

Leonardo da Vinci and the Perspective of Light

by D. Stephen Pepper

The remark has been attributed to Napoleon, that, when it comes to generals and prostitutes, sometimes amateurs do better than professionals. And, I believe that's true of historians. I'm using the term "amateur historian" in the Labor Committee* sense of the term; that is, someone who pursues truth for the love of it. Whereas, professional historians are more inclined to dilute the truth, in order to make a living. So, we have a kind of simple definition of an amateur, and a professional, in this field.

Now, I speak with some authority, because I am both. I have been, and to a certain extent, still am an amateur in the love of truth, in the sense that we have used that in the Labor Committees. I also make a living as a professional art historian, and so I know something about diluting the truth, or doing whatever one does in the course of making a living. And, this evening, I'm going to try to use both experiences, so to speak, to try to set up an argument which has the validity of the pursuit of truth, but which also has a certain amount of what we used to call in the bad old days of the 1960's, "bourgeois historian professionalism." That is to say, I'm actually going to try to quote directly from the sources, so that you can see that I'm not making it all up.

The first thing that I want to show you, is this famous image, the "Baptism of Christ"—and, for those of you who've had



FIGURE 1. *Andrea del Verrocchio, "Baptism of Christ" (with Leonardo da Vinci), c. 1470.*

the good fortune to be in the Uffizi in Florence, you will recognize this as Leonardo da Vinci's earliest contribution to the history of the visual arts [SEE Figure 1]. He

This article has been edited from a lecture presented in Leesburg, Virginia, in September 2000. A biographical note appears on page 53.

* The International Caucus of Labor Committees, the philosophical association founded by Lyndon LaRouche.

painted this figure here, the angel on the left, and this landscape here above the angels, in a painting that was otherwise done by his master, Verrocchio. And, what I'm going to try to show you, is that these are indeed two different universes, side by side, one by Verrocchio, and one by Leonardo, which operate on fundamentally different principles. And this was so striking, that when Verrocchio saw Leonardo's contribution to this painting, he decided to quit painting. He realized that if this young man, who was less than twenty years of age when he did this, was so far ahead of him, there was no point in pursuing the *métier* of painting. So, he devoted himself for the rest of his life, to being one of the greatest sculptors who ever lived.

Verrocchio was no fool, however. He was no second-rate man. But, the incredible effect of this contribution of Leonardo's, staggered Verrocchio, and staggered the world. So, let's try to look at it in greater detail if we can [SEE detail, front cover, this issue].

The point is, that compared to Verrocchio's work, and to everyone else's at the time, Leonardo's figure was bathed in atmosphere. It was bathed in a luminous atmosphere, and therefore, it appeared to be much more natural, and breathing, and much more complete, than anything that Verrocchio did, or anybody else did. And you can see all of that in the various flickering ways that the light plays, and so on. This is not just a technique, or an approach to art. This was a fundamental understanding of the physical universe. Which is, for Leonardo, that the fundamental, the primary character of the physical universe, is *light*, and its correlate, shade. Light and shade, from which all objects emerge.

Pascal has said, that we understand more than we know; that is, our grasp of what is true, or what is real, or what is existent, is greater than our level of knowledge at given any time. And this is exactly the situation with Leonardo. It fits Leonardo perfectly, because Leonardo was, I think, nineteen years old, when he did this. He did not know, as yet, the principles on which he based this image, but he under-

stood them. He understood that this is a physical universe. That it was not an abstract universe, made up of lines, or contours; but, actually, it is *phenomena* that he was dealing with. And from this time forward, from the very beginning of his activity, Leonardo was interested in only one thing: the exploration and understanding of these phenomena. Only later did his knowledge grow, as to what he was already actually comprehending, and acting upon, in this image.

And that's what we will try, in very brief fashion, to recognize tonight.

Leonardo: Father of Physics

What I'm saying, to put it very simply, is that Leonardo is really the father of physics. For him, this was not abstract, but physical in nature. And I want to try to document that, beginning with this passage from his Notebooks, which I want to read to you:

Among the studies of natural causes and reasons, light chiefly delights the observer. And among the great features of mathematics, the certainty of its demonstrations, is what preeminently elevates the mind of the investigator. Perspective, therefore, must be preferred to all the discourses and systems of human learning. In this field, the radiating line of light is explained by those methods of demonstration which form the glory, not so much of mathematics, as of physics, and are graced with the flowers of both. But, its axioms being laid down at great length, I shall abridge them to a conclusive brevity, arranging them by the method both of their natural order and mathematical demonstration. Sometimes by deduction of the effects from the causes, and sometimes arguing the causes from the effects, adding also to my own conclusions, some of which, though not included in them, may nevertheless be inferred from them.

Thus, if the Lord, who is the light of all things, vouchsafed to enlighten me, I will treat of light, wherefore, I will divide the present work into three parts, being a treatise on light.

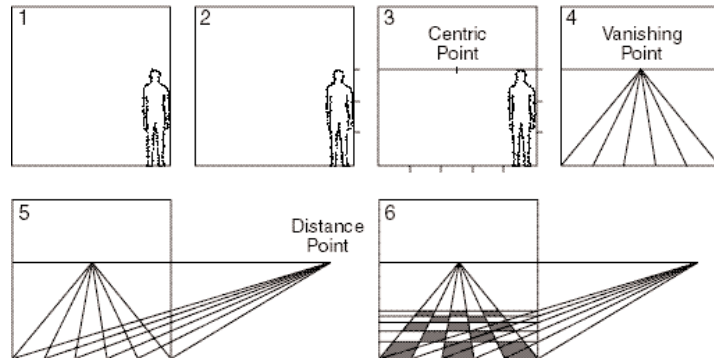
Now, this is a beautiful statement, and certainly puts to rest the claim that

Leonardo was an atheist, which is advanced by many people, because he didn't spend all of his time talking about God. But he had it very clear here: "The Lord is the light of all things," which I think is a very adequate statement. From that light, we are enlightened, and he pursued the study of light. Perspective, is the study of light. Now, this was a radical departure.

