[Commonplace Lectures]

The Lab and the Flag:

Science, Democracy, and a New Worldview

A LECTURE BY
Mott Greene

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MOTT GREENE
The Lab and the Flag:
Science, Democracy, and a New Worldview
Portland, Jean Vollum Natural Capital Center, October 20, 2006

The Lab and the Flag:
Science, Democracy, and a New Worldview
by Mott Greene. A lecture given at the Jean Vollum
Natural Capital Center in Portland, Oregon,
on October 20, 2006.

GOOD EVENING. I'm here tonight to talk to you about updating our scientific worldview to reestablish an alliance between science and democracy—an alliance that has become somewhat rickety and creaky of late. I'm going to talk not so much about physics itself, but about the implications one can draw from physics and, to a certain extent, from evolution as well, about the conduct of politics. Most of us are not working scientists, and many of us are not even consumers of science, let alone producers, although most of us use products made by scientific means. And, because we live in the civilization we live in, we have a particular scientific viewpoint, even if we don't know what that means.

While I was working on the final stages of this presentation, my wife came into my study and gave me a sheet from one of those little calendars where you tear off yesterday's page and get a new saying for the day. The text read, "Nothing is so simple that it cannot be misunderstood." I take that as a reminder to me, more than to you, but maybe you should think about it, too. I'm going to talk about scientific worldviews. I'm not going to prescribe anything. I'm going to be making a suggestion about how to think a little bit differently about some things, but I'm not telling anyone what to think or do.

What is a "scientific worldview?" For one thing, it is a view of the whole world. For another, it is a notion of where human beings fit into this scheme of things and an idea about how the world works. Finally, it is an idea about the best way to get true and useful knowledge of the world.

The author of the scientific worldview most of you learned in school was Isaac Newton (1642–1727). He is the author of a book called *Mathematical Principles of Natural Philosophy*. "Natural philosophy" is a phrase used in the 1600s for what we now call science. The basic outline of this scientific worldview that we inherit from Newton is that the world consists of matter in motion in space. Matter is made of atoms, and the atoms gravitate together to form more complex structures. Matter obeys invariant laws of motion that govern the whole universe, and these laws are ordained and guaranteed by God.

One of Isaac Newton's closest colleagues and friends was the British philosopher John Locke (1632–1704). Locke was the author of a philosophical treatise called *Essay on Human Understanding*, and the foundation of this theory of knowledge is that more complex ideas are built out of smaller atomic ideas linked together. Locke was a strong supporter of William and Mary, who ascended the throne of England in the Glorious Revolution of 1688. While in exile with them in Holland, Locke had written a treatise entitled *An Essay Concerning the True Original, Extent, and End of Civil Government*. This treatise is the application of Newton's scientific worldview to politics. Where Newton used atoms of matter, Locke used human individuals. Where Newton's atoms assembled into molecules, Locke's individuals assembled into political associations. Newton's atoms obeyed laws of nature, as did Locke's individuals. In both cases, the physical and political, God ordained and guaranteed order.

Locke's political theory was studied closely by Thomas Jefferson, who incorporated it into the Declaration of Independence. If we look at the preamble to the Declaration, we find the following statement:

> When in the course of human events, it becomes necessary for one people to dissolve the political bands which have connected them with another, and to assume among the powers of the earth, the separate and equal station to which the laws of

> Nature and of Nature's God entitle them, a decent respect to the opinions of mankind requires that they should declare the causes which impelled them to separation.

Of particular importance is the phrase "to which the laws of Nature and of Nature's God entitle them." When Thomas Jefferson wrote these words in June of 1776, he was, in effect, founding our democratic system of government on a faith in the truth of the Newtonian worldview.

This has had some interesting consequences. Benjamin Franklin had an idea for the great seal of the United States. An engraving of his idea from August 1776 survives. It shows a pillar of fire and a pillar of smoke hovering in the heavens. To the left on a promontory, Moses and the Israelites are gathered giving thanks to God. In the foreground and to the right are the chariots of Pharaoh and his army being swallowed by the Red Sea. The inscription that surrounds this picture reads, "Rebellion to Tyrants is Obedience to God." This idea for a great seal for the United States takes its warrant from holy scripture, referencing the exodus from Egypt and characterizing the Declaration of Independence as a religious duty.

