged and checked.

This same kind of methodology could also be applied to eliminate serious work-related injuries. Contractor cost over-runs could also be phased out, by employing foreknowledge machines at the bidding stage. These simple examples already suggest that the widespread adoption of foreknowledge machines envisioned here would vastly improve societal efficiency and well-being.

Two Fundamental Kinds of Civilizations

Any group or civilization that universally comprehends and utilizes foreknowledge machines or has some equivalent set of capabilities will be referred to as *future-sighted*. All other kinds of groups or civilizations will be referred to as *future-blind*. Upon these definitions, a civilization would not qualify as a future-sighted civilization until the existence of foreknowledge machines has become common knowledge and access to viewer foreknowledge has been declared a basic sentient right.

So, even if secret future-sighted groups operate behind the scenes within a given civilization, that civilization would still essentially be future-blind. This important transitional stage between a future-blind civilization and a future-sighted civilization will be discussed in detail below, after several further considerations have been presented.

Interference Viewing Scenarios

Several new terms are required. An *outcome-isolated foreknowledge machine* will be defined as a foreknowledge machine that will not pass information to any automatic system which, in turn, could attempt to use such information to interfere with any outcome that that machine attempts to future-view. The opposite term will be *outcome-implicated foreknowledge machine*.

The interval of time between reception of a given instance of viewer foreknowledge and the corresponding outcomes will be called the *viewing interval*. At the beginning of every viewing interval, an operator receives viewer foreknowledge of some set of outcomes that will transpire at its conclusion.

An *operator pool* refers to the operator of a foreknowledge machine along with any witnesses (if any) during an instance of attempted future-viewing of outcomes, along with additional individuals (if any) who, during the viewing interval, will be apprised of the results or who will be instructed or inspired to act based on such results (whether or not they have also been told about the existence of foreknowledge machines). An *outcome-isolated operator pool* is an operator pool that will not interact with the future outcomes which define them as an operator pool following any given future-viewing attempt. Finally, the opposite term will be *outcome-implicated operator pool*.

Using the above terminology, it is possible to make a categorical statement about how operator pools could act to ensure the reception of viewer foreknowledge: Any outcome-isolated operator pool which is receiving information about a given set of future outcomes from any outcome-isolated foreknowledge machine will be participating in a non-interference viewing scenario and will therefore receive viewer foreknowledge of those outcomes. Correspondingly, if either the foreknowledge machine or the operator pool are outcome-implicated during a given instance of attempted future-viewing, an interference viewing scenario may result.

It is vital to observe, however, that outcome implication would not always lead to interference viewing scenarios. The robotic arm thought experiment establishes this, since while the arbitrarily powerful future-viewing machine in it is outcome-implicated throughout, any run involving P_0 nevertheless constitutes a non-interference viewing scenario (causing x to happen and not opposing x are both examples of not interfering with x). Similarly, an outcome-implicated operator pool that plans and orchestrates future outcomes according to what its members have learned in viewer foreknowledge would be operating in a non-interference viewing scenario.

During the viewing interval, exactly when an operator pool forms or would come to include outcome-implicated members is of no importance with respect to the effect that their inclusion would have upon the original attempt to gain viewer foreknowledge of the associated outcomes. This should not be surprising, since whether viewer foreknowledge will be received or an interference viewing scenario will be encountered would always depend upon all the factors which will arise during the viewing interval.

Events on the world stage are obviously important to discuss, but such events

arise from the decisions of individuals, so it is first necessary to understand the relationship between individuals and viewer foreknowledge. For the most part, individuals would be prevented from gaining information about their personal future actions and decisions from foreknowledge machines because anyone whose memories will remain intact could not achieve outcome-isolation with respect to such outcomes. This will be called the *self-implication effect* of viewer foreknowledge. This effect would not always lead to interference viewing scenarios, since it would have a P_0 mode, but it would cause them often enough to prevent people from being able to use foreknowledge machines to "live their lives for them."

One expression of self-implication deserves special mention: No individual could be included in an operator pool that would be able to receive viewer foreknowledge which details that individual's future creative works, since such a severe level of outcome-implication would prevent the ability of the entire pool from accessing such instances of viewer foreknowledge. Detailed reasons to establish why the future originator of any innovation could not see or be told anything specific beforehand about what he or she will originate (at least, not anything that he or she would remain aware of during the relevant creative process or would be able to fully appreciate until after the fact) have been given in *Understanding Future-Viewing Machines and Time Travel*. Interference viewing scenarios would always intervene to prevent any possibility of such a slip, so no operator pool which could gain such information could use it improperly.

