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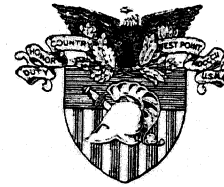

The 24th
Sol Feinstone Lecture

on

THE MEANING OF FREEDOM

By

Stephen J. Gould

31 October 1996

The United States Military Academy is pleased to sponsor an annual lecture series on the Meaning of Freedom. It is significant that this lecture program has been made possible by the generosity of the late Mr. Sol Feinstone, a dedicated American Patriot whose commitment to the ideals of the American Revolution led him to devote many years of effort, as well as considerable personal resources, to the collection of important letters, manuscripts, and books dealing with our heritage of freedom. His donation of these items to libraries and educational institutions ensures that the message which they proclaim will be preserved and transmitted to future generations of Americans.

Mr. Feinstone's abiding faith in the brotherhood of free nations of men has found further expression in several lecture series which he has endowed in order to permit prominent Americans to interpret the Meaning of Freedom.

The United States Corps of Cadets and the staff and faculty of the Military Academy are pleased to recognize the generosity and loyalty of this great American for providing a living endowment in the defense of freedom.

The Meaning of Freedom

By Dr. Stephen J. Gould

SUPT: Members of the Class of 1998, it is good to see each of you in your creative rally outfits tonight. Distinguished guests, ladies and gentlemen, it's my great pleasure to welcome you to the twenty-fourth in a series of lectures addressing the meaning of freedom. This annual lecture series was endowed in 1970 by Dr. Sol Feinstone, who had a very personal interest in ensuring that Americans explore regularly and from a variety of perspectives the meanings that we attach to the concept of freedom. Dr. Feinstone arrived in the United States at the age of fourteen, a refugee from Lithuania, alone and penniless. As with so many newly arrived immigrants, he worked very hard to take advantages of the opportunities this new land afforded him. And he achieved the American dream by becoming a very successful businessman. His success enabled him to establish national awards and scholarships and build libraries such as the David Library of the American Revolution located at Washington Crossing, Pennsylvania. The annual lecture this evening, as well as the twenty-three which preceded it over the past several years, is endowed by Dr. Feinstone as a means to help cadets become more aware of their heritage, their freedom. Representing the Feinstone family here tonight are Dr. Feinstone's daughter, Miriam Golub, her husband Nathan, and Deborah Golub, granddaughter of Sol Feinstone. We are honored by your presence at this lecture made possible by your father and grandfather, and we warmly welcome you back to West Point once again.

We are extremely honored this evening to have a world-renown author and evolutionary biologist provide his unique take on the meaning of

freedom. Dr. Stephen Jay Gould, a native New Yorker and a passionate Yankee fan, graduated from Antioch College in 1963 with a degree in geology. In 1967, he was awarded the Doctorate in Evolutionary Biology and Paleontology from Columbia University. From 1967 until the present, Dr. Gould has been a professor at Harvard University and currently serves as the Alexander Agassiz Professor of Zoology and Curator of Invertebrate Paleontology at the Museum of Comparative Zoology. Just saying that, Jay, is an exam.

Our distinguished lecturer is the recipient of more than forty honorary degrees from distinguished universities across the U.S. and Great Britain. Dr. Gould is also a prolific author of several landmark books in his field and the recipient of scores of national and international literary awards. His more recent works include, *Eight Little Piggies*; *Bully for Brontosaurus*; *Ever Since Darwin*; *The Panda's Thumb*; *Wonderful Life*, for which he was a finalist for the Pulitzer Prize; and most recently, *Full House: The Spread of Excellence from Plato to Darwin*. Dr. Gould is also a regular contributor to *The New Yorker, The New Yorker Review of Books, Discover, Natural History*, and the British journal *Nature*.

Dr. Gould, it is a distinct pleasure to have you with us this evening. We look forward to your thoughts on the Meaning of Freedom Lecture entitled "Evolution in Freedom." Ladies and Gentlemen, please join me in a warm welcome for our distinguished Feinstone lecturer, Dr. Stephen Jay Gould.

Given the venue, we ought to start with a military anecdote. The great French physicist and astronomer Laplace, several years after teaching him at the military academy, met with his star mathematics pupil. This student had become emperor, Napoleon. Laplace handed to Napoleon, according to legend, the first two volumes of what was to be his massive five-volume treatise on celestial mechanics. Now, according to legend—probably not true, but it's a great story—Napoleon looked at these two very weighty volumes, thumbed through them, looked at all the mathematics and formulas and then turned to Laplace and said,

"How can it be that you've written this grand text on the mechanism of the universe and have left out all mention of he who created the universe, God?" Laplace is supposed to have looked back at Napoleon and said, "Sire, I have no need of that hypothesis." Now, what this comes from is Laplace's determinism. I am not going in the direction in which you think; this is not an anti-religious lecture. In fact, if anything it is a plea for reconciliation between two fields that are entirely separate and have equal insight to give us about the nature of the world. No, I bring it up for another context in discussing the meaning of freedom, because what I want to talk about is Laplace's determinism. You see it is the same Laplace—and that's where the statement came from, "Sire, I have no need of that hypothesis"—who was, philosophically at least, the arch-determinist of his time. It is Laplace who famously said, and this he truly did say on many occasions, that if someone could tell him the position and motion of every particle in the universe at any one time in the past, that the entire future history of the universe would then be completely and totally predictable, down to last iota of detail, including my movement of this hand, this much, this way, as I gestured to you. I like to call that notion Laplace's Demon.