Now let us consider the great seal that was actually adopted in 1782. On the back of this seal we see a motto in Latin, "Annuit Coeptis," which translates to "approves our undertaking." Mirroring this motto we see another, "Novus Ordo Seclorum," which translates to "new order of the ages." Bracketed between these two mottoes is an unfinished pyramid of thirteen tiers (for the thirteen colonies that were a work in progress), and floating in the air above it is an all-seeing eye enclosed in a triangle, harmonious and symmetrical with the human-built structure below. Here we see the idea of human and divine plans realized together in mathematical order. The American Enlightenment (and Masonic) notion of God as the rational architect trumps God as a direct agent in political affairs.

Let's now consider the relationship of science and democracy from

the standpoint of the founding principles of American constitutional government. First, they are indissolubly joined in a single world system. Democracy is deemed scientifically suited to humankind and its place in nature. Politics is a process of rational decision-making similar in content and procedure to natural science. We can deliberate, debate, decide, and act from common principles on the basis of a single and shared worldview.

Holding this idea in mind, let us now turn to the second author of the worldview you learned in school: Charles Darwin (1808–1882). Darwin is the author of a book entitled *The Origin of Species by Means of Natural Selection, Or the Preservation of Favored Races in the Struggle for Survival*, published in London in 1859. The struggle for survival, or struggle for existence, was a well-worn phrase by the time Darwin picked it up. A common visualization of this phrase before Darwin might be a herd of animals, such as horses or musk oxen, drawn up in a circle and battling against a marauding pack of wolves in the midst of a howling winter storm.

To understand Darwin's version of the struggle for existence, we could look at another snowy landscape—this one a bitterly cold urban street on a late winter afternoon in a nameless northern European city. We see a group of women and children with empty lunch pails struggling against one another to reach up to a window where food is being given out. The fundamental message here is that the struggle for existence is not between predator and prey, but between oneself and other members of one's own species. As Darwin wrote:

> This is the doctrine of Malthus applied to the whole animal and vegetable kingdom. As many more individuals of each species are born than can possibly survive; and as, consequently, there is a frequently recurring struggle for existence, it follows that any being, if it can vary however slightly in any manner profitable to itself, under the complex and sometimes varying

> conditions of life, will have a better chance of surviving and thus be naturally selected.

Darwinian evolution is a remarkably simple idea. It begins with a variation. Individuals within a species vary. Then there is heredity: offspring resemble their parents more than they resemble unrelated individuals. To variation and heredity we add natural selection: different variants leave different numbers of offspring. A simple, colloquial translation would be the following: You and your brothers and sisters do not look exactly alike. You look more like your parents than you look like the parents of the kids next door. Different households have different numbers of kids. From the above three simple statements, it follows mechanically that evolution will occur. This was Darwin's great genius.

The dynamic driver of this process is a struggle for existence. Translated deliberately into the modern economic language that Darwinian writers tend to use because it is so easily understood by everyone, some variants leave more offspring because they are better able to appropriate resources in short supply and reinvest these resources in the production of offspring. This superior efficiency is a manifestation of a greater degree of engineering perfection in solving problems posed by the environment. The excellence of fit between a variant and its environment is called "adaptation."

Seen in this way, Darwinism is a harmonious add-on to democratic constitutionalism. It emphasizes progress rather than stasis. It is about "becoming" rather than "being." It emphasizes freedom and a disarticulation of the parts of the world, rather than some unalterable and indissoluble unity.

Among other things, it led to a philosophy in the United States called Social Darwinism that was popularized by Andrew Carnegie in his book *Gospel of Wealth* (1889). Carnegie argued that struggle was essential and that its outcome improved all humanity, that capitalism was

a natural system and followed evolutionary laws. It also led to another version of Darwin—a "Darwin without Malthus." The Russian philosopher Peter Kropotkin, in his book *Mutual Aid* (1902), argued that cooperation was essential to improve the human species, because humans were a social species. He argued that socialism was a natural system following evolutionary laws.