In the context of time machines, this general kind of imagined problem is referred to as the "paradox of auto-generated information,"[32] or the "unproved theorem paradox,"[33] but it arguably represents no paradox at all.[34] In this context, another parallel between foreknowledge machines and Gödelian time travel becomes apparent: No time machine could establish the required CTCs to allow future-derived information to be delivered to anyone who would have been prevented by interference viewing scenarios from gaining the same information from a foreknowledge machine.

Although persons who will originate future creative contributions will always automatically be kept in the dark until they have fulfilled their roles, other individuals could possess such works far earlier and could even utilize yet-to-be-invented technologies, whenever they would receive viewer foreknowledge which reveals such information. Whether acquired by using foreknowledge machines or through time travel, anyone who has obtained (or who has brought back) anachronistic information could not use it to short-circuit the developmental

[32]Romero, G. E., Torres, D. F., "Self-existing objects and auto-generated information in chronology-violating space-times: A philosophical discussion," *Modern Physics Letters A*, 16 (2008): 1213-1222.

[33]Lloyd, S., et al., "Closed timelike curves via postselection: theory and experimental demonstration," *arXiv*:1005.2219 (2010): 5 pages. Deutsch, D., "Quantum mechanics near closed timelike lines," *Physical Review D*, 44 (1991): 3197-3217.

[34]Lloyd, S., et al., "Closed Timelike Curves via Postselection: Theory and Experimental Test of Consistency," *Physical Review Letters*, 106 (2011): 4 pages. Feeney, A. M., *Understanding Future-Viewing Machines and Time Travel*, Kindle electronic edition (Buffalo: Aaron M. Feeney, 2014).

continuity of ideas, even accidentally.

So, among many compartmentalized operator pools, the various eras of a future-sighted civilization would be somewhat porous with respect to the technical information, concepts, and artistic works they might access. However, in the public sphere and among the largest operator pools, time periods would be insulated from one another in several important ways that could not be breached. This set of ideas shows that maintaining secrecy is related to fundamental processes and is essential to the conduct of civilization, since the maintenance of secrecy in certain matters must automatically result within, and would be actively practiced by, even the most advanced civilizations.

In this context, it is also interesting to note that secrecy becomes absolutely unbreakable when foreknowledge machines are employed; if viewer foreknowledge reveals that a given fact will remain secret until a certain date, no significant breach prior to that date would be physically possible. This understanding must be balanced with the corresponding concept that the agenda of what will be kept secret, and for how long, would not be a matter that future-sighted secret keepers could arbitrarily decide. Instead, viewer foreknowledge would ultimately set the guaranteed-to-be-compatible agendas of all involved future-sighted groups.

So, it is important to understand something about the content of the outcomes operator pools would receive in viewer foreknowledge. This topic will be addressed in the next section.

With the above background, consider the case of world leaders who might attempt to view personal future decisions which also constitute outcomes on the world stage. While world leaders operating in a future-sighted context would tend to be stymied by self-interference from gaining viewer foreknowledge of upcoming personal decisions that will affect the world stage, nearly everyone else in the world would be able to gain prior knowledge about future world affairs, including such decisions. Along with world leaders, however, a few other people would also be unable to see what such future decisions will be: Whoever would tell a world leader what that leader could not become aware of from any source would also be unable to learn such information from any source.

However, the fact that interference viewing scenarios affect world leaders would not be troubling to anyone. Viewer foreknowledge would leave no room for people to doubt that a given leader will make every future decision just as viewer foreknowledge has shown. So, while the physics of the situation would generally prevent anyone from telling world leaders what they will decide, the same details of physics would also mean that there would never be any reason to do so.

A Matter of Outcomes

To discuss outcomes in the context of viewer foreknowledge, it is important to recognize two categories of desirable outcomes. These categories are familiar to us from personal experiences. Inherently desirable outcomes need no introduc-

tion. On the other hand, a person might occasionally conclude that events which were not desirable in isolation, and which might have even been very painful at the time, nevertheless were essential for making subsequent inherently desirable outcomes possible. This second category of desirable outcomes will be termed *contextually desirable outcomes*. These two categories of desirable outcomes would also be evident in viewer foreknowledge.

Consider an analogy here: Making large incisions in a man's abdomen to expose his internal organs is not an inherently desirable state of affairs. However, for a man in the midst of life-saving surgery, these drastic actions are contextually desirable. A surgical procedure is often horrible in appearance, but if the continuation and vast improvement of the life of the patient will be the result, it would not only be morally correct for the surgeon to plan and perform the procedure, it would be wrong for him to withhold it.