Now, I bring that up, that strictest anecdote of determinism in science, because clearly our vernacular sense of freedom is tied up with the notion of a liberty we have to do one thing rather than another, with the concept that we conventionally call free will. And to that extent, if Laplace's style of determinism is correct, and is the proper way to interpret the dictates of science or a scientific view of the world, then, indeed, there is some kind of conflict between what science teaches us about life and evolution and any vernacular concept of freedom. Now, perhaps I should begin, before I give some of the conventional answers or ways out of that paradox, by pointing out that the notion that there isn't free will—that things are determined—in a very broad sense has enormous social implications. And particularly in my field of evolutionary biology, the most negative of those implications have been with respect to social versions of a generalized theory of biological determinism in which people are inevitably condemned to a certain

status in society by this notion because they're simply made that way. So some people are dumb, or some people are less competent. This is the traditional defense of racism and other ugly social doctrines, but they come out of, insofar as they are biologically—falsely—biologically justified, they have come out of a notion that in fact there isn't much freedom, that our social status is pretty much a reflection of the genetics of our biology: we were made that way, and that's how social circumstances are determined.

Let me just show you the first two slides, which are rather ugly illustrations from our history of racism, to illustrate this point. Just to show you that the history of racism is not an artifact of evolutionary theory but is an ancient and unfortunate tradition in the history of Western science . . . this is a pre-Darwinian version, from 1799, in England, and it's not an evolutionary version at all, but is a static or created chain of being. And it's in the conventional order of racism from black Africans to American Indians all the way up to Greek statues, the idea being that if these folks are now politically dominating these folks, it must be a necessary result of the way people are made. This is the ugly side of the lack of freedom implicit in a strictly deterministic view of our social arrangements. The next slide is another version. This is not a racist tract; this is an illustration from the leading Antebellum American textbook of anthropology. This is not in Glidden's *Types of Mankind* of 1853. And in 1854, we see the same sequence—false sequence—from African ape to African human to Greek statuary. So, I do want to record that there is an ugly and immediate political side of this kind of strict determinism.

There are two conventional answers or responses to Laplace's challenge to the idea that everything really is determined . . . just tell me at any time in the past the position and motion of every particle and I will tell you the entire future. But one is Laplace's own answer and the traditional one given by people who philosophically are determinists. Laplace also wrote the greatest 19th Century treatise on probability theory. Now, why should anyone who believed that everything was

determined be worrying about probabilities? It seems paradoxical, except it isn't. Because Laplace's answer is "Oh yes, everything is determined in theory." But, of course we can't know the position and motion of every particle at any one time; therefore, based on intrinsic limit—even though there is true determinism in nature—given intrinsic limitations on our knowledge, we often have to use probabilistic and statistical procedures. When I flip a coin, indeed, whether it is going to come up heads or tails is determined, but it is determined by hundreds of factors that I can't control or know about. And all of these factors cancel each other out and balance each other, and therefore 50/50 is the best prediction that I can make. So that's one answer, namely that there really is determinism, but since we can't know it, the universe appears probabilistic. The other answer of course—and it's the one that I would hold to, though this is really a philosophical position; I can't validate one or the other in any strictly scientific way—is that there is genuine randomness in the universe. Not that everything is random, but that there is enough genuine, irreducible, what philosophers would call ontological—that is, intrinsic to the nature of things—randomness so that there really isn't, in principle, anything that's determined. It isn't a question that we can't know the true determinism of the universe. It really isn't determined; there is just a lot of randomness out there.

Either way you make the argument, the fact remains that there is no potential knowledge of the future, at least in complex historical circumstance, and therefore in that limited scientific sense—because we cannot know the future and we cannot say that people's actions are totally determined in a way that we can predict—there is, at least practically, that sense of freedom. I would go further—now I enter my own role as a professional biologist and evolutionary theorist—that in fact, although we tend to operate under a rather naïve and simplified notion that science effectively means experiment, prediction, determination, replication, and that it isn't real science unless we have that harsh and hard predictability, I would put it to you that that is in fact not correct. Science is a much broader enterprise. It does include certain rather simple problems, relatively, like celestial motion, which