The conclusion we may draw is that Darwinism was seen as compatible with democracy and was acceptable across the full spectrum of economic theory. The basic debate in the United States was not whether humans evolve and adapt, but what sort of economic system best serves that evolution and adaptation.

I've sketched out for you a scientific worldview in two parts, widely taught—in fact, universally taught—in our school system, both directly and indirectly. It is partly made up of seventeenth-century physics and political philosophy and nineteenth-century biology and political philosophy.

The first reason I wanted to talk about this is that Isaac Newton was mostly wrong about the universe. Newton's theory began to fall apart in the late-eighteenth century. It could not be used to explain heat, light, electricity, magnetism, or chemical combination. Even for gravity, its one great success, it was replaced by something called "field theory" by about 1870.

Modern physics and cosmology are based on a quite different theory. The first part of this is the Special Theory of Relativity (1905), which is what most people mean when they say "relativity," supplemented by the General Theory of Relativity (1915), about which we don't hear too much, and also the Quantum Theory (1905), about which we are told but never in detail until fourth-year college physics. The author of all of these theories, and therefore of the modern worldview, is Albert Einstein (1879–1955). We all know his face. We all know he's the image of genius. We've seen him on the cover of *Time* magazine, chosen as the "Person of the Century." We've seen pictures of him with his woolly

hair, shambling about with no socks on, giving earnest lectures in front of blackboards with incomprehensible symbols. We've seen him puffing his pipe dreamily or riding joyously on a bicycle around a courtyard.

Here's a question that occurred to me sometime ago and had a role in my desire to talk about this topic tonight: if Albert Einstein is so smart, and so cute, and the author of the modern worldview, and the person of the century, why didn't you spend a lot of time in school learning about his theories rather than a three-hundred-year-old theory by Isaac Newton that isn't true?

There are several excuses usually given to explain this. The first is that relativity and quantum mechanics are "too hard." The second is that relativity and quantum mechanics are "too weird." The third, and most often heard, is, "We need to do Newton first. Oops! Time's up!" Let us take a look at each of these excuses in turn.

For the first, let's go back to John Locke, Isaac Newton's friend. In 1687, John Locke wrote a letter to another of his friends, Christiaan Huygens, "Newton has sent to me his principles of natural philosophy. I can follow the argument, but cannot understand his mathematicks. Should I trust he has it correct?" To which Huygens, the inventor of the pendulum clock and one of the world's greatest living physicists at that time, responded, "You can trust the math." The point is obvious: Newton was too hard. That should not actually be a surprise. If we could all understand what is going on at the research front of theoretical physics at the time it is going on, we would probably have long since invented a star drive and traveled to distant galaxies. The whole point of theoretical physics is that at the time really smart people are actually working on it and devoting their entire lives to it, it is way too hard for anyone who is not highly trained and very, very smart. But there is no reason why you can't be told what the conclusions of this work indicate.

And what about the excuse that Einstein is "too weird"? Here we are getting closer to the real reasons that Newtonian rather than

Einsteinian theories are taught in school. The notion that Einstein is "too weird" breaks out into several component parts. The first is the notion that Einstein's work is so contrary to our experience of the world that all one can say is that it is nutty and then refuse to believe it. The second part is the idea that saying "everything is relative" is really bad for the moral development of the child. The third component is the reluctance to accept Einstein's idea that when rational observers see different things (which often happens), there may be no way to resolve their differences. That rational observation and discussion cannot result in agreement seems to undercut democracy's link with science.

What about the tendency to say of Einstein's theory, "I don't believe it?" When the French political scientist Alexis de Tocqueville visited the United States in the late 1830s, he wrote a book about his experience called *Democracy in America*. It is astonishing, as you page through this book, to discover how many of his observations then are still applicable today. On this point of "I don't believe it," Tocqueville wrote: "Americans have a great confidence in their intellectual powers. They think that anything they do not understand after an hour's careful study cannot possibly be true." This attitude is certainly at the root of the claim that we should not teach relativity. There's a larger issue here about the role of expert testimony in a democracy compared to the role of common understanding, but the disinclination to believe anything that one cannot understand after a short period of study must be a challenge to scientific literacy in an age like our own.