It turns out that it is possible to know something definite about the content of the outcomes operator pools would receive in viewer foreknowledge. This understanding will emerge in the course of answering the following question: Is attaining future-sightedness always more advantageous for a civilization than continued future-blindness?

To answer this question, it is helpful to recognize a spectrum between *matters of choice* and *rigid matters*. Matters of choice are matters that beings are able to decide or influence to some degree. Rigid matters are matters that beings cannot manage to influence in order to produce different outcomes, due to limitations in their capabilities with respect to the physical situation at a given time. The advantages that future-sighted civilizations would have in matters of choice and in rigid matters will be presented below in order to answer the question at hand.

Foreknowledge machines cannot misinform and cannot control behavior in any way. These essential properties combine to produce a constant of viewer foreknowledge: Total agreement between the future outcomes an operator pool has received in viewer foreknowledge and the outcomes that will result from the course of action they will ultimately choose within the viewing interval is guaranteed, since the (outcome-isolated or outcome-implicated) non-interference viewing scenario they must have achieved in order to have received viewer foreknowledge in the first place requires this match. This constant of viewer foreknowledge will be termed *foreknowledge-decision agreement*. The continual accumulation of the results of this phenomenon for future-sighted civilizations (and future-blind civilizations containing secret future-sighted groups) will be referred to as the *desirable future effect* of viewer foreknowledge.[35]

Over time, foreknowledge-decision agreement will always lead to inherently and contextually desirable outcomes. As these outcomes accumulate, increas-

[35]Due to foreknowledge machine secrecy, future-sighted groups operating within a future-blind civilization would have to evaluate many types of negative outcomes in matters of choice as either neutral or contextually desirable (e.g., normal levels of air accidents). Since a future-sighted civilization would not have any similar reason to accept negative outcomes in matters of choice, and could act to readily eliminate them, the benefits a civilization may derive from the desirable future effect can be expected to vastly increase once access to viewer foreknowledge has become available to all.

ingly desirable future states will emerge for a given civilization.

This background allows the question at hand to be answered. With respect to matters of choice, an operator pool will always choose and achieve what their motivations lead them to achieve among what they will be able to achieve. In many or most cases, operator pools will be unaware of all of the relevant considerations that will factor into their ultimate decisions until the viewing interval is well underway. For some events, the viewing interval could span decades, so there might frequently be a great deal of time for operator pools to deliberate.

A case wherein an operator pool would ultimately end up wishing they could achieve a particular outcome, if only viewer foreknowledge were not "forcing" them to do something else, cannot happen. This follows, for two reasons: First of all, the principle of independence means that no mysterious mechanism generated by foreknowledge machines could stop them from achieving anything they would decide to achieve and would have the resources to achieve. So, an operator pool is always free to choose any course of action they wish to choose. On the other hand, a VCO would result if they were to choose any course of action that would produce an outcome other than what viewer foreknowledge has shown, but VCOs cannot happen with foreknowledge machines. Foreknowledge-decision agreement reconciles these freedoms and constraints; viewer foreknowledge will always be consistent with what an operator pool will ultimately and freely choose, given everything they will discover during a viewing interval.

An operator pool might also receive an outcome in viewer foreknowledge which they initially perceive to be a negative outcome, even though they also see that it will emerge in the context of matters of choice. Such cases could be very alarming for future-sighted parties, at least initially. However, since matters of choice are at issue, in such situations they will always come to realize, during the viewing interval, that what they have received is a contextually desirable outcome. For the most part, the reasons which make a given outcome received in viewer foreknowledge contextually desirable would not initially be clear to an operator pool. However, they would eventually learn why such an outcome is contextually desirable by studying viewer foreknowledge of subsequent outcomes, and all of the discoveries that will lead them to reach that conclusion will be made during the viewing interval.

Of course, there are also rigid matters. Rigid matters facing operator pools could lead to irredeemably negative outcomes for them. However, by definition, since operator pools do not have the capacity to interfere with matters that are rigid matters for them, interference viewing scenarios will not obscure approaching rigid matters from future-sighted civilizations. So, future-sighted civilizations would have the earliest possible warning concerning any rigid matters that approach them, far earlier than prediction or detection methodologies could alert future-blind civilizations.

For these reasons, future-sightedness offers decisive advantages over continued future-blindness for all beings in both matters of choice and in rigid matters. Attaining future-sightedness, then, is always more advantageous for a civilization than continued future-blindness.