probably are pretty determined by mathematically definable laws of nature. On the other hand, in the realm of science, which is after all the enterprise that tries to figure out the factual state of the universe and its history, we have a whole set of fundamentally historical disciplines, like my own of paleontology. We have these disciplines that are fundamentally historical like paleontology, like geology, and like human history, for that matter, in which you really don't have strict predictability intrinsically. To give you an example from human history, and also a military one, but a key moment in American history . . . this is the angle, as many of you will recognize, of Gettysburg, the very clump of trees that Robert E. Lee, the former Superintendent, directed his men in the infamous Picket's Charge. And the next slide is the famous cycloramic painting of Gettysburg, which many of you have seen, depicting the moment of Picket's Charge. Now we recognize this as a fundamental determinative event in American history. The battle could easily, for reasons you'd know better than me—that's your expertise not mine—could have easily gone the other way, but for a few factors. Lee thought he had silenced the Northern battery, but they were merely withholding their fire. As soon as he sent his men into this withering fire, he knew what was going to happen. I was very touched by the scene in the film *Gettysburg* of Sheen playing Robert E. Lee going back and forth on his horse saying, "This is entirely my fault." The point being that we have enough knowledge historically of what happened at Gettysburg to be able to render a pretty good explanation of it. But, it is a historically based explanation. It didn't have to occur that way. Any one of a hundred events could have led to a different outcome: if the Southern troops had taken the high ground on the first day, if they had managed to outflank the Northern troops on Little Round Top, etc., etc. Moreover, I think that we all have that sense if we could wind back that tape of American history, say to the Dred Scott decision in 1857, would you have gotten this again? If you could wind it back to the Battle of the Plains of Abraham in 1763, and Montcalm had beaten Wolfe, I suppose I'd be giving this lecture in French and we'd have had a very different system.

That's the point. That's the nature of history. Historical events are explainable after they unfold, but they are utterly unpredictable beforehand. And in that sense, although we have satisfactory understanding of history, we do not have predictability; historical sequences can unfold in any one of hundreds of thousands of ways. The best vernacular illustration of that is the *Back to the Future* movie trilogy, which is based on this notion that historians call contingency. That's the key notion that I would rest this talk on: the historian's notion of contingency, namely that what happens makes sense, but since any one of a hundred million sequences could have unfolded, any one of which would have made sense and been be explainable after the fact, and there is predictability beforehand. In that sense our will is effectively free. And I need hardly remind you that had slightly different events occurred and Lee had inflicted on the Northern forces as bad a defeat as he in fact suffered, that the whole course of American History might have been quite different. And although I didn't accept that when I was younger, I think that as I have matured, I've understood better and better that it was not just rhetoric that led Lincoln to his continued statements that we cannot let the Union fall apart, because this is the one great experiment in the building a pluralistic system of many people with different beliefs. And if this fails, and balkanizes and breaks up into lots of different nations, then it will fail as a global experiment. And when we look at the former Yugoslavia and other parts of the world, I'm not so sure that he was wrong. So, in that sense, if this had gone the other way and the South had won the war, which was distinctly possible, I think it's not only American history but all the world's history that may have been much different and not nearly, despite our problems now, as favorable as the light in which it now appears.

So, that's the nature of freedom. There is this kind of contingent freedom. Contingency actually, I'd say, arises because complex historical sequences are tens of thousands of steps. At each step, any one of hundreds of thousands of circumstances could arise. The tiniest little change, apparently insignificant at the moment, could cause history

to cascade down a completely different channel, which would also make sense but would be utterly different from what actually happened. And in that notion of contingency, the unpredictability of complex historical sequences, including evolutionary sequences, lies, I think, the best scientific reading I can give of a meaningful concept of freedom in this factual sense. I will get back to freedom in the moral sense in the end.

But, that's my introduction. But what I want to do for the rest of the time is make two distinct arguments both evolution theory and evolutionary record that is the history of life as paleontologists understand it. And then at the end I want to make a quick closing comment on the ethical dimension of freedom which is something quite different from this scientist concept of how unpredictable is the unfolding of life's history, how unpredictable is the unfolding of our own life, because I think in some notion of unpredictability lies our usual sense of freedom.

I want to talk about the control of evolution by not what we usually think . . . we usually conceive of evolution as at least a broadly predictable process of increasing complexity through time. That would give us far less freedom and far more predictability than we usually imagine. Because under that view, which largely exists for Western prejudices in order to validate our sense that humans had to arise, I would like to propose the alternative view that humans are, in fact, an accidental little twig on this enormously arborescent tree of life, that if you could ever plant it again from seed, from the origin of life and re-grow it, you would be very unlikely to get anything like us again. I do want to say that evolution is ruled by quirkiness and contingency and that humans are very lucky to be here.

First I want to show you a series of slides quickly that illustrate in a humorous way, but I think it's culturally quite deep, our bias in conceiving of evolution as a predictable sequence of increasing complexity through time. That is in fact the only way we picture or understand evolution, and I think that it is a very deep error. I'm going

