

RECOVERING A FORGOTTEN PIONEER OF SCIENCE STUDIES: C. E. AYRES' DEWEYAN CRITIQUE OF SCIENCE AND TECHNOLOGY

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ABSTRACT

This paper brings to light the ideas of a pioneering but largely forgotten social critic, C. E. Ayres. In his first book, *Science: The False Messiah* (1927), which was written in consultation with John Dewey, Ayres advanced a forceful and original critique of science and technology. He argued that technological change was occurring at a pace that had overwhelmed existing social institutions, and further claimed that efforts to solve the problem by educating citizens about science and technology would prove fruitless. The analysis presented in this paper outlines Ayres' key arguments, examines the mutual influences between Dewey and Ayres, and makes a case that many of Ayres' innovative arguments remain surprisingly relevant today.

INTRODUCTION

In 1926, C. E. Ayres, a young assistant editor of *The New Republic*, had completed a draft of his first book, *Science: The False Messiah*. His publishers, Bobbs-Merrill, were enthusiastic but also somewhat worried—the book, which was a blistering critique of the public understanding of science, was engagingly written and eminently readable, but it was also provocative. Bobbs-Merrill were concerned that Ayres' "very saucy" approach might damage sales, especially given that he was a complete unknown as far as the general public was concerned; and in order to boost Ayres' credibility and, hence, future sales of the book, they felt that he needed an endorsement.¹ Ayres thus dutifully set about writing to his friendly acquaintance, John Dewey, to whom he had previously shown an early draft of the manuscript. In his letter to Dewey, Ayres grumbled a bit, noting that he was not the sort of person who liked "sidling up to be patted on the head."² But he then asked for the endorsement, commenting to Dewey that "the book is your stuff, however wildly perverted."³ Having long been convinced of Ayres' promise as a scholar, and having already given critical but positive feedback on the early chapters that Ayres had sent him, Dewey agreed to write some favorable text for the book jacket.⁴

Undoubtedly, from Dewey's perspective, his exchange with Ayres was not especially momentous. In the 1920s, at the height of his fame as America's leading public intellectual, Dewey would have received many requests for favors. Yet as I will argue below, Ayres's work did, in fact, have a meaningful impact on Dewey. More importantly, though, Ayres' work was innovative in its own right; although it was, in a very significant sense, "Dewey's stuff," it was also a pioneering effort. In a time when science was coming into its own in the public eye and the philosophy of science (let alone the philosophy of social science) was still nascent, Ayres was a thoughtful, incisive critic of science and technology. His method, as I will show, was a Deweyan one, but Ayres' interpretation of science and technology is genuinely original and substantially less optimistic than that of Dewey.

This analysis will proceed in the following manner. Given that, even amongst Dewey scholars, little is known about Ayres, I will begin by presenting a short biographical sketch. This will be followed by an exposition of the core aspects of the argument offered in *Science: The False Messiah*. I will then explain how Ayres' analysis is Deweyan in its overall orientation—specifically, I will argue that Ayres adopts three important elements of Dewey's analysis in *Experience and Nature*. Finally, I will speculate about how Ayres' analysis may have had an effect on Dewey. In sum, in addition to exploring the nature of Ayres' interactions with Dewey, I hope to highlight the originality of Ayres' account of science and technology, which remains relevant today and in fact anticipated later developments in the field of science studies in a number of important ways.

WHO WAS C. E. AYRES?

Ayres was born in Lowell, Massachusetts in 1891, in a strictly religious Baptist family. After a brilliant career as an undergraduate at Brown, he first came to Dewey's attention in 1916, when he was a doctoral student in philosophy at the University of Chicago. He applied for a dissertation fellowship at Columbia and submitted an essay critical of pragmatism. Although his application for the fellowship was rejected, Dewey, having been impressed with Ayres' essay, wrote Ayres a personal letter promising to gather donations in order to create a special fellowship for him. In the meantime, however, Ayres had already accepted a fellowship at Chicago.⁵

After Ayres completed his doctorate, he went to work as an assistant professor. In brief stints at Amherst and at Reed, Ayres proved to be a successful and popular teacher. However, at each institution he was irritated by administrative changes, and so he decided to go east to take a job as an associate editor of *The New Republic*, to which he had been an occasional contributor over the years. This was a prestigious position, as *The New Republic* was one of the most influential publications of the time. Ayres strengthened his acquaintance with Dewey during this time, writing positive reviews of Dewey's work for the *Journal of Philosophy* and *The New Republic*.⁶ Dewey enjoyed Ayres' work and remarked that he was one of the "best of the younger men."⁷

Ayres, however, was unhappy with the pressure of his job in New York, and decided to retreat to a desert ranch in New Mexico, where he settled down to write *Science: The False Messiah*. He lived happily in the desert for several years (he sent Dewey several invitations to visit, touting the horseback riding and hunting, but also pointing out that there was “no fishing” in the desert), until an opportunity came to return to the academy when the University of Texas at Austin needed a replacement historian of economics.⁸ Ayres soon attained a tenured position and stayed in Austin for the rest of his career.⁹

Ayres accomplished a great deal during his time in Texas. He was popular and renowned for his prowess as a teacher, and he wrote a well-regarded book on T.H. Huxley. More importantly, he made substantial contributions to economics. He played a role in the construction of the New Deal, and his most important work, *The Theory of Economic Progress*, which was heavily influenced by both Dewey and Veblen, helped define a significant economic school of thought known as institutionalism, which focused on the interactions between technology and institutions, and, more broadly, on the social and economic orders that these interactions created.¹⁰ His work in this regard was noted by John Kenneth Galbraith, who read Ayres’ books and nominated him as a fellow of the American Economic Association.¹¹

Despite this success, Ayres’ life in Texas was, at times, far from serene. He had never lacked for frankness, and he deeply antagonized some of the less-than-liberal inhabitants of the Longhorn State with his economic and political views. In 1951, members of the Texas House of Representatives called Ayres an “educational termite,” suggested he be deported, and subsequently voted 130-1 to dismiss him from his job.¹² Ultimately, the legislature’s efforts were unsuccessful, but these efforts did, if nothing else, testify to Ayres’ tendency to voice what he felt to be inconvenient truths. As I will show in the next section, this tendency was on full display in *Science: The False Messiah*.