Viewer Foreknowledge in a Future-Sighted Society

Interference viewing scenarios prevent the reception of viewer foreknowledge and would thus interrupt the desirable future effect. Assuming outcome-isolated foreknowledge machines, interference viewing scenarios could only arise due to outcome-implicated operator pools. So, to conceive of a way that a civilization as a whole could benefit from the desirable future effect on the world stage, the primary challenge is to discover a method whereby a number of overlapping operator pools, such as might exist in a future-sighted civilization, could possibly maintain the right mix of outcome-isolation and non-interfering outcome-implication to enable them to receive viewer foreknowledge of the very outcomes that some of their members will help bring about.

To propose a method for achieving this, some thoughts about how foreknowledge machines would be utilized by a future-sighted society serve as helpful preliminaries. First of all, it is unlikely that foreknowledge machines would ever be made available directly. Rather than distributing the machines themselves, people would access viewer foreknowledge over the Internet.[36] Foreknowledge machines would be connected to servers to ensure that appropriate limitations with regard to the future spacetime coordinates that would be accessible, in any given case, could be maintained. For instance, legislation would likely be enacted to render residences, businesses, schools, and government buildings strictly inaccessible to foreknowledge machine probing, except in extraordinary circumstances sanctioned by law.

Different limitations would govern the use of machines for visually probing our local past, which have long been referred to as chronovisors. (For more detail about the concept of chronovisors, see *Understanding Future-Viewing Machines and Time Travel*.) Chronovisors are an important auxiliary technology for future-sighted civilizations. The servers governing chronovisors might be programmed to make all recent parts of our past inaccessible, unless an event-limited warrant or historical research license has been issued, while time periods more than two centuries in our past, for example, would be at least partially open to historians, documentary film-makers, scientists, and a curious public. While public spaces would become accessible after such an amount of time has

[36] Though many individuals would become very skilled at operating foreknowledge machines in order to explore viewer foreknowledge firsthand, many people would be content watching compilations of viewer foreknowledge discovered and assembled by others. It is interesting to note, however, that these compilations could not be distributed in the form of standard videos. Though recording viewer foreknowledge would not be at all problematic in and of itself, successfully recording a video of viewer foreknowledge and distributing it during the viewing interval is an unlikely combination, since wide distribution during the viewing interval would tend to cause an interference viewing scenario and ruin the original attempt to make the recording. For outcome-isolated individuals, compilations of viewer foreknowledge would appear to be standard videos, but they would not be video recordings at all. Instead, they would consist of instructions for foreknowledge machines, containing all spacetime coordinates and vantages, so that all of the various instances of viewer foreknowledge in a compilation could be freshly received in the specified order. If live viewer foreknowledge reconstructions are used to present compilations of viewer foreknowledge in this way, any interference viewing scenarios which might happen to arise for a given party would not affect other parties.

passed, governmental and residential privacy should be maintained permanently.

These kinds of limitations would be fully justified on the basis that totally unrestricted foreknowledge machines and chronovisors would allow anyone to spy on what people will do or have done in the privacy of their homes and easily carry out corporate or governmental espionage. As a result, placing the described kinds of limitations upon the coordinates that foreknowledge machines and chronovisors could probe would be entirely appropriate. With such controls in place, the following way of preserving the desirable future effect could also emerge:

An important activity for any society is that of electing its leaders. As a matter of course, all buildings which house voting booths would be rendered inaccessible to foreknowledge machine or chronovisor probing. This measure alone would allow a society to benefit from the desirable future effect on a large scale, since it would mean that voters could not encounter any kind of interference with regard to their personal contributions to world events, i.e., their votes. Well before an election has occurred, voters who will not play direct and individually significant roles in the coming administration could know virtually unlimited specifics regarding what the major future world events will be, beginning with who will win the election, as well as how the coming administration will handle things.

This set of ideas takes some getting used to, but notice that the collective desires of the preponderance of voters with access to viewer foreknowledge would automatically be served, considering everything that would be accessible to them before the polls open. Administrations which would have carried out policies inconsistent with a nation of future-sighted voters would automatically be factored out of our future, similar to the way in which destructive interference serves to make the formation of inconsistent CTCs impossible.

One might attempt to argue that widespread knowledge regarding the outcome of an election would eliminate any possibility that voters could genuinely choose. However, this is not the case. Voters would still experience the accustomed uncertainty concerning who will win before they have joined an informed operator pool, and most importantly, all of their voting decisions would remain theirs alone to make.

In order for voters to have a choice in a future-sighted context, it would also have to be rational for some voters to want to vote for candidates they know will lose. This presents no problem at all. People have always found reasons to vote for candidates they know will lose to a virtual certainty, and such motivations would not be interrupted by the absolute certainty that foreknowledge machines would provide. Voters choose to vote for a losing candidate in order to express preferences and to help give momentum to an underdog politician or party, and these same justifications would hold in a future-sighted context.