to show you these slides. I have boxes and boxes of them. The only way we ever depict evolution in standard advertisements, newspaper accounts, is the ladder of progress. Everybody knows that picture. Now of course it is a parody. It's a simplification; it's a caricature. But it is a caricature of what we do believe, or else it wouldn't be so immediately understandable and uniquely used. So, let me just show a series of the slides, which is the over-deterministic view under which there wouldn't be a whole lot of freedom in the history of life. It's just necessarily moving towards something like us. Let's look at the next. This is the American regionalism series, if you will, the California version of surf trunks through history [laughter]. Next slide. I'm a New Yorker, obviously and this is my version. Let's see what's next. All American cultures love this, business culture loves it, especially the computer industry because their products have gotten lighter and cheaper, so it is easier to depict the chimpanzee weighted down by this heavy vacuum tube computer and up it goes to a white male in a business suit with a power-book, thereby enfolding other biases of Western culture into the same picture. Let's see what's next. Oh, yes, pop culture uses it too [laughter]. And next is a comment on my least favorite sport, for which I may be booed out of here. I understand you like this sport. I'm a baseball fan, what can you do. I hear you even have a good team this year. Okay, what's next. Social and political commentary, it's also the only picture of nudity [applause and laughter]. Terrible, terrible. Shame on you. Shame on you all. This is not a sexist cartoon; it's a commentary on sexism. If you want to view the next one as its antidote, I will not object. [laughter and applause] Same icon is used in all countries; we don't know one other way to draw it. I will just show you one other example. This is the only Israeli example I have, and it goes right to left. For those who can read the ancient language, it is a Pepsi ad, and it's a fairly traditional view of human evolution moving up the from the chimp to this penultimate stage of this middle age stogy gentleman drinking his Coke, up to this apotheosis or this acme of evolutionism, this beautiful young thing with a Pepsi. Let's skip the next one because I am running out of time. Skip, obviously the next one. We understand it no matter how it goes. Here's another comment

on my least sport. Or as the next slide shows, a comment on recent American passions, being repeated at the moment, but not for your television delectation. And the next and last slide. This is the only picture we know; we understand that this picture is only four monkeys in dunce caps, but we all immediately understand why it is funny because of the unstated picture of the march to progress. Now, this is the *incorrect* view that evolution is broadly progressive, predictably so and sensibly leading to us.

Let me give you two arguments against that, and that will constitute most of the rest of this talk. First I want to give you an argument from theory, from evolutionary theory, and it's the argument we call the creativity of evolution, creativity that made it possible to make this human brain from an original bacterial stock. The creativity doesn't come because there is a predictable deterministic law that is pushing evolution towards ever more optimal stages of increasing complexity, but rather the quite opposite reason, which enhances that general notion of freedom that the creativity of evolution lies in sloppiness and redundancy and unpredictability in multiple capacities. Then I will give you a factual argument from the actual pathway from life's history, and then I will make a few comments on the other and more common ethical meaning of the concept of freedom.

Let me begin with an analogy, and the next slide will show this because this is true in human culture. Do you know what happens to automobile tires? You see in this wealthy society of ours, we don't recycle. We throw things out. But, in much of the rest of the world, not so fortunate, everything is reused. And the fate of automobile tires, once you can't use them on cars anymore, is that they are used for other things. And in fact, they get carved into sandals all over the world. They make very good, sturdy sandals. I have sandals made from automobile tires purchased in three Third World nations: in India, in Ecuador, and in Nairobi, Kenya. This is a small town in India I passed through where sandal makers are making sandals from automobile tires. The next slide shows the same in Nairobi. I'm going to show you a series of slides

from the recycling market in Nairobi, Kenya. Again the cutting up of automobile tires to make sandals. See here is the point, and why I bring this up as an analogy to evolution: if you just had the sandals, you would look at them and say, "Hey, these sandals are really well designed. Oh, they are made out of automobile tires. Now I know why automobile tires are made. Automobile tires are made so that somebody in a third world nation would have sandals some day." Well obviously that's nonsense; that's ridiculous. It's quite the opposite. It's the unpredictability. Automobile tires are made for automobiles. They happen to have, because of their sloppy redundancy, they happen to have a secondary, quirky, unpredictable utility once they are worn out to be still useful in this totally different role as sandals. The Goodyear Company does not intend this when they make truck tires. And I want to argue that evolution is the same thing. Everything that we value in evolution, everything we think is driving in complexity and predictable and necessary really arises from these same odd, quirky transfers of utility based on redundancies. Let me show you more from the Nairobi recycling market though. We'll go through these pretty quickly. Sorry, it's backwards, but it doesn't matter. This is the part where tin cans are sawed in half and made into Kerosene lamps. Next, where scrap metal is assembled into traveler's trunks. And next, this is most interesting. I came upon a place in the market where all these old, battered oil drums were, and I couldn't figure out why they were there. The next slide shows what happens. They are sawed off at the top and beaten into cooking pans. The next slide shows the cooking pans beaten out from the tops of oil drums. Now, again, when the Shell Oil Company makes its drums, they don't do it so that the tops will be converted into bowls.

Now let me give you an organic analogue from evolution, and then I will make the main analogy that I want to make to the human brain. So, let's look at the next slide. This is a species of heron that lives in African, and it can fly but it rarely uses its wings for flight. It uses it wings instead to shade the water, so it can see fish and catch them. Now, if you ever looked at this species of heron, you would say "Ah," or you might be tempted to say if you were a real determinist, "Oh, this works