THE ARGUMENT OF SCIENCE: *THE FALSE MESSIAH*

Science: The False Messiah, which was a comprehensive critique of the role that science and technology play in American society, begins with a central contention that was suggested to Ayres by Dewey. That is, Ayres argued that science had, in the popular mind, acquired the character of folklore, which he defined as “a body of truth verified by repetition and sanctified by faith.”¹³ One reason for this faith-based folk belief was the nature of scientific knowledge; anticipating arguments that would later be made popular by Thomas Kuhn¹⁴, Ayres pointed out that most scientific knowledge was “utterly inaccessible to all but those few who make it their profession.”¹⁵ A second ground for this folk belief in science stemmed from the “popular” aspect of science that was of interest to the public, which Ayres called “the lore of science.” Ayres noted that science was capable of accomplishing powerful things—discovering microbes, explaining the workings of the sun—and

that as a result of these accomplishments, a large segment of the public had come to believe in science. This belief, however, was not based on knowledge, but rather on faith—the lore of science, Ayres contended, was revealed to the public in much the same manner as Moses revealed the tablets: “Scientists emerge from the awful obscurity of their laboratories and announce that these, their decalogues of physics and biology, are based upon direct observation. We do not doubt them, because they have been in the laboratories and we have not.”¹⁶ Science, in the public mind, was a mysterious, quasi-magical process that had the power to bring about extraordinary progress, and was, hence, the object of veneration. This argument about the folk-belief in science is the root of the title of the book; the population, Ayres felt, looked upon science as a “messiah” that would define new realities and deliver humanity from its difficulties.

Having established the faith-based character of the popular understanding of science, Ayres then began to construct an argument that highlighted the dependence of science upon technology. Ayres noted that, in the face of criticism, scientists would tend to maintain that their facts were established by direct observation. However, as Ayres suggested, the observation wasn’t really direct—it was, rather, largely mediated by machines. He commented:

Whenever and wherever a happening can be trained through a machine, and that machine converged upon a dial, and that dial marked off into standard units, and those units numbered: then and there an exact, scientific, mathematical observation has been made possible.

Ayres then analyzed the example of an oil drop machine, which was used to study electrons. The public could not discover the electrons for themselves; they were only available for discovery and inspection through the machine. Ayres acknowledged that the electron theory seemed to function well; he remarked, “reasoning upon it as a basis, various additional happenings have been provoked which thus far ‘fit’ the theory.”¹⁷ However, Ayres was especially keen to note that the entire theory was dependent on particular pieces of machinery:

The theory may or may not be “true.” Electrons may exist, or they may be as mythical as the late lamented phlogiston, the supposed inflammable constituent of combustibles. The answer will be read in the machines. If the machines say no, no it is. . . . Thus, the sum and substance of science appears to be that it begins in machinery and ends in machinery.¹⁸

Without machinery, contended Ayres, science “would soon soar into the region of pure imagination” and become a kind of magic.¹⁹ Technology, Ayres claimed, was the true power behind the throne of science. Whereas the history of science was usually understood in much the same way as the history of nations—namely, as a series of achievements brought off by a succession of great men—a more accurate understanding, he suggested, would acknowledge the dominant role of machinery.

He commented, “Modern science . . . springs from just one source: that is, from instruments of precision. That is, from machines.”²⁰ This line of analysis, which was popularized by Bruno Latour in the field of science and technology studies almost sixty years later²¹, was unprecedented at the time.

After laying out the case for the dependence of science on machinery and, therefore, he thought, the primacy of technology over science, Ayres turned his attention to the effect that machine technology had on society. He noted the ease with which certain technologies (he gave the examples of rifles and railroads), which he dubbed “technical culture traits”, moved from one society to another. The peoples who imported the items appreciated only their usefulness, without appreciating how these new technologies might change their culture in unforeseen ways. This principle held true, he believed, for all societies, including our own. Ayres commented, “. . . none of us hesitates to install a radio, or to exchange his used car for a later model. Why should we? Are not these things obvious improvements?”²²

The thoughtless adoption of new technology, Ayres maintained, often led to problematic social change. Inventions like the car and the telephone changed the way that we live, and these changes were impacting existing social institutions—the family structure, morality, religion. At the time when he was writing, Ayres thought that there was a striking mismatch between social institutions and technology. Our social institutions were medieval and our technology was modern, a mismatch which, he maintained, could not persist. He commented, “it is not reasonable to suppose that the institutions of the dark ages will consort through an indefinite future with the technology of the machine ages.”²³ Medieval social institutions were developed in response to a particular way of life, and that way of life no longer existed. “Our present civilization is a hybrid,” said Ayres, and “like most hybrids, it shows every sign of being unfertile and impermanent.”²⁴ The dissolution of our social institutions, Ayres reasoned, was already in progress, and although new values and social institutions needed to be developed in response to technological change, nothing was being done.

Ayres was also intensely critical of the arguments made by scientists concerning the compatibility of science and religion, and he devoted a significant portion of the book to analyzing this thesis.²⁵ In this section, he launched a number of blistering critiques, the two most notable being his attack on the attempt to make religion scientific and his critique of the claim that science still leaves room for faith. As far as the effort to scientize religion was concerned, Ayres appraised it as an ill-fated attempt to combine utterly different explanatory systems. Religious folklore, he maintained, did not lend itself to scientific analysis, and the reverse was true as well. Ayres commented drily, “Such are the conditions of our life that it has become necessary to gage the horsepower of the Omnipotent.”²⁶ The claim that science somehow left the ground open for religious belief (“There’s so much that we don’t know!”) also left Ayres skeptical. Although he granted that this position was

popular amongst scientists, he noted that “scientists had the same body of folkways and folklore as everyone else” and had also duly “given hostages to polite society” (what *would* Aunt Mabel think?). Ayres agreed that science was provisional and conjectural, but this did not warrant the conclusion that a space had been cleared for faith. He remarked, “Incomplete science no doubt is, but not in such a fashion as to lead any one to go behind it to an antique and alien ceremonial.”²⁷ The mysteries of the atom were deep indeed, Ayres conceded, and there was much to be learned about them, but that did not mean that there was any space for divine caprice within whichever new models of the atom emerged.