Let us turn to the second reason, the notion that saying "everything is relative" is really bad for the moral development of the child. This certainly points to the link between science education and moral development of citizens in U.S. education. And, from this vantage, it is perhaps a plausible reason not to teach Einstein. Yet, one might offer a contrary view. Sidney Hook, an American pragmatist philosopher, a philosopher of liberal education, and a follower of John Dewey, strove

throughout his later life to convince his fellow countrymen that the opposite of fixed views was not subjectivity but "context dependence." Hook argued that moral action required the matching of moral principles to particular circumstances. For example, "thou shalt not steal" is one of the King James Ten Commandments. Another of these commandments is "thou shalt honor thy father and thy mother." Here's the problem: if your parents are starving and the only way you can get food is to steal it, what you do? To honor your father and mother and to save their lives, you must steal. If you do not steal, your parents will die, which, I suppose, is interpretable in some frames as "honoring" them, but for the most part, one would not consider it so. In this scenario, you're going to end up breaking one commandment or another.

The notion that one moral principle you hold could come in conflict with another you hold with equal fervor is not something that is part of the moral education of most children, yet it is true. Moral choice is sometimes tragic, and "tragic" here does not mean "sad" or "pathetic"—it means the contest of right against right rather than the contest of right against wrong. Sometimes your duties will conflict and you must do the best you can. This is equivalent to saying that moral choice is relative to the circumstances in which you find yourself. It seems to be an important and worthwhile lesson for children, and it is at least debatable.

The third reason is that it undercuts democracy's link with science to say that two rational observers will see different things and that there is no way to completely resolve those differences. This strikes me as the fundamental fear and the primary reason why Einstein is not taught in every public school grade from kindergarten on up.

Is it true that Einstein's theory of relativity implies that two rational people can look at the same set of facts and not be able to resolve their differences over what they have seen? Yes, that is the case. Is it true that this fact threatens the link between democracy and science? No. Let's consider why not.

In order to discuss this, I must introduce the idea of reference frames. I think you know what I mean: three pencil lines meeting at a single vertex with the lines marked ABC or XYZ, and then a similar diagram drawn next to it—this is the kind of thing that discussions of relativity always seem to lead to. Soon after we begin to look at these reference frames, we shall have poorly drawn pictures of people in spaceships and railroad cars going past each other in opposite directions with a variety of clocks and measuring rods and so on. When you're teaching relativity, this is where everyone checks out. So, forget about the clocks and the rods and observer A and observer B. It doesn't matter. Here's the point: you see something. I'm looking too and I see something. We don't agree about what we saw. What do we do?

Here is the Newtonian solution that came packaged with the Declaration of Independence. We begin a process of negotiation to find a reference frame in which we can see what really happened. We go to that reference frame and find out what really happened. Let's consider a game of baseball. A player sliding into home is called out. The manager of that player clearly sees from the dugout that his player is safe and dashes to home plate to make his case. It happens to be the case in baseball that managers lose most of these arguments. But there is access to an instant replay camera from another angle, as anyone who has ever watched a baseball game on television can attest. There's also an umpire at third base and one at first base, both of whom are often called upon to give opinions. The replay camera is perhaps our best example. Perched high up in the stadium, it looks down upon the entire field and can be used to settle these disputes. That is what I mean by going to another reference frame to find out what really happened. This is a somewhat idealized version, but it is true to the Newtonian spirit of things.

Now let's try again. You see something. I'm looking too and I see something. We don't agree about what we saw. What do we do? Here is the Einsteinian procedure. I tell you what I saw from my vantage (from

my reference frame). You tell me what you saw from your vantage (from your reference frame). We "do the math" to make sure the laws of physics were working where you were and where I was. If we agree on the numbers, we are done. That is, we agree that our different views of things are legitimate and irresolvable. In the Einsteinian world, there is no reference frame we can go to that trumps the frames we are in and allows us to see "what really happened." All frames for which the math checks out are equally real. Relativity is really relative. Some scientists who teach relativity become enraged when you say this and talk about how they can determine exactly what happened, but all they're saying is that they can determine exactly that the math checks out between two different reference frames. In the Einsteinian world, the world of relativity, science is no longer about the world—science is about human beings viewing the world. This is an important distinction. It is all too often overlooked. So let me say it again: in the Einsteinian world, talk about what is going on is talk about human interpretations of what is going on and human comparisons of different viewpoints about events, without recourse to a single, unique, ideal, privileged, and prevailing frame of reference. To return to our example of the Great Seal of the United States, we get the pyramid but we do not get the all-seeing eye hovering above the top.