so well. My goodness, what a wonderful device! They are shading the water and being able to eat. Now I know why the heron has wings. Obviously it has wings so it can shade the water and catch fish, because that's essential to its life." But, of course you know that that is wrong in an evolutionary world. The heron has wings because its ancestors flew with them for two hundred million years, and then it discovered, through the redundancy of wings, this quirky, secondary utility of shading the water. The reason why I like this example is that it's the same problem of the evolution of wings. There's this old problem in evolutionary theory—I call it "the five percent of a wing problem," but it has a more technical name—that it is perfectly obvious what a wing is for once you have it: it's very good for flight. But, five percent of a wing doesn't help you fly at all, and therefore, although it is clear what it's good for once you have it, how do you ever get there if you have to proceed through a gradual evolutionary sequence from the forearm of a small running dinosaur. The answer that Darwin proposed—and now it is experimentally validated and I wish I had more time to go into it—it must be that when a wing was only five percent of a wing, it wasn't being used for flight, because it offered no aerodynamic advantage at all, it was being used for something else. And our best models, and there's experimental proof, that feathers are extremely efficient thermo-regulatory devices. And the smallest dinosaurs, because of their high surface to volume ratio, had severe thermo-regulatory problems. So, the feathers presumably, initially evolved for thermo-regulation. Later on, they were co-opted for flight, and for two hundred million years the ancestor of the heron flew, and then they were co-opted again—this is a double co-optation—for shading the water. Now, here is the point with respect to predictability and freedom. If you were living back in dinosaur times and you saw this small running dinosaur with feathers covering its forelimb, and recognized that it was useful in thermo-regulation, could you have ever predicted the future history of birds? Would you ever have known that these would enlarge, be co-opted for flight? That a very successful group would fly with them for a couple of hundred million years? That one species would then use them again for something totally different? You would never know that. It's like the

contingency of history. You can explain it after it happens, but you never could have predicted it because history could have gone down one of millions of other potential, equally sensible pathways. That is why that anything that exists is here by the luck of the draw in that profound sense, including ourselves.

Now, this same argument has such applicability to most of the human brain and what we call human nature. There are many things that we do that are universal—reading and writing are obvious examples—and obviously important in understanding our domination and our importance on this planet today. But you cannot argue that the brain got big so that we could learn to read and write. That is, the brain got big for some set of reasons useful to our ancestors on the African Savannas a few million years ago. But by virtue of becoming so large for other reasons, the brain became the most complex computing device that nature has ever evolved. And just by virtue of its structure, it became capable of doing any number of things that have nothing to do with why it first got large. Make the obvious analogy to computers. I own a small factory. I put a computer in my factory in order to issue pay checks and keep accounts. But that computer can do orders of magnitude of other things that I am never going to use it for just by virtue of its structure. It can tie me in tic-tac-toe forever, probably beat me in chess, factor and analyze my data on land snails. That's just an inevitable side consequence of the complexity of its structure. Likewise, our brains were as big as they are now one hundred thousand years ago when no one was reading or writing. Clearly, the brain did not get big so that we can read or write, essential as that may be to what we call human nature today, and human domination. That is just a lucky side consequence of a neurological complexity built for other reasons. That's how quirky, that's how unpredictable, even though the end results are sensible, evolution is. That's one of the chief fascinations of evolution, in producing sensible and eminently unexplainable, but utterly unpredictable and unrepeatable phenomena.

All right that's the first one, but now let me give you my favorite illustration of the history of life, illustrating the principal of numerous multiple possibilities. This is a brief summary of the main theme of my book *Wonderful Life*, published in 1989. The next slide shows a biased way we draw the tree of life. I call this bias the "cone of increasing diversity." That is, we start with a single common ancestor, and that is correct because evolutionary theory does tell us that all related forms have common ancestry. But then we always draw the tree. This may be subtle, but it is a very severe bias. We always draw the tree just going smoothly up and out. Now up is only supposed to mean younger in time. But, it is so easy to conflate up with better. And so we see everything moving upward and "betterward" if you will. And the reason why it's a bias is the shape of the cone itself. That's why it is so identified. The point is that there is so little room at the bottom, that there is only space for a couple of branches, and you can't draw any extinct lineage down at the base of the tree. And since there are only a couple of spaces for lineage, it must be the precursors of major branches that come later, and therefore, the whole tree achieves this predictable and inevitable character. The early lineages must leave large numbers of descendents because everything grows up and out to more and better. The next slide just shows one other textbook example of this biased way of looking at the world. The next slide shows a theoretical alternative. I want of course to argue in a moment that it is actually what happens as well. Here we keep the requirement of beginning at a single point, but instead of just moving up and out to more and better, predictably increasing excellence through time, without much freedom, play, experimentation, unpredictability in the process . . . instead you get a maximum spread of anatomical designs very early in the history of life. Not a large number of species, but a vast range of anatomical possibilities. And then most of them die out. The history of life is mainly the story of extinction. Let's look at the next slide, which is actually a better illustration of the same. Same story, only a few lineages survive. Now, the surviving lineages may generate a large number of species, and consequently there may be many more species than there ever were, but those species are in fewer anatomical groups.