One possible consolation of the decimation of religion by science could be that new scientific discoveries and technologies would emerge which would help address the social problems brought about by technological change. This messianic belief in science, Ayres felt, was widespread, and he set out to ridicule it. Thus he commented, “We find it very easy to believe that science will provide. Our oil may be exhausted: science will find another way; our population may multiply like flies: science will find food.”²⁸ Ayres thought that this messianic faith was at least partly based on another problematic aspect of scientific folklore: the Great Man theory of science. There was a widespread view that a great genius, a conquering hero of science and technology, could suddenly emerge to save the day. Ayres believed that this image was at least partly due to press accounts that had helped to create this illusion, and he devoted some space to analyzing a popular book that he believed exemplified this problem, Paul de Kruif’s *The Microbe Hunters*. Ayres began by examining the example of Lazzaro Spallanzani, a bacteriologist that de Kruif exalted for his dedication to undertaking experiments that would falsify his hypothesis. Ayres mocked the proposition that verification implied devotion at some length, comparing scientists to bookkeepers, who, “so great is their devotion to the truth,” that they double-check their figures to make sure that they are correct.²⁹ Ayres quipped, “In doing as he did, [Spallanzani] behaved exactly as any sane man or child above the age of five would have behaved. . . . He makes sure that the lid is on the jam jar before he says, ‘I didn’t do it.’”³⁰

Having presumably disposed of Spallanzani, Ayres proceeded to dismantle de Kruif’s heroic account of Paul Ehrlich, the discoverer of the cure for syphilis. Ehrlich had been working on organic dyes that had the unique capacity to stain certain microbes and not others. From this datum, Ehrlich conceived of the possibility that these dyes could be used to selectively poison microbes. He tested this idea successfully with a large trypanosome, which he later realized was similar to the syphilis bacterium. Ehrlich was quite modest about this discovery, attributing it largely to luck. De Kruif had vaunted Ehrlich for this; according to De Kruif’s analysis, this modesty was only to be expected of a great hero of science. Ayres, however, maintained that Ehrlich’s luck attribution was largely correct. Ehrlich was an unusually able and thoughtful scientist, maintained Ayres, but he was fortunate

in that he happened to be working on a particular puzzle that had an unanticipated application. Most apparently great discoveries, maintained Ayres, came about in this seemingly haphazard way. Once again anticipating Thomas Kuhn³¹, Ayres suggested that key discoveries were generally not a product of heroic thinking in the usual meaning of the term; they were, rather, part and parcel of some kind of existing tradition of technological or scientific inquiry.

An obvious corollary of this idea was the proposition that science and technology did not produce discoveries on command. In order to support this argument, Ayres turned to the example of cancer. He noted that although there was a great interest in curing cancer, “so much so indeed . . . that to get a free education or to prosecute a problem you have only to show your great interest in cancer and the rest is added unto you,”³² there had been very little progress made. The problem was, to borrow a Rumsfeldian phrase, that cancer was an unknown unknown—scientists simply did not know where to begin the inquiry. Ayres commented, “Just what it is that we do not know or can not do, the lack of which sets at naught all our efforts . . . no one can state. Consequently we are quite at a loss.”³³ Science was effective at solving well-defined puzzles where the unknowns were known, but could not deliver solutions to ill-defined problems on demand, regardless of how pressing those problems were.

From this analysis, Ayres concluded, perhaps hastily, that scientific and technological change were beyond effective human control:

Inventions come because they are possible, not because they are wanted, and scientific inventions come in precisely the same fashion; and in the case of every invention its ulterior effects are what nobody has wanted and most people would acutely dread. Science as a whole will surely go on to the discovery of things we little dream of; and the effects of those discoveries will be such changes in human life and civilization as we can hardly tolerate to think about. To bring about one of these inventions in answer to our prayers is only just short of impossible. To check the general flood is equally impossible. In all the affairs of men, science included, the wind bloweth where it listeth.³⁴

Ayres, who had long since repudiated his Protestant upbringing, was nonetheless fond of Biblical references, and the end of this paragraph is a reference to John 3:8: “The wind bloweth where it listeth, and thou hearest the sound thereof, but canst not tell whence it cometh, and whither it goeth.”³⁵ Clearly, Ayres’ outlook on the future of science and technology was not particularly sanguine.

Yet even given this grim analysis, one might be tempted to think that education might extricate the public from these misconceptions—if one could, for example, teach citizens the scientific method (Ayres may have had Dewey in mind here), perhaps people would be less credulous about science. Ayres, however, concluded *Science: The False Messiah* on a pessimistic note by suggesting that it was

hopeless to try to educate people to think scientifically. Civilization was necessarily grounded in habit, he felt, and it was therefore unrealistic to expect people to make a habit of not having habits—in other words, a habit of being experimental. The American people, Ayres felt, could only become a scientific people “in the sense in which we are now a Christian people.”³⁶ In other words, a certain amount of hand waving about the importance of critical thinking was attainable, and a generalized educational endorsement might even be possible, but ultimately, the average person

sends down roots into the coarse and fetid soil of common tradition, standardized, institutionalized, accumulated from the dropping of countless generations of similarly stupid, obvious, and standardized Children of the Lord. . . . To limpid intelligence the world is a mud-bank of deceit on which crawls the human race gorging itself on self-deceit.³⁷

From this, one of the parting shots in the book, it's quite evident that Ayres was not longing for the Elysian fields of educational reform in order to refashion America into a science-savvy nation.

AYRES' DEWEYAN INSPIRATION

Ayres is an elegant writer, and although he had an occasional tendency toward the florid, the key elements of his critique of science and technology are clear. What is substantially less clear, however, is how this argument is, as Ayres suggested to Dewey, “your stuff, however wildly perverted.” As noted above, Ayres thanked Dewey for the suggestion that science should be thought of as a form of folklore, and this obviously became a key element of Ayres' argument, but beyond this, there is no clear elaboration in any of the letters on how Ayres believed he was drawing upon Dewey.