Is agreeing about legitimate differences sufficient to underwrite a vital and desirable connection between science and democracy? Let us move from physics to politics and see what we get without the hope for a single unique and privileged standpoint called "what really happened."

Let us consider the case of the Turkish novelist Orhan Pamuk. A little more than a year ago, Pamuk, while on a book tour in Europe promoting his new novel, gave an interview to a Swiss newspaper in which he alluded to Turkish refusal to face up to the Armenian genocide immediately after the First World War. Upon his return to Turkey, Pamuk was arrested and charged with the crime of "denigrating Turkish identity." Making any

public reference to a genocide of Armenians in the confines of the former Ottoman Empire is considered to be a denigration of Turkish identity, regardless of whether such a genocide occurred, which it did.

Following Orhan Pamuk's arrest, there was worldwide outcry. Turkey insisted on its sovereign right to enforce its laws without foreign interference. However, the European Union commissioners voted to send representatives to observe Pamuk's trial. They had no role at the trial; they just showed up and sat there. The Turkish press went ballistic, saying, "You're trying to pressure us and interfere in our affairs!" The European Union's response was, "Not at all." However, the EU continued, Turkey would like to join the European Union, and a prosecution like the prosecution of Pamuk would, in the European Union, be considered a violation of his fundamental human rights. Turkey is of course sovereign, but if it continues to prosecute Orhan Pamuk, it cannot join the European Union.

So, let's look at the scorecard. Turkey asserted its sovereign rights. The European Union said "okay." The European Union asserts that the prosecution of Orhan Pamuk makes Turkey's membership in the European Union impossible. Turkey did not dispute this claim. There was no public denial by Turkey of the Armenian genocide, but there was an assertion that discussing it publicly was illegal. The European Union did not dispute Turkish law. So, what is our result? Turkey and the European Union agreed to disagree. But in doing the math, they both came to the conclusion that Turkey cannot be both in the European Union reference frame and in the current Turkish reference frame at the same time. Turkey cannot be in a position to both violate and not violate Orhan Pamuk's human rights under the European Union Charter at the same time.

As of mid-October 2006, the charges against Orhan Pamuk have been dropped, and Pamuk has won the Nobel Prize for Literature. Similar charges against another Turkish author have also been dropped. Turkey's

European Union membership application is currently back on track. One would say that the Einsteinian frame worked pretty well here. No party in the dispute insisted that their way of looking at it was the only way, and there was public agreement on the consequences of maintaining the differences as long as these two reference frames also persisted.

Let us now turn to a much more difficult example, that of the Israelis and Palestinians. I went online and googled the phrase "Palestinian martyrs" and then googled the phrase "Palestinian terrorists." I asked Google to find me some photographs. What I got from each of these searches was the same set of photographs of the same set of white clad and hooded men with what look like explosives strapped around their midriffs. I then googled the phrase "Jerusalem bus bombing." I got a picture of charred wreckage and blood. What we are left with here is an inability currently to find a unique and definitive standpoint from which we may decide whether someone who blows up a bus full of civilians in Jerusalem is a martyr or a terrorist. What we do know is that such a person is a killer in both these reference frames. We know that the people on the bus died a terrible death. The math checks out.

In continuing my second case and experiment, I then googled the phrase "West Bank" and googled the phrase "Judea and Samaria." Again I asked for photographic images and was offered the exact same map. I then googled "deployment of Israel Defense Forces." I obtained a map of the portion of real estate variously termed "West Bank" and "Judea and Samaria." This map showed which roads were open and which roads were closed whenever IDF forces were on the move.

It is certainly the case at the moment that we cannot find a unique standpoint on which everyone can agree about what this part of the world should be called. However, whether or not Israel wishes to say that IDF forces are occupying this region—a statement Israel does not like-when we do the math and look at the borders and look at the roadmap for the redeployment of IDF forces in this area, we can determine that

Israeli troops are there on top of that chunk of real estate.