Now you may look at this and wonder, "Why is he bringing this up?" Because the obvious interpretation of this quite different geometry for life, the obvious interpretation is if anything even more deterministic in the cone of increasing diversity, because this must be telling us that there was a great Darwinian struggle going on down here. All these lineages were living here all at once, and they duked it out and nuked it out with each other. And the ones that fell by the wayside were predictably said to lose by virtue of an anatomical inferiority, and the winners were destined to do so. That is a possible interpretation. I do not deny the logic of that possibility. However—and this is the reason that I bring this up—under this geometry, which could be bogus, there is an alternative interpretation which is a very friendly to contingency and which is simply not available under the old biased cone of increasing diversity. And that is, if I may speak metaphorically for a moment, suppose instead of this grand Darwinian struggle with winners surviving by predictable cause based on their anatomical superiority, suppose instead all you got, speaking metaphorically, by living in this early period of enormous diversity, all you got from nature was a ticket, a ticket in the biggest lottery ever held on the surface of this planet. And the groups that survived were only those who held the winning tickets by chance. And therefore if you could wind back the tape of life to this early period and just redistribute the tickets differently and at random, you would get a completely different set of survivors every time. It would always make sense, but you would never get anything like the creatures we know. And in that crucial sense—because, indeed, I think that is how the history of life works on this planet—in that sense every lineage, including our own, alive on the surface of this planet today is here fundamentally by the luck of the draw. And our very existence is part of nature's freedom, if you will, a non-determinism of evolutionary pathways. And I think that there is good evidence that this is so. As you probably know, effectively all major groups of organisms appear—of animals, of complex multi-cellular animals—appear in the fossil record in a short space of about ten million years, 530 years million years ago, called the Cambrian Explosion. Since then, no new phyla, that is basically new anatomical designs except on tiny group that you probably

never heard of called the Bryozoa, has appeared, and that in itself is an interesting puzzle. So, indeed this seems to be true. There was once this enormous spread of diversity, and the survivors were few, and in fact we have no reason to think, though I recognize the limitations of negative evidence, we really have no reason to think or suppose that the few survivors of this grand Cambrian Explosion were predictably meant to do so. Luckily, we know this because we have a wonderful fossil locality in western Canada called the Burgess Shale where luckily the soft parts of organisms were preserved, and it came right after the Cambrian Explosion. Therefore, we do have good evidence of the full range of anatomical design realized in these early times. I just want to quickly show you some of these creatures and then I will make my few final comments on the moral notion of freedom.

First of all, eighty percent of modern animals are insects. I think you know that. Our planet is dominated not by vertebrates, but arthropods. It's the age of arthropods among multi-cellular creatures. And yet all modern arthropods, although there are a million described species, only go in three major groups. There's the insect group, the scorpion/spider/horseshoe crab group, and the crustaceans—the marine arthropods: the lobsters, crabs, and shrimp. In the Burgess Shale—it's *one quarry* in British Columbia, and there aren't many species there; there's just this much broader range of anatomies . . . in one quarry in British Columbia, shorter than the width of this auditorium, there are a dozen of other kinds of arthropods that just didn't make it, and we do not know why. Redistribute the tickets differently and you would have a different world. Let me quickly show them to you. This is *Merrella,* the most common organism in the Burgess Shale. It is clearly an arthropod, segmented appendages, but not related to any modern group; they just died out, though they were the most abundant then. Next, this is *Yohoia.* It looks vaguely like a shrimp, but shrimp are crustacean and therefore have five pairs of appendages on the head. This creature instead has three pairs of walking legs on the head shield and this odd, bent appendage, which is so unlike anything else in an arthropod that the man who described it simply called it the "great appendage. Let's look at the

next. Little *Sarotrocercus*, a couple of millimeters long, legs converted into swimmerets, swims on its back. Next slide. *Odaraia* looks like a bivalve crustacean, but it isn't. Only one pair of appendages in this whale-like tail flute, but it's only this big. Next slide. I am running out of time, so we are going to have to go quickly. *Sidneyia*, which looks vaguely like a horseshoe crab but it isn't; horseshoe crabs are chelicerates. Chelicerates have six pairs of appendages on its head and this one has one. Who knows what it is—they just died out. Next, this is *Leanchoilia.* If complexity and excellence of adaptation won you a ticket—in other words, if it wasn't a lottery—the world should be crawling with *Leanchoilias* today. This is the most elegant, complex, adaptive creature in the Burgess Shale. It's got this marvelous great appendage with a right-angled bend and three whiplash extensions. This whole apparatus can be folded back against the body for streamlining and swimming, because this both swam and crawled. But they are gone. There are no *Leanchoilias* on this planet today, and we don't know why. By contrast, the next slide, the *Sanctacaris*, which is the first chelicerate, that is, a member of the spider/scorpion/horseshoe crab group, did leave descendents. We don't know why this and not others. And this next one, *Aysheaia*, a member of a small group called the velvet worms, the onychophora, they also left descendents. We don't know why, maybe they just got a lucky ticket.