One legitimate possible counterinterpretation here is to suggest that there isn't much of a connection at all between Ayres' project and “Dewey's stuff.” Ayres needed an endorsement, and to have it, he might have attempted to curry favor with Dewey by suggesting that his project was in the Deweyan spirit. Given Ayres' general temperament, however, I believe that this interpretation is extremely unlikely. Unlike Dewey, who generally did not adopt an *agent provocateur* role when writing book reviews, Ayres had a tendency toward frankness in his *New Republic* book reviews—for example, he titled one extremely negative review, “For Hammock Consumption Only.”³⁸ Furthermore, as the Texas legislature vote would appear to indicate, he did not moderate his opinions in later life. Finally, long after Ayres had lost contact with Dewey and had ceased to need Dewey's help in his career, he nonetheless continued to write laudatory articles for *The New Republic* about Dewey.

Given that this “favor currying” interpretation is unlikely, a reasonable place to look for evidence of possible links between Dewey and Ayres is in *Experience and Nature* (1925), which was published just a year prior to Ayres' book. The evidence

to be found is substantial; there are three ways in which Ayres can be said to adopt Deweyan positions: first, he adopts Dewey's empirical method; second, he hews to Dewey's non-foundationalist analysis of science; and finally, *Science: The False Messiah* is also a paradigmatic example of the kind of criticism that Dewey calls for in the final chapter of *Experience and Nature*. Although Ayres' conclusions about science diverge substantially from Dewey's more optimistic evaluation, Ayres is Deweyan in his general orientation.

This is especially clear from Chapter One of *Experience and Nature*, in which Dewey offered a bold, clear statement of his overall approach. His "empirical method" was a call to take experience seriously as a primary philosophical datum. He commented, "the very meaning and purport of empirical method is that things are to be studied on their own account, so as to find out what is revealed when they are experienced."³⁹ Philosophers had a tendency to identify various other sources—including underlying material substance, sense data, or ideal being—as being somehow primary, but this was a false view, Dewey suggested. All of these supposed primary sources were more and less helpful after-the-fact reconstructions of experience and were, hence, secondary. He remarked, "As a natural history of mind, this notion is wholly mythological. All knowing and effort to know starts from some belief, some received and asserted meaning."⁴⁰ In Chapter One, Dewey further claimed that the job of empirical method was to provide a genealogy and analysis of the state of belief. He commented, "empirical method points out when and where and how things . . . have been arrived at. It places before others a map of the road that has been travelled."⁴¹

Arguably, it is precisely this sort of method that scholars like Michel Foucault would later successfully pursue with books like *The Birth of the Clinic* and *Discipline and Punish*.⁴² But it was also Ayres' method in *Science: The False Messiah*. Instead of lionizing the Great Heroes of science or eulogizing its miraculous capacity to deliver the goods that civilization needed, Ayres attempted to throw open the laboratory doors and describe the way in which scientists functioned on an everyday basis (compare his comments on the nature of discovery and his analysis of the dependence of science upon technology). Instead of emphasizing its compatibility with religion or decrying it as an agent of destruction of traditional values (both of which were popular approaches at the time), Ayres attempted to draw a skeptical but accurate map of both the nature of popular belief in science as well as the effects that science and technology were having upon culture. By doing this, he was performing what Dewey referred to as the "analytic dismemberment and synthetic reconstruction of experience," applied specifically to the popular understanding of science.⁴³

The second way in which Ayres took a Deweyan position can be seen in his non-foundationalist understanding of science. In a 1927 *New Republic* article, "Back to Locke," Ayres commented,

In other words, when scientists are doctoring us, or dieting us, or housing us, or transporting us by the magic of their mechanical control, they have our confidence. But when they begin to tell us what we are, we are immediately skeptical. . . . As a result, some of us—largely at the instigation of John Dewey—have taken to calling science a technique. It is an instrument for doing certain things.⁴⁴

In the second chapter of *Science: The False Messiah*, “The Lust for Truth,” Ayres had laid out a roughly similar position at greater length. Science was a powerful tool, he conceded, especially when combined with machine technology, but that did not imply that science was identical with knowledge, truth, or reality. In terms of everyday lived experience, Ayres felt, science was largely useless, and only became relevant through its manifestations in terms of machine technologies. Ayres pronounced acerbically, “Science is a contribution to knowledge only if we mean by knowledge, science.”⁴⁵

Dewey’s position in *Experience and Nature* is substantially more refined and carefully justified than the view that Ayres sketched out, but there are substantial similarities between the two views. In Chapter Four of the book, in which Dewey laid out his conception of science, he steadfastly resisted the temptation to declare that mathematico-mechanical objects (the objects of physics) were constitutive of reality, and suggested instead that the entire problem of ultimate realities was wrongheaded. He argued that once we stopped thinking in this foundationalist manner and began thinking of the objects of science simply as useful tools to effect certain kinds of results, we could escape from a number of important philosophical problems, most notably the tendency to crown either phenomenal appearances or underlying scientific objects with the mantle of ultimate reality.⁴⁶ Although Dewey was much more optimistic about science than Ayres, and would have certainly disagreed with Ayres’ contention about the lack of usefulness of scientific knowledge, he certainly agreed with Ayres’ view that scientific knowledge was knowledge for science rather than knowledge tout court.

A final way in which Ayres can be seen to be Deweyan in his approach is in his embrace of Dewey’s call for philosophical critique. In the final chapter of *Experience and Nature*, Dewey explained that our lives are full of things that seem immediately good to us. All things, from a fast food meal to a Cezanne painting are, insofar as we enjoy them, immediate goods. Dewey further maintained that these goods are, at least in the moment, equal in terms of their goodness; only upon reflection could we differentiate between them and value them appropriately, and this reflection is what constitutes criticism.⁴⁷ When this criticism was carried out carefully and systematically, or, to use Dewey’s terms, “in the grand manner,” it was philosophy, and Dewey suggested that science should be one of the key targets of critical reflection: “Positive concrete goods of science, art, and social companionship are the basic subject-matter of philosophy as criticism . . .”⁴⁸ Ayres had set out

to offer some criticism that would clarify the value of science, and as I will make clear in the next section, although this criticism was caustic (as is clear from the summary of Ayres' argument above), Dewey's reaction to it was surprisingly positive, and it may have even had an effect on his subsequent thinking about science and technology.

AYRES' EFFECT ON DEWEY

As I indicated above, it is evident that Ayres was a pioneering STS thinker and that he was powerfully affected by Dewey's work. In this section, I will show how the vector of influence also points the opposite way--from Ayres to Dewey--although the strength of the influence is weaker and some of the connections are more speculative.⁴⁹ I will begin by detailing the direct, tangible ways in which Ayres affected Dewey over the years, and then I will offer a broader but more speculative connection between the two thinkers.