I chose this example deliberately because of its extreme and volatile character. The Wikipedia site devoted to this area is currently locked down, because it has become a battleground for editorial changes between two reference frames. The point—and it is extremely important to stay on message here—is to define the reference frames, do the math, and indicate that there is no common viewpoint from which we can decide definitively and uniquely whether someone is a terrorist or a martyr, whether the west bank of the Jordan is a Palestinian homeland or the historic Israeli provinces of Judea and Samaria, or what name should be given to the very large Israeli military presence in this area. Here the agreement to disagree leads to violence and war, but the point concerning reference frames is the same as in the case of Turkey and the European Union and the prosecution of Orhan Pamuk.

Perhaps we can make a brief summary of where I think we are. The Newtonian version of resolution asks you to "think outside your box." This phrase has become a trope for innovative problem-solving in which one moves from a given frame of reference to another frame of reference, which has a solution not visible in the first frame. Confidence, in the Newtonian world, that such a unique and powerful reference frame exists if only we can find it, has much to recommend it and still retains a great deal of utility, but it does not work for most contested and difficult cases. That is, it doesn't work in politics.

Now let's turn to the Einsteinian version of resolution. In the Einsteinian world we ask that you look at your box. You are asked to characterize the frame of reference that you are in and give a description of what you have seen from inside that box. You have to admit that you are, indeed, inside a box, rather than claiming that you see things as they are and that the other guy sees them from a badly distorting box. However, to resolve conflict, you must also ask the other guy to think about his box, to admit that he's in a box, and to give an account of the

world as seen from his box. Then, the two of you meet and compare boxes. You "do the math" and resolve the factual issues. Then you draw up a list of interpretations of these same facts: "terrorist" versus "martyr," and so on. At this point, you may be able to make some progress, but you may not. In the case of Orhan Pamuk, Turkey, and the European Union, some progress was made. In the case of Israel and Palestine, things are bad and still getting worse.

Thus, it might seem to some that in switching from a Newtonian viewpoint to an Einsteinian viewpoint, you give up a good deal for a bad one. I would say, and say quite vigorously, that what you are giving up is a large-scale, distorting illusion about the possibilities for finding unique, problem-solving reference frames that are acceptable to all parties where difficult and contentious issues are concerned. I think this is a hard lesson but not a hopeless one. In the Einsteinian world, our actions are still consequential. Everyone is permitted to have a reference frame in which they have a viewpoint about some set of facts, but they are not allowed to change the facts themselves, only the interpretations of those facts. The lockdown of the Wikipedia regions devoted to Israeli and Palestinian issues has taken place precisely to stop people from trying to change the facts, but not trying to make anyone accept a single interpretation. This is where science comes in, separating fact and interpretation.

The Einsteinian world demands that we see that every situation consists of competing interpretations of facts, with no promise of resort to which interpretation is really correct. This is true of both the Einsteinian relativity world and the Einsteinian quantum mechanical world. If I had more time, we could talk about the duality of waves and particles, or the impossibility of finding both the momentum and location of a particle. These are also reference frame questions. Quantum mechanics is a very fertile area for this sort of discussion and sheds much additional light on some of our difficulties in finding perfect reference frames we can all inhabit and share.

My conclusion is that we should teach relativity in our schools from kindergarten on up because it reestablishes a vital alliance between current natural science and democratic politics. It offers concrete approaches and suggestions to conflict management resolution that grow out of the soil of our own problems and prospects. It is completely compatible with the theory of evolution in both its Darwinian and more modern population genetic forms, another topic I wish I had time to discuss with you.

Einstein had something to say about this business of reference frames with regard to our political and social dilemmas: it was he who first extended the implications of this idea beyond the bounds of the physics he had created. He wrote, "a human being ... experiences himself, his thoughts and feelings, as something separated from the rest. ... This is a kind of optical illusion of his consciousness. ... Our task must be to free ourselves from this prison." The first step to getting out of this prison is to acknowledge that you are in a box. Then you must learn to describe your boxy worldview not as the truth or the only reasonable view or the only correct view, but as a box where the "math checks out." This is a politics of conversation and negotiation not a politics of intransigent declamation.

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