Now, let's jack it up a level. Let me just show you some of the organisms in the Burgess Shale that are just completely unlike anything we know. Let's see what's next. This is *Opabinia*, which had five eyes and this vacuum cleaner-like nozzle that bent around to bring food to a central mouth. Next, *Nectocaris*, which vaguely looks like a chordate, that is, a member of humans' phylum at the rear but an arthropod in front. Next, *Amiskwia*, a flattened, worm-like creature of unknown affinities. Next, this is *Odontogriphus*, a flat, annulated, gelatinous creature with a row of soft tentacles around the mouth, with these two pits, which were presumably sensory. Next, *Dinomischus*, a rooted creature, which vaguely looks like an echinoderm, but it isn't, and in many ways the most interesting. Next slide. The *Anomalocaris*, the

largest of all Cambrian organisms, the terror of the Cambrian seas, up to three feet in length, the dominant predator of its age. It had this odd mouth on the underside, which uniquely in nature worked on the camera constriction principal, rather than the flopping hinge jaw principal. And its arthropod-like pair of appendages, its bellows like body, three to five feet long—completely gone. And one last creature, the last slide you'll have to see. A very humble rare creature in the Burgess Shale named *Pikaia*, but it is the first chordate, the first member of our lineage. But distribute the tickets differently and *Pikaia* doesn't get one this time, and all of vertebrate history, all of us, from seahorse to trout to hippopotamus to you and I are wiped out of the history of life, and no one is the wiser, and you get just as explainable, just as sensible, just as interpretable history of life, except that history includes no self-conscious creature to ruminate about it. That is how contingent and odd our evolution is. That's how the history of life looks. That's how I read evolution.

What I want to acknowledge in closing is that I'm talking about this almost factual concept of freedom as multiple possibilities. I do of course want to acknowledge that when we discuss freedom, we usually mean the term in the very different, moral sense. Freedom is an ethical concept. And I do want to acknowledge that there is nothing about the factual world of science that can possibly resolve ethical issues for us. Science is the realm of the "is." How *is* the world made? Why *is* the world made that way? Ethics is the realm of the world of "ought." How should we be living our lives? There's no necessary connection between the two. As T. H. Huxley said in a famous essay in the 1890s, "Let's study nature and see how it works. But maybe proper moral behaviors to figure out how nature works and then do exactly the opposite." There is no necessary connection. That is why there should be no conflict between science and religion. Science, properly construed, is the enterprise that deals with the factual state of the universe. Religion, properly construed, is an explanation of ethics and values. We desperately need to consider both sides of that in developing the wisdom of any complete life. We need to know how the universe is made, and

we need to struggle with issues of how we ought to behave, but one can't inform the other. They are separate and therefore both important. That is the proper resolution. I think most theologians would accept this, that so-called issues of science and religion should not exist. They are just different and equally valuable enterprises. So freedom as an ethical concept is quite different. It does not make reference to whether we are determined or not. Freedom as an ethical concept says that we should be free to strive. We should be free to reach our potential, whatever it is or however determined it might be in any scientific sense.

So let me end with a story from antiquity that is, in a sense, the ultimate answer to an overly deterministic view. See, I don't deny that there are biological influences on our behavior, on our thinking processes and that these constrain us in important ways. But, ultimately we are not automata; we are not a part of a Laplacian system where everything we do is determined. Because in the complex mentality of our brains is the great flexibility—the same one that allows the tires to be made out of the sandals, that gives us the freedom even under constraint to do otherwise than what our inclinations may lead us.

The story is this. Plato was not the only person to write dialogues about Socrates. There are a few Ciceronian dialogues about Socrates, or tales about Socrates. In one, a man named Zopyrus comes to Socrates—and Zopyrus is an early phrenologist, that is, he feels that he can look at the shape of a man's head and determine what his moral behavior is like. Zopyrus goes up to Socrates and looks at him and then tells Socrates' disciples that their master is a venal character. I mean, he is someone who obviously has very bad traits of morality, and he can tell by looking at his head. Now, Socrates' followers are infuriated. "How dare he say that about our perfect master, our ethical master?" And they are about to stone Zopyrus, but Socrates stops them and says, "No, you must not do this. This man is right. What Zapirus says is entirely correct. I do have these traits of character, but I have overcome them by the use of reason."

Thank you.

Q & A.

Q: Sir, I was wondering if you think there is any room in science for predicting this latent potentiality, or is this just nature's way of being creative? And if it is just being creative, then perhaps it shouldn't be predicted at all?

A: No, I think . . . Certainly one could look at the automobile tire and say there is a range of potential uses, and you can certainly specify what it can't do. It's not going to function at certain temperatures and will wear out at a certain rate. But, I think that the potential is so broad, and human inventiveness is so high, that to think that we could get in a a Laplacian sense, a fully determined and exclusive, exhaustive list of such possibilities is fatuous. And since the argument is entirely transferable to larger patterns in the history of life, I think very much the same. Yeah, I can look at a vertebrate and say it is this size and has these appendages, and that an elephant is never going to fly, except in *Dumbo*. So there are constraints, but there are so many possibilities within those constraints, we could never enumerate them.

Q: Sir, what you said about religion and science—and I don't know, I'm just a cadet—but to try to bring them a little closer together, what I was thinking is that . . . Sir, to go to your lottery metaphor, maybe God fixed the lottery and that maybe he was controlling that machine where all the balls come out and say what numbers come out. Maybe he had it set so that like the lottery would come out for humans?