Dewey's initial reaction to Ayres is largely detailed in a favorable review of *Science: The False Messiah* that he wrote for *The New Republic*. In his introductory remarks, he commented:

Rarely in one book have so many glittering bubbles been so deftly and, in style, so delightfully pricked. Indeed, at times the brilliance and wit of form almost conceal the solidity of substance underneath.⁵⁰

In keeping with his usual reviewing style, after having given a synopsis of the book, Dewey offered a more detailed evaluation. Dewey did not see "how any thoughtful person [could] demur" at the main propositions of the book, which included Ayres' characterization of technology and its effects on society.⁵¹ In addition, Dewey stated that he felt that science, in and of itself, was not the answer to human problems. Dewey interpreted Ayres as believing that science "delivered only means" and left outstanding the critical question of how those problems should be solved. In other words, he validated Ayres as mirroring his own views on these issues.⁵²

However, Dewey was keen to dispute Ayres on one particular point: the possibility and desirability of educating all people to think more scientifically. Those who are familiar with Dewey's educational work will know that Ayres' arguments are completely opposed to Dewey's educational prescriptions. The primary purpose of Deweyan education was to create citizens who were effective thinkers and actors, and this effectiveness was to stem, at least in part, from a robust understanding of science and technology; one of the primary goals of Dewey's system of education through occupations was to instill this understanding.⁵³ As noted above, Ayres had been extremely pessimistic about this possibility, and Dewey certainly disagreed with this sentiment. Although he was willing to concede that many people would not be able to understand science in its full technical sense, he felt that it was possible to instill a scientific attitude in people. He remarked:

But there are generic attitudes, like those of facing facts, of analysis, of receiving conclusions hypothetically, which are radically opposed to the dispositions which have supported the folk-lore of the past. It is no easy task to incorporate these newer dispositions . . . but any implication that the task is hopeless implies an estimate of human nature which paralyzes human effort.⁵⁴

In sum, although Dewey felt that Ayres' book served as a useful corrective to a naively optimistic faith in science and technology, he was not prepared to endorse the full range of Ayres' pessimism.

Clearly, however, he did regard Ayres' book seriously, as he subsequently proved when he drew upon it and referred directly to it in *The Public and Its Problems* (1927).⁵⁵ In this book, Dewey was, among other things, working toward a more thorough analysis of the problem of scientific understanding. Dewey explained that he wanted the results of science (especially social science) to be made fully accessible to the public. The scientific enterprise, he felt, had made many discoveries that were relevant to human life, and these discoveries were changing, or had the potential to change, the way life was lived. However, the public did not have an adequate understanding of either science or technology. Dewey reprised Ayres' analysis here, commenting, "For most men . . . science is a mystery in the hands of initiates."⁵⁶ He then suggested that if a better public understanding of science and technology could be effected, it would serve to address some of the concerns raised by Ayres. Science might not "provide" for the public, but a better understanding of science and technology would, at least, allow the public to "use and control its manifestations" to some extent rather than merely "undergo the consequences."⁵⁷ Diffusion of the results of science, especially the results of social science, might allow for a more rational approach to social problems, and make the public less susceptible to attempts to manipulate public opinion.

A better public understanding of science and technology might also lead in the direction of a more egalitarian, freer society. As things stood, Dewey felt that scientific knowledge was not applied by the whole public to society, but rather was *inflicted* on working people by the rich. He remarked: "At present, the application of physical science is rather *to* human concerns than *in* them. That is, it is external, made in the interests of its consequences for a possessing and acquisitive class."⁵⁸ This appropriation of science by the rich had wreaked terrible damage:

Knowledge . . . has played its part in generating enslavement of men, women and children in factories in which they are animated machines to tend inanimate machines. It has maintained sordid slums, flurried and discontented careers, grinding poverty and luxurious wealth . . . Man, a child in understanding of himself, has placed in his hands physical tools of incalculable power. He plays with them like a child, and whether they work harm or good is largely a matter of accident. The instrumentality becomes a master and works fatally as if possessed of a will of its own—not because it has a will but because man has not.⁵⁹

Dewey clearly felt that Ayres had described the problem of technology correctly, which is why he remarked, “The instrumentality . . . works fatally as if possessed of a will of its own.” However, he obviously did not feel, as Ayres did, that it was an unsolvable problem. Dewey thought that the public might one day be able to re-appropriate scientific and technological knowledge and exert itself self-consciously and knowledgeable upon the scientific and technological apparatus. This re-appropriation would imply a more free society in two ways: it would free people from their mechanical bondage, and it would bring about a society that was capable of self-consciously directing its own path.

Beyond 1927, limited textual evidence linking Dewey and Ayres means that it is difficult to gauge the precise impact of Ayres’ work on Dewey.⁶⁰ There is some evidence, however, which points towards an enduring connection between the two thinkers. In 1943, for example, Dewey acknowledged an important contribution that Ayres had made to the understanding of science:

Dr. Clarence Ayres, as far as I am aware, was the first one explicitly to call science a mode of technology. It is probable that I might have avoided a considerable amount of misunderstanding if I had systematically used “technology” instead of “instrumentalism” in connection with the view I put forth regarding the distinctive quality of science as knowledge.⁶¹

This pronouncement⁶² is a clear testament to the enduring influence of Ayres’ double view that science *is itself* a technology and that that science is deeply dependent upon machine technology. As Hickman points out and as Ayres himself had acknowledged in his 1927 *New Republic* review, “Back to Locke,” the former aspect of Ayres’ view was derived from Dewey, and so this granting of credit was generous on Dewey’s part.

An additional marker of Ayres’ lingering influence is that Dewey continued to be a partisan of Ayres’ work long after their initial 1927 correspondence. After Henry Hazlitt (a *Wall Street Journal* editorialist and prominent proponent of the Austrian School of economics⁶³) submitted a negative review of Ayres’ *Theory of Economic Progress* to the *Saturday Review*, Dewey attacked Hazlitt’s critique, suggesting that Hazlitt had distorted Ayres’ argument completely in order to demolish a straw-man version of it. Dewey was blunt in his condemnation: “The thesis of my comment is that nowhere in the notice does Mr. Hazlitt state either the issue, Mr. Ayres’ position regarding it, or the reasons given by the latter for taking it.”⁶⁴ At this stage in his career, Ayres was well established; he did not need Dewey’s help, nor did Dewey need to give it. Evidently, Dewey still felt that Ayres was someone worth supporting.