With all of these considerations in place, it is reasonable to conclude that the desirable future effect could be retained, at least with respect to the overarching context within which elected officials must earn the periodic support of citizenry to operate. In a future-sighted context, no candidate could merely appear to be the right candidate, but fail to deliver; a winning candidate would always go on

to actually deliver, or that candidate simply would not have shown up in viewer foreknowledge as the winning candidate in the first place.

The Transition to a Future-Sighted Civilization

Between a future-blind civilization and a future-sighted civilization, a transitional stage may exist which will be referred to as a *predominately future-blind civilization*, i.e., a future-blind civilization that contains one or more secret future-sighted groups. Secret future-sighted groups within a predominately future-blind civilization would come to know our (inherently or contextually desirable) future and would accept the enormous responsibility of overseeing all the stages of transition to that future, which in some cases might include P_0-mode orchestration of outcomes in response to viewer foreknowledge.

No instance of viewer foreknowledge, once received, can ever be lost to a future-sighted group, since every instance of viewer foreknowledge would have only been available to a given operator pool in the first place if all intervening factors (including all of their decisions and capabilities) will indeed result in the corresponding outcomes. The initial reception of viewer foreknowledge by a secret future-sighted group establishes that they will sustain their role in the associated outcomes, whatever that role may be. Furthermore, and most importantly, the nature of viewer foreknowledge guarantees that secret future-sighted groups will incorporate every outcome they have received into their agendas.

The desirable future effect leads to at least two major beneficial outcomes stemming from matters of choice for any predominately future-blind civilization. First and foremost, if future-sightedness has been achieved early enough with respect to the world situation, utter nuclear catastrophe and other threats to the very survival of the species or the continuation of the civilization will be permanently averted. Once all associated interference viewing scenarios have cleared and it can be seen both that this most important objective has been accomplished and that no outcomes stemming from rigid matters will destroy or disrupt the civilization, then, another beneficial outcome of vast importance in the realm of matters of choice must also eventually occur: Such a triumphantly enduring civilization will gradually transform itself, without any possibility of failure, into a future-sighted civilization.

The first of these achievements is what future-viewing machines would have been built to accomplish in the first place. The second achievement is something a secret future-sighted group or groups might not have expected before learning of its immanent approach in viewer foreknowledge. Of course, an entirely future-blind civilization that manages to avoid the threat of nuclear destruction by sheer luck might become a future-sighted civilization without the transitional step of being supported by secret future-sighted groups. The point here, however, is that an enduring predominately future-blind civilization will eventually achieve future-sightedness with certainty.

All of the most desirable futures for a civilization are predicated upon its

transition to future-sightedness. As a result, continued secret use of foreknowledge machines will always gradually move the surrounding civilization toward such an outcome. No secret future-sighted group could both continue to use foreknowledge machines and permanently manage to keep foreknowledge machines secret. This is because continued use of foreknowledge machines always leads to an accumulation of desirable outcomes, and this progression must eventually exhaust the meager options for desirable futures available to a predominately future-blind civilization. As a result, any enduring predominately future-blind civilization will eventually become a future-sighted civilization, sooner or later.

So, every secret future-sighted group within an enduring predominately future-blind civilization will receive viewer foreknowledge which shows that foreknowledge machine proliferation will occur. For this reason, foreknowledge machine proliferation must eventually become one of the top priorities of all secret future-sighted groups. However, secret future-sighted groups could not act to accelerate the transition to future-sightedness by sharing foreknowledge machines with the world themselves if they have seen that foreknowledge machine proliferation will occur in a different manner. They might find instead that they will have to wait for isolated thinkers among the future-blind masses to realize and suggest that foreknowledge machines are possible, and watch as the topic is initially ignored or ridiculed and then as all the associated ideas are debated, knowing all the while that insightful scientists and engineers will eventually succeed to end all debate by producing a working prototype.

This section has so far discussed issues which would apply to any civilization. Referring to our world in particular, while future-viewing machines were probably once a topic of great sensitivity, this state of affairs has apparently changed: If secret future-sighted groups do exist, then they must consider the introduction of detailed works which explicitly describe foreknowledge machines and advocate that they should be reinvented and utilized for the elevation of humanity to be a desirable state of affairs, at least contextually. On the other hand, if there are no secret future-sighted groups, then discussing future-viewing machines is akin to discussing matters of science fiction. Either way, everyone should feel free to discuss foreknowledge machines and publicize all the breakthroughs that will be required as we progress toward their possible realization, in an atmosphere of open inquiry.