A: You know you are free, obviously to construct philosophically a lottery claim any way you want as long as it has the factual character that we predict. Science just can't address a question like that. There isn't room. It doesn't mean that you are wrong. I am not saying that. I'm saying that science . . . every field has to respect the disciplinary boundaries of its own methods. Science is a discipline that can determine the factual state of the universe and propose theoretical

explanations for why it's that way. We can't answer questions—I don't think anyone can—but we certainly can't, answer questions about ultimate meaning, such as you are proposing. So, what you say is conceivable, I can't refute it, but it's just not a part of science. Similarly, as we have that responsibility not to end of the world of ultimates, of ethical decisions, religion also has a responsibility not to lay claim to be able to determine the factual state of the universe through a reading of a particular document that was written a couple of thousand of years ago. So, if your notion of religion requires you to believe that the earth is six thousand years old, I'm sorry you are wrong. It isn't. So, I think that each side has to respect the limits, the intrinsic limits of the discipline. And when you do that, and I will say science has to respect its limits as much as religion. What I am saying is not at all radial; it's just the conventional position of leading theologians of all major religions. In fact last week, when the Pope made this announcement that evolution was kosher, and it got front page news in the *Times,* I just couldn't figure out why, because that's been the Catholic position all along. That is the conventional position of all major religions. I mean [Pope] Pius [XII] argued in the early 50s that Catholics may believe whatever science has determined about the evolution of the human body, so long as they believe that at some point God infused the soul. Well, I don't deal with souls as a scientist; I can't. So of course anyone is free to believe what they wish or what they think they can validate in their souls about souls. I claim the realm of the body as a scientist, and that's a fair resolution.

Q: Sir, I believe you stated that if the chordates hadn't received their lottery ticket then there wouldn't be any conscious minds to ruminate about the history of evolution. That seems overly deterministic, do you . . .

A: Well, where is the alternative. I just asked you to look at the actual history of life. The only lineage that has produced anything even at all close is a very good lineage, and the best that you can do otherwise are octopus and squid, among the mollusks. The only argument you can

make against that is that the vertebrates suppressed the possible evolution of self-conscious intelligence in other groups. I don't see any other way to validate that. Admittedly, it is a limited record, but it is the only record we know, the record of life's history on this planet, and empirically, there is not lineage other than vertebrates that seems poised in any way to invalidate that claim.

Q: Sir, I understand that I'm wrong and that there is no way that the universe can be six thousand years old, but could you please explain the relationship between the second law of thermodynamics, which is entropy, sir, to the theory of evolution?

A: I don't know how you want me to do it. The traditional form of Creationists' invocation of the second law of thermodynamics, which is entirely incorrect and is a misconstrual of the second law of thermodynamics, holds that since the second law does argue that entropy or disorder must increase, that since order has in fact increased on the earth, therefore, it cannot be a natural process and there must be divine inspiration behind it. But that's simply in error, because second law doesn't say that. Second law says that entropy must increase within closed systems, because in an enclosed system that has no input of energy, there must be a homogenization of the energy that's in there that leads to entropy or increasing disorder. The earth is not a closed system. The earth is bathed in a constant supply of solar energy of which we use just a tiny percentage by the way. Consequently, locally—and the earth is just a local little dot in the solar system—locally, order may increase on earth, because throughout the history of earth there has been this constant and unending influx of vastly more energy than we ever use. And therefore, if there is an increase in complexity of life's history on earth, there isn't anything at all contrary to second law of thermodynamics that's going to . . . And look, the official creation is rhetorician, like Duane Gish, you know that perfectly well. And it's, in my book, the best indication of their prevaricative nature. They are rhetoricians; they are not trying to make a scientific argument. Gish knows that as well as I do.

Thank you.

Dr. Gould, on behalf of the Class of 1998 and the United States Military Academy, I would like to thank you for taking the time to come out and speak with us this evening. As a brief token of our appreciation, I would like to present you with this book, entitled *The Corps of Cadet: A year at West Point*, signed by the Superintendent, LTG Christman.

SOL FEINSTONE'S CREDO

DEDICATED TO

The Judeo-Christian commitment of self-sacrifice for peace on earth, and the brotherhood of free nations of free men;

The Spirit of '76, a struggle of free men to remain free

The immigrants who came after the revolution and helped build our country in freedom;

The underprivileged of all races who, by uplifting themselves, will raise all mankind to a higher humanity.

MY DEFINITION OF FREEDOM

In the beginning there was a void of sameness; the spark of life made everything different.

The stamp of sameness is the stamp of death.

Freedom to me means a social order based on individual freedom to live differently and to dream differently. I dream of a Brotherhood of Free Nations of Free Men.

SOL FEINSTONE

PAST FEINSTONE LECTURES

1971 - General Harold K. Johnson
1975 - Rear Admiral Jeremiah A. Denton, Jr.
1976 - Herman Wouk
1977 - Sidney Hook
1978 - Vernon E. Jordan, Jr.
1979 - Barbara W. Tuchman
1980 - Alistair Cook (Feb)
1980 Isaac Bashevis Singer (Sep)
1981 - Carl Sagan
1982 - George F. Will
1983 - Hanna H. Gray
1984 - Milton Friedman
1985 - Daniel Patrick Moynihan
1986 - Tom Wolfe
1987 - Elie Wiesel
1988 - A. Bartlett Giamatti
1989 - Dr. Richard Selzer
1990 - Dr. John Stoessinger
1991 - Fred Friendly
1992 - Dr. Orlando Patterson
1993 - Terry Anderson
1994 - Ambassador Madeleine K. Albright
1995 - Dr. Doris Kearns Goodwin