Clearly, Dewey and Ayres had a number of meaningful interactions, and there is ample evidence that Dewey was a strong supporter of Ayres’ work. Yet the question of whether Ayres had a lasting influence on the content of Dewey’s work remains

outstanding. Here, our conjectures must be framed more tentatively. In the years following his initial interactions with Ayres, it appears that Dewey had a heightened concern for dealing with the question of science and technology. In *Individualism: Old and New* (1930), Dewey quoted Ayres directly and, once again, reprised Ayres' suggestion that scientific and technological progress were spinning out of control. Resolving the question of control over technology, Dewey indicated, was a crucial precondition to the development of a more cooperative society that would be characterized by both new, more corporate forms of individualism and stronger notions of community.⁶⁵ He offered a similar, briefer analysis some years later in *Freedom and Culture* (1939), in which he noted that although technological progress had destroyed old values, our culture had failed to propose new, more appropriate values.⁶⁶

This position is, one should note, in contrast to some of Dewey's earlier writings, in which he adopted a very optimistic tone in his pronouncements about science and technology. In his early work especially, Dewey had a quasi-religious faith in the power of science—in "Christianity and Democracy" (1893), an early essay, he spoke of it as a "revelation" that gradually uncovered the unity of all things, and he suggested that democracy was connected with "the machinery of telegraph and locomotive for distributing truth."⁶⁷ In a later essay the same year, he upbraided French historian Ernest Renan for having lost faith in science, and expressed his belief that social science would advance to the point where it would guide daily practice and decision making.⁶⁸

This fervent optimism had dissipated by the time Dewey wrote *Experience and Nature*, where he commented on the existence of an unduly "abject" admiration for science and its fruits.⁶⁹ Given that *Experience and Nature* was published before Dewey had read Ayres' draft, one cannot say that reading Ayres was the sole cause of Dewey's diminishing optimism about science and technology. Yet Dewey's positive response to Ayres' work, and the number of times he subsequently referred to Ayres when speaking cautiously about technology, point up the possibility that reading *Science: The False Messiah* had a substantial lasting effect on Dewey's thinking about technology. Beyond this, it also highlights the fact that Dewey was far from being a naïve optimist about science and technology, contrary to the allegations made by some of his critics.⁷⁰ Dewey's interaction with Ayres gave him access to criticism of science and technology that cut deeply and powerfully, and the evidence indicates that he was very receptive to this critique.

CONCLUSION

Albert Barnes, in a 1927 letter to Dewey, suggested that *Science: The False Messiah* would make Ayres famous.⁷¹ Evidently, and perhaps unfortunately, he was wrong: In 2012, as I write this essay, Ayres' star has long since faded from the academic scene. His works are out of print, and have mostly been forgotten but for a few Dewey scholars and historians of economics. Yet in offering this exposition of one of Ayres'

works and an explanation of the reciprocal influences between him and Dewey, I have been making the case that he deserves substantially more attention than he has gotten. His position on science and technology was radical and innovative in 1927 and struck Dewey forcefully. In the 1920s, there was no organized field of science, technology, and society (STS) scholarship; Ayres was a pioneer in a field that would not emerge until the 1960s and 1970s. Given that the field has come into its own, many of Ayres' arguments have now become conventional wisdom amongst STS scholars—for example, Ayres' core point that there is a prevailing popular folklore about science has become generally accepted. There is, however, still a lot of life in some of his other arguments, especially his contention that science begins and ends in machines, and with particular reference to his example of the oil drop machine examined above. As I have indicated, sociologist of knowledge Bruno Latour has taken up a position that bears a family resemblance to Ayres' suggestions here, a position which is still controversial today. Ayres' and Dewey's contentions about the non-foundational nature of scientific truth are also very much live issues.

Notably, some of the questions that concerned Ayres are also alive and well in education. Although Ayres can't be connected directly to contemporary educational developments, science education is beginning to move in a direction that Ayres would appreciate. The types of STS issues that preoccupied Ayres have been on the rise in science education for the last 30 years and are now gradually being accepted (albeit not without substantial resistance⁷²) in textbooks and curricula.⁷³ In concert with this development, the old definition of science literacy, in which the core educational goal was to develop an introductory-level understanding of several scientific disciplines, is being replaced by a new definition that focuses on connecting scientific knowledge to situations that citizens might actually encounter. As Noah Feinstein has noted, the old vision of science literacy produced "marginal insiders," who understood very little of the core knowledge that the conventional definition prescribed, while the new definition holds the promise of producing "competent outsiders" who, while not possessing insider-level expertise, can at least navigate the seas of scientific information when necessary.⁷⁴ Granted, even this fairly modest conception of science literacy might generate an acerbic pronouncement or two from Ayres, but he would at least be more enthused about this new movement than its predecessors in science and technology education, which combined naively triumphalist accounts of science with ineffective education for citizens.

Perhaps the most impressive aspect of Ayres' work, though, is how well it has stood the test of time. How many books written about science and technology in 2011 will still be worth reading 85 years in the future? I suspect that the vast majority of these books will seem, to the denizens of the year 2095, quaintly comic. Pessimistic and corrosive though it is, Ayres' analysis has retained its critical relevance—there is almost none of it that fails to apply to the situations we face today. Take, for example, the belief that science will provide. Today, we find ourselves at the brink of a possibly

catastrophic period of global warming. Yet somehow we are not particularly anxious, and this may at least be partially attributable to a faith that science and technology will descend, *deus ex machina*, and provide us with a solution to our ills. Ayres' cancer example is especially instructive in this regard; although the situation is substantially improved in 2011, his 1927 analysis largely applies. We have been desperately longing for a cure for cancer since Ayres' time, but despite some significant progress and a great deal of hopeful fund-raising and grant-generating handwaving, science has mostly failed to deliver on its promises in this regard.