The End of War

When an organism has internal problems that hinder its life, we call these problems symptoms. If a cause of all the symptoms can be identified, that cause is called a disease. Unfortunately, there is no similar set of terms for civilizations. However, as a civilization, we have plenty of internal problems that hinder our collective life, and most of these problems would not be allowed to continue in future-sightedness.

In addition to the beneficial effects already discussed, such as the elimination of many kinds of accidents and the transformation of business and pol-

itics, widespread future-sightedness would also essentially lead to the end of all forms of war. Future-sighted civilizations will never sub-divide themselves into factions that could ever be convinced to go to war with one another, since future-sighted groups always approach major outcomes by accessing viewer foreknowledge. Viewer foreknowledge of outcomes involving interactions between any two future-sighted groups would essentially put them in a common operator pool with respect to those outcomes. So, all major pending interactions between any two future-sighted groups within a future-sighted civilization would always "already" be settled in a mutually agreeable fashion as soon as operator pools would come to learn anything about what those future interactions will be. How, then, could destructive disagreements arise?

Now, consider the interactions of entire future-sighted civilizations. When two future-sighted civilizations would meet for the first time, each civilization would have already learned of this upcoming event of major importance in viewer foreknowledge and thus would have already merged into a common operator pool before meeting. So, two future-sighted civilizations will always meet peacefully, and enjoy mutually agreeable interactions. It would also be possible for representatives from each civilization to learn the language and customs of the other, at least in a rudimentary fashion, before meeting. They could accomplish this by gaining viewer foreknowledge of lessons prepared for them at a later time by fully informed specialists. So, it is clear that any two future-sighted civilizations will meet in peace and mutual understanding and will never engage in warfare with one another throughout the entirety of their relationship. Whenever and wherever future-sighted civilizations come together, they will essentially operate in complete accord.

Of course, future-sighted civilizations could also encounter future-blind civilizations, although probably much less frequently than they would encounter other future-sighted civilizations.[37] Future-sighted civilizations would certainly be interested in keeping an eye on any future-blind or predominately future-blind civilizations they would discover, due to the inherent instability of the condition of future-blindness. However, no future-sighted civilization would consider a fledgling future-blind civilization to be a potentially unmanageable threat. The relationship of a future-sighted civilization to a future-blind civilization would be similar to that of a nurse and a newborn she is caring for, a nurse who wants to ensure that the newborn will rest safely until it opens its eyes and

[37]This is because, if foreknowledge machines can be constructed at all, only those civilizations which do not know any better would choose to remain future-blind for very long, since future-blindness is such an inherently dangerous and problematic state. The combination of future-blindness and nuclear weapons is a recipe for extinction, and it does not take long for an intelligent civilization to progress to the point of splitting the atom. Once nuclear weapons have been invented, it seems that there are essentially only two ultimate outcomes: future-sightedness or oblivion. For these reasons, intelligent future-blind civilizations are characteristically ephemeral, one way or another. On the other hand, no similar limitations would apply to civilizations that have achieved future-sightedness, and furthermore, they would be welcome to spread throughout the universe. On the basis of these considerations regarding the relative durability of the two fundamental kinds of civilizations, one would expect intelligent future-blind civilizations to be quite rare among civilizations in general.

begins to become aware of the world. For this reason, she will see to it that the newborn will remain unaware of her until morning. Warfare is essentially over for a future-sighted civilization.

These considerations, of course, provide a direct answer to Fermi's question. Circa 1950, when Enrico Fermi and other scientists were discussing the possibility of intelligent extraterrestrials, favorable estimates of the number of possible habitats in our galaxy and the vastness of time caused him to wonder, "Where is everybody?"[38]

The answer in this context is clear. Nearly all future-blind civilizations would be just starting out (like ourselves) and so it is unlikely that any future-blind civilization would have the technology to get here. On the other hand, while many future-sighted civilizations could get here, even if future-sighted beings did happen to come to a system which harbors a future-blind civilization or a predominately future-blind civilization, they would want to avoid meeting or otherwise capturing the full attention of its unpredictable and reactionary future-blind population(s). After all, future-sighted civilizations could not use foreknowledge machines to see what would happen among outcomes that will not occur, and even if they were to resort to post-processing Everett machine data to assess alternative courses of action, such a technique could not deliver any guarantees. So, a future-sighted civilization would not have any means of acquiring sufficient assurance that initiating first contact with a future-blind civilization would not be ruinous to that civilization or extremely inconvenient for themselves. Simply waiting for a given future-blind or predominately future-blind civilization to achieve future-sightedness appears to be the only way that future-sighted civilizations could guarantee acceptable and mutually beneficial outcomes in such situations. Keep in mind, also, that a future-sighted civilization would be able to know all along, potentially even thousands of years beforehand, just when a given future-blind or predominately future-blind civilization will become future-sighted.