Ayres' call for us to reflect on the value of science and technology thus remains current. The gospel of science (and the newer gospel of technology) continues to win converts and, as Ayres would have predicted, these converts are not always particularly thoughtful in their faith. Now, more than ever, we need to embrace the Deweyan imperative to examine the value of science and technology critically. In ways that are more powerful and pervasive than most of the other goods that present themselves to us, science and technology are immediate goods that make extraordinary promises. In other words, the prophets of the new creed have never been slicker, and popular faith, despite occasional eruptions of misplaced skepticism (e.g., climate change deniers), remains strong. Were he still around today, the Ayres of 1927 would doubtlessly be holed up in a Social Studies of Science Department, suggesting that it was high time for a few heretics to emerge.

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NOTES

1. C. E. Ayres to John Dewey, 1926.12.30, *The Correspondence of John Dewey: 1871–1952, Electronic Edition*, ed. Larry A. Hickman (Charlottesville: Intelix Corp., 2008).
2. *Ibid.*
3. *Ibid.*
4. C. E. Ayres to John Dewey, 1927.1.26, *Dewey Correspondence*.
5. William Breit and William Patton Culbertson, "Clarence Edwin Ayres: An Intellectual's Portrait," in *Science and Ceremony: The Institutional Economics of C. E. Ayres*, ed. William Breit and William Patton Culbertson (Austin: University of Texas Press, 1976), 3–22.
6. William Breit and William Patton Culbertson, "Clarence Edwin Ayres: A Chronological Bibliography," in *Science and Ceremony: The Institutional Economics of C. E. Ayres*, ed. William Breit and William Patton Culbertson (Austin: University of Texas Press, 1976), 190–201.
7. John Dewey to Albert Barnes, 1912.11.02, *Dewey Correspondence*.
8. Breit and Culbertson, "An Intellectual's Portrait," 8.
9. *Ibid.*, 19.
10. Cf. James M. Buchanan, "Methods and Morals in Economics: The Ayres-Knight Discussion," in *Science and Ceremony: The Institutional Economics of C. E. Ayres*, ed. William Breit and William Patton Culbertson (Austin: University of Texas Press, 1976), 163–74; Joseph J. Spengler, "Limits to Growth: Biospheric or Institutional?" in *Science and Ceremony: The Institutional Economics of C. E. Ayres*, ed. William Breit and William Patton Culbertson (Austin: University of Texas Press, 1976), 115–33.
11. John Kenneth Galbraith, "Foreword," in *Science and Ceremony: The Institutional Economics of C. E. Ayres*, ed. William Breit and William Patton Culbertson (Austin: University of Texas Press, 1976), vii–viii.
12. Breit and Culbertson, "An Intellectual's Portrait," 16.
13. C. E. Ayres, *Science: The False Messiah* (Indianapolis: Bobbs-Merrill Co., 1927), 30.
14. In *The Structure of Scientific Revolutions* (Chicago: University of Chicago Press, 1962), Kuhn explains that once a paradigm (e.g. Darwin's theory of evolution) is firmly established, the character of scientific communication changes such that only disciplinary insiders can understand it.
15. Ayres, *Science: The False Messiah*, 40.
16. *Ibid.*, 42.
17. *Ibid.*, 54.
18. *Ibid.*, 54.
19. *Ibid.*, 54.
20. *Ibid.*, 47.

21. To someone who is not familiar with the discipline of science studies, Ayres' contentions about the dependence of science on machinery may seem strange and/or irrelevant. Why would it matter if machines mediate the facts of science? As it turns out, Ayres' line of thinking here is similar to the program of a thinker who has been hailed, in some circles, as revolutionary: Bruno Latour. In their most famous work, *Laboratory Life*, Bruno Latour and Steve Woolgar maintain a thesis about the dependence of science on machinery. Machines, they suggest, are used not merely to discover facts, but to construct them. See *Laboratory Life* (Princeton: Princeton University Press, 1986). In a later book, *Science in Action* (Cambridge, MA: Harvard University Press, 1987), Latour contends that the facts of science are extremely fragile and require an extensive mechanical infrastructure to support them. Latour comments:

No one has ever observed a fact, a theory or a machine that could survive *outside* of the networks that gave birth to them. Still more fragile than termites, facts and machines can travel along extended galleries, but they cannot survive one minute in this famous and mythical 'out-there-ness' so vaunted by philosophers of science" (Latour, *Science in Action*, 248)

Thus, outside of the mechanical network of laboratories, there are no electrons. Although it is not clear that Ayres would support a claim this radical, Latour would agree with Ayres that, absent the support of machines, science drifts off into the realm of the magical. Machine technology is more than just the handmaiden of science; at the very least, science is deeply interwoven with and dependent upon machine technology to construct its facts.

22. Ayres, *Science: The False Messiah*, 66

23. *Ibid.*, 87.

24. *Ibid.*, 87.

25. Given the title of the book, one might suppose that Ayres is friendly towards religion. In fact, as the following paragraphs make clear, nothing could be further from the truth.

26. *Ibid.*, 147.

27. *Ibid.*, 200.

28. *Ibid.*, 253.

29. *Ibid.*, 255.

30. *Ibid.*, 255.

31. Ayres' account here has important similarities with Kuhn's notion of normal science. This popular idea, which posits that the everyday activity of science is a matter of puzzle solving within a paradigm, is largely anticipated in Ayres' analysis of de Kruif's *The Microbe Hunters*. However, it must be noted that Ayres does not posit a full-fledged theory of scientific change as Kuhn does.

32. Ayres, *Science, The False Messiah*, 261.

33. *Ibid.*, 262.

34. *Ibid.*, 263.

35. John 3: 8 (King James Version).

36. Ayres, *Science: The False Messiah*, 275.

37. *Ibid.*, 280.

38. C. E. Ayres, "For Hammock Consumption Only," *The New Republic*, September 1, 1926, 49–50.

39. John Dewey, *The Later Works*, vol. 1, ed. Jo Ann Boydston (Carbondale, Southern Illinois University Press), 13.

40. *Ibid.*, 320.

41. *Ibid.*, 34.

42. Cf. Michael Foucault, *The Birth of the Clinic* (New York: Routledge, 2003); Michel Foucault, *Discipline and Punish* (New York: Vintage, 1995).

43. Dewey, *Experience and Nature*, 40.

44. C. E. Ayres, "Back to Locke!" *The New Republic*, July 27, 1927, 248–49.

45. Ayres, *Science: The False Messiah*, 33.

46. Dewey, *Later Works*, vol. 1, 110ff.

47. *Ibid.*, 301ff.

48. *Ibid.*, 308.

49. This is, ultimately, why the essay is *primarily* about Ayres and *secondarily* about Dewey. Before beginning my review of the effects of Ayres' work on Dewey, a disclaimer is in order. At the beginning of this project, I had initially hypothesized that it would be possible to demonstrate beyond any doubt that Dewey's orientation toward technology changed significantly as a result of his having read Ayres' work. I had further hoped to uncover some strong connections between Ayres' STS orientation and Dewey's subsequent work in education. Unfortunately, the textual evidence has proven to be insufficient; while there is evidence that Ayres had an important influence on Dewey, I was not able to ground these conclusions quite as strongly as I initially hoped.

50. John Dewey, *Later Works*, vol. 3, 305. Although this remark was couched as a compliment, Dewey had actually raised a legitimate concern here. Ayres' writing, as is evident from some of the extracts quoted above, is, as his publishers had indicated, "very saucy," so much so that it distracts from Ayres' argument, which is genuinely innovative. Ayres had taken up this posture as a pedagogical device in order to provoke debate, but his combativeness and jokey style may have also lessened the work's impact.

51. Dewey, *Later Works*, vol. 3, 309.

52. It should be noted here that Ayres did not maintain the same level of skepticism concerning science and technology for the entirety of his career. In works like *The Theory of Economic Progress* (Chapel Hill: UNC Press, 1943), Ayres offers a far more optimistic take on technology, and in "The Significance of Economic Planning," (in *The Development of Collective Enterprise*, ed. Seba Eldridge (Lawrence: University of Kansas Press, 1943), 460–81), Ayres notes, "We are just now beginning to realize that science and technology, the fine and the mechanical arts, contain within themselves the criterion of value by which they must be judged. Technological progress is not 'meaningless apart from ends'; on the contrary it is the locus of meaning" (p. 479). However, given the complexities of dealing with Ayres' changing position (and also the fact that this new position intersects with Dewey's work significantly less and at a much later period in Dewey's life), I am limiting the analysis in this essay to *Science: The False Messiah* and other contemporaneous writings.

53. David I. Waddington, "Scientific Self-Defence: Transforming Dewey's Idea of Technological Transparency," *Educational Theory* 60 (2010): 621–38.

54. Dewey, *Later Works*, vol. 3, 310.

55. Not only does Dewey reprise aspects of Ayres' analysis in *The Public and its Problems*, as I here argue, but he also refers specifically to Ayres in Ch. 2. Dewey's references to specific works are rare enough that this merits notation.

56. John Dewey, *Later Works*, vol. 2, 337.

57. *Ibid.*, 338.

58. *Ibid.*, 344.

59. *Ibid.*, 344.

60. Ayres' work also had a small effect on Dewey's private life, as it caused substantial upset to Dewey's eccentric longtime correspondent, retired naval officer Scudder Klyce. Klyce, who was

never one to mince words, and who was already angry at Ayres for having failed to respond to a negative review of *Science: The False Messiah* that he had written some months earlier, suggested that Ayres' book showed that Ayres was "an agnostic" and "a failure." Ayres' agnosticism, however, was only the tip of the iceberg—Klyce was also furious that Ayres had, in *The New Republic*, interpreted Dewey as viewing science as a technique, which Klyce viewed as being contrary to his own views. He demanded that Dewey repudiate Ayres' interpretation—he concluded his letter to Dewey as follows: "For if you accept as sound this article by Ayres, then all I have to say is that you are a menace to the welfare of the human race. It is just that bad" (Scudder Klyce to John Dewey, 1927.07.27, *Dewey Correspondence*). Dewey, however, refused to concede to Klyce's position here, and eventually published his full, positive review of Ayres in *TNR*, which irritated Klyce even more. Klyce read Dewey's review as indicating that Dewey had "no understanding and respect for the scientist type," amongst which Klyce included himself (Scudder Klyce to John Dewey, 1927.11.06, *Dewey Correspondence*). Immediately after this letter, Dewey's patience with Klyce, which had been thinning for some time, finally ran out, which led to the rupture that resulted in Klyce's unauthorized publication of his correspondence with Dewey.

61. Dewey, *Later Works*, vol. 15, 89 (Note 3).

62. This pronouncement, incidentally, provides strong support for Larry Hickman's thesis that Deweyan inquiry is a mode of technology. Cf. Larry A. Hickman, *John Dewey's Pragmatic Technology* (Bloomington: Indiana University Press, 1990)

63. Of which Congressman Ron Paul is a prominent contemporary follower.

64. Dewey, *Later Works*, vol. 15, 359.

65. Cf. Dewey, *Later Works*, vol. 5, 86.

66. Cf. Dewey, *Later Works*, vol. 13, 172.

67. John Dewey, *The Early Works*, vol. 4, ed. Jo Ann Boydston (Carbondale: Southern Illinois Press), 6–9.

68. Dewey, *Early Works*, vol. 4, 11–18.

69. Dewey, *Later Works*, vol. 1, 129.

70. Cf. Lewis Mumford, *The Golden Day* (New York: W.W. Norton, 1926); Bertrand Russell, *A History of Western Philosophy* (London: George Allen and Unwin, 1947).

71. Albert Barnes to John Dewey, 1927.11.06, *Dewey Correspondence*.

72. Glen Aikenhead, *Science Education for Everyday Life: Evidence-Based Practice* (London: Althouse Press, 2006); David I. Waddington and Amanda Imbriglio, "Relegated to the Margins: The Place of STSE Themes in Québec Secondary Cycle One Textbooks," *Canadian Journal of Mathematics, Science and Technology Education* 11 (2011): 160–79; John Wilkinson, "A Quantitative Analysis of Physics Textbooks for Science Literacy Themes," *Research in Science Education* 29 (1999): 385–99.

73. Leonard Waks, "The Responsibility Spiral," *Theory into Practice* 31 (1992): 13–19; John Ziman, *Teaching and Learning about Science and Society* (Cambridge: Cambridge University Press, 1980).

74. Noah Feinstein, "Salvaging Science Literacy," *Science Education* 95 (2010): 168–85.

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