As for us, extraterrestrial future-sighted civilizations may have taken a stance of interest in us long ago and may well be monitoring our activities, possibly to ensure our survival. If any future-sighted civilizations are interested in us, they also would almost certainly want to make sure that all of the potentially devastating effects of our future-blindness will remain confined to our planet and its immediate neighborhood. According to these ideas, our current loneliness is only to be expected. In all likelihood, our efforts to achieve first contact with intelligent beings from other worlds will be met with frustration until sometime after we have become a future-sighted civilization.

While the full process of transition to future-sightedness for any future-blind civilization would culminate in the cessation of warfare, the predominately future-blind stage leading to this supremely fortunate outcome would probably last for several decades and would certainly be fraught with difficulties. Along with all the other frustrating problems which afflict future-blind civilizations,

[38] Jones, E. M., "'Where is everybody?' An account of Fermi's question." (Los Alamos, NM: Los Alamos National Laboratory, 1985).

warfare would continue during this transition, but only in cases where at least one faction is entirely future-blind. During this period, no two secret future-sighted groups (or secretly future-sighted nations which benefit from capabilities which might very well remain unknown to their leaders) would go to war with one another or truly operate at cross purposes, regardless of any appearance of frosty relations. Prospects for the future of such a civilization may well appear grim during such a period. However, the support of secret future-sighted groups would mean that such a world would be moving, without any possibility of failure, toward the kind of amazingly bright future that future-sightedness grants to all civilizations.

Looking Forward

For these concluding remarks, foreknowledge machines will be presented as an immanent technology, rather than as a purely hypothetical technological concept. Some readers may wish to interpret this shift in presentation as pure fantasy, but others might agree (and still others might know) that such a profound change is likely to become (or will become) an important aspect of our future.

Foreknowledge machines could emerge within a generation. To bring this about, physicists will need to uncover all of the principles that could allow foreknowledge machines to be constructed,[39] and talented engineers will need to devise ways of properly engaging such principles in their designs.

This is surely our best course of action. A population best prepares itself to learn of profound technological advances, and proves that the time has arrived for everyone to learn of such technologies, simply by achieving such advances. Inventing all of the key technologies for vastly improving our world appears to be up to us, and we should not let the idea that we may be several decades "behind the curve" with respect to secret work discourage us. On the contrary, this idea should inspire us all the more. With open-mindedness, ingenuity, and focused collaboration, we are fully capable of developing foreknowledge machines and every other awe-inspiring technology that may have been secretly developed in

[39]The following works and their references might contain clues: Feynman, R. P., Wheeler, J. A., "Interaction with the absorber as the mechanism of radiation," *Reviews of Modern Physics*, 17 (1945): 157-181. Peres, A., Schulman, L. S., "Signals from the Future," *International Journal of Theoretical Physics*, 6 (1972): 377-382. van Vlaenderen, K. J., Waser, A., "Generalization of Classical Electrodynamics to Admit a Scalar Field and Longitudinal Waves," *Hadronic Journal*, 24 (2001): 609-629. Sparling, G. A. J., "Germ of a synthesis: space-time is spinoral, extra dimensions are time-like," *Proceedings of the Royal Society A*, 463 (2007): 1665-1679. Pavlov, D. G., Antanasiu, Gh., Balan, V., eds., *Space-Time Structure. Algebra and Geometry*, (Moscow: Lilia-Print, 2007). Kastner, R. E., Cramer, J. G., "Why Everettians Should Appreciate the Transactional Interpretation," *arXiv*:1001.2867v3 (2010): 15 pages. Hall, M. J. W., Deckert, D.-A., Wiseman, H. M., "Quantum Phenomena Modeled by Interactions between Many Classical Worlds," *Physical Review X*, 4 (2014): 17 pages. Tan, D., Weber, S. J., Siddiqi, I., Mølmer, K., Murch, K. W., "Prediction and retrodiction for a continuously monitored superconducting qubit," *arXiv*:1409.0510v2 (2014): 9 pages. Pavlov, D. G., Kokarev, S. S.,"The hyperbolic field theory on the plane of double variable," *arXiv*:1502.06985v1 (2015): 51 pages.

the legendary past.

In this effort, we must be willing to deeply reexamine physics. We should pay careful attention to every turn made during the formative stages of current mainstream thought, since initially hiding powerful new discoveries and the associated theories or theoretical concepts, and keeping them hidden, would be the most effective way to keep all resultant technologies out of general consideration, or at least out of reach. After all, if a series of significant discoveries with enormous implications occurred generations ago in the course of secret experimentation, or as a result of deciphering secreted plans or devices, however obtained, the knowledge gained would have provided exactly the information necessary for designing believable but carefully limited theories which would serve to prevent future generations of scientists from the sorts of experiments that would lead to similar discoveries. Has anything like this occurred during the labyrinthine development of modern science? It is certainly possible.

After all, ever since experiments based on Einstein's work confirmed that Issac Newton's wildly successful (and still very useful) equations are nevertheless incomplete as a description of the workings of nature, scientists have known that incomplete (and thus incorrect) hypotheses which manage to get correct answers within limited contexts can appear correct and satisfactory to scientists who are only aware of such limited contexts. The claim here is not that any of our theories are empirically wrong with respect to any of the contexts we know. Indeed, those are the contexts where our theories have been shown to be correct. Instead, the claim is that there are bound to be contexts outside of anything mainstream science has explored so far, and that if there are such contexts, we will need new theories (which predict the same phenomena as our current theories, and others we have never seen) in order to begin to understand phenomena that are only apparent in those greater contexts.

It is important to recognize that if empirical data happens to be consistent with more than one hypothesis, it cannot be counted as evidence for any hypothesis. Maintaining an environment of conceptual shortsightedness that serves to keep people unaware of the existence of viable theoretical alternatives, or which prevents known theoretical alternatives from being taken seriously, then, is the only way rational thinkers can be kept satisfied (or can satisfy themselves) with incorrect or incomplete theories which happen to be consistent with known experiments. For these reasons, it is incumbent upon us to do everything we can to counteract narrow horizons of thought. Bertrand Russell provided an indispensable technique for both maintaining an empirical foothold and eliminating conceptual shortsightedness during all of our forays into the unknown: "I refuse to affirm the existence of anything for which there is no evidence, but I equally refuse to deny the existence of anything against which there is no evidence."[40]

Since the middle decades of the 20th Century, secret scientific and technological work was initiated on a vast scale. This led to separate scientific-technological contexts, one public and the other secret. While this fact might not be advertised, it is an entirely uncontroversial and obvious reality. Secret

[40]Russell, B., "The Philosophy of Logical Atomism," *The Monist*, 29 (1919): 345-380.

scientific knowledge and technology is decades ahead of what the public understands or even dreams might exist; the gap between secret knowledge and public knowledge has been growing for generations. This is what happens when a two-tier system has existed for so long and the secret tier (which consists of numerous groups around the world) has many of the top minds, compartmentalized access to all secret and secreted sources of information, is tasked with the most ambitious and critically important projects, and has always had thousands of times more funding. That is the reality of the world situation, and there is nothing wrong with it. Frankly, it is how things had to be, and it is how things must continue to operate. Getting up to speed with secret work to whatever degree we can is (and has always been) our responsibility, and the invention or reinvention of foreknowledge machines provides a worthy focus to spur on all the efforts that will be required for us to begin to catch up.

Could it really be true that foreknowledge machines have played a significant role in the behind-the-scenes operation of the world for decades? Such a concept will be difficult for many people to take in. Upon first considering it, one might be tempted to condemn secret future-sighted groups for not preventing any of the worst things that happened. While this is an understandable instinct, such a reaction is inappropriate in terms of the logic of foreknowledge machines; a future-sighted group could not have altered any of the future outcomes they discovered in viewer foreknowledge any more than they could have used a time machine to alter our past.

The outcomes such groups would have seen in viewer foreknowledge could not have been planned by them before the earliest instances of associated viewer foreknowledge had been received, or its logical equivalent. If any future-sighted groups have secretly formed on our planet, rather than condemnation, they deserve our gratitude. If such groups exist, where would we be as a civilization, or would we even still be here at all, if not for what they have achieved?

Any future-sighted groups that may exist will eventually be known and embraced. Even given all of the negative outcomes to emerge in recent memory, by the time the existence of such groups has been confirmed and their history has been revealed, we will have already come to see them in a favorable light. The process of understanding the nature of such groups, in the context of a widespread understanding that the logic of foreknowledge machines serves to clear them of any misplaced concepts of wrongdoing, will begin soon after the proliferation of foreknowledge machine technology.

Foreknowledge machine proliferation is up to us, but in another sense, it is coming. So many profound societal and philosophical developments will accompany its arrival, and everyone will finally learn about a major subtext of recent history. In this process, society will also begin to understand the enormous difficulties that previously secret future-sighted groups endured, first to usher us all to safety, and then to prepare us to finally glimpse our unbounded future.