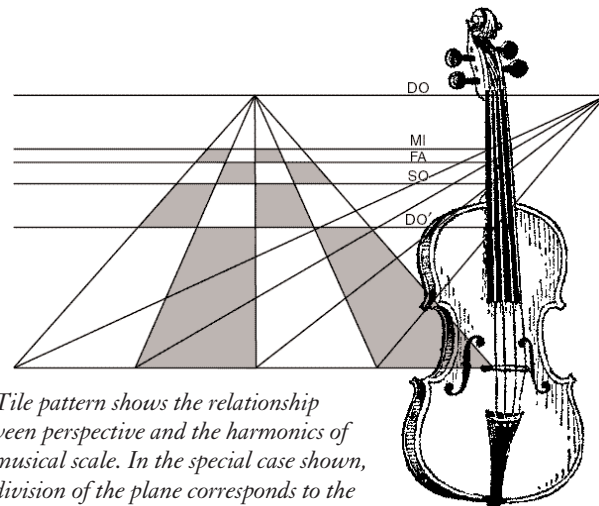
First of all, we see how important perspective is, that this is what we're dealing with in the Fifteenth and early Sixteenth centuries, in what we call the Renaissance. Perspective was a fundamental issue in the Renaissance.

I brought along a couple of charts that some Labor Committee members and I did many years ago [SEE Figure 2]. I want to just show you the background, briefly, of perspective. Figure 2(a) is what is called a "*costruzione legittima*." The great architect, Filippo Brunelleschi, this great genius, was also a political office-holder in Florence, he was in charge of the Maritime Commission of Florence, he was everything, a multi-faceted character. Now, Brunelleschi *demonstrated* perspective: He did not prove it. He did not argue it. He demonstrated it. He made what we would call a "camera obscura," a little box, which was pointed at the Baptistery of Florence. He put in a mirror, and he made a perspective drawing, and in the perspective drawing, he made a small hole, which is the key thing in the story of the camera obscura. So, when the light rays came through that hole, he had drawn on the back of this screen, the Baptistery, so when people looked through it, they could see, on the mirror, reflected, an absolute construction of the Baptistery, done by a perspective drawing. And they were absolutely astounded. They couldn't believe it. They didn't know what they were seeing, whether they were seeing somehow the Baptistery transformed, or whatever. Then, he did it again, with a two-point perspective, for the Palazzo Signoria, the seat of government. I've always believed that it was important for Brunelleschi to show that perspective worked both for the Church and for the State. It wasn't just something that worked for one part of the society, and not for the other. Because, that's the way his mind worked.

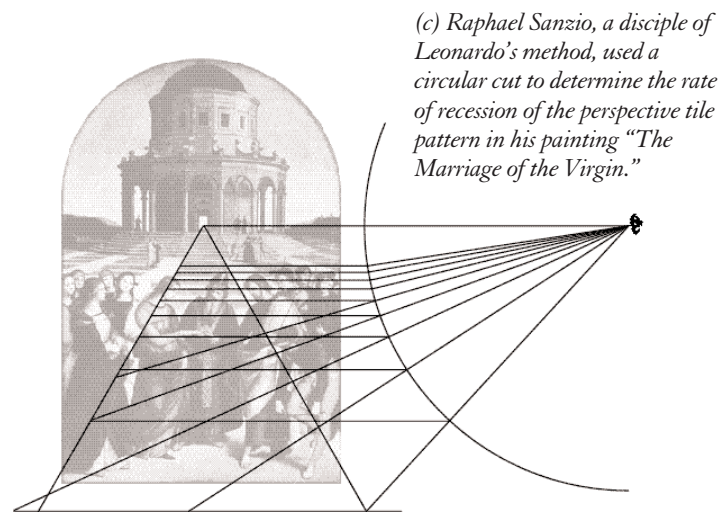
FIGURE 2. *Development of perspective in the Renaissance.*



(a) Construction of perspective "tile floor" by Leon Battista Alberti, using "*costruzione legittima*."



(b) Tile pattern shows the relationship between perspective and the harmonics of the musical scale. In the special case shown, the division of the plane corresponds to the diatonic scale.



(c) Raphael Sanzio, a disciple of Leonardo's method, used a circular cut to determine the rate of recession of the perspective tile pattern in his painting "The Marriage of the Virgin."

In any case, along came Leon Battista Alberti, a dozen years later, and he wrote a small book called, *On Painting*, originally in Latin, and then translated into Italian, and there he showed how you could construct a perspective drawing, which is shown right here [Figure 2(a)]. Basically, what Alberti did, is he applied principles that were used in surveying, to create the *costruzione legittima*. You have the horizon line, which is placed here at the height of a man; then, you have orthogonals, lines which are receding into space, which meet at a central point; and then, by extending the horizon line to a certain point, you then create a series of diagonals, which cut the orthogonals in such a way, that when the drawing is completed, they give you the tiles of recession, corresponding to visual perspective, linear perspective.

And, it's further shown in the diagrams, that these lines would cut a string, in such a way as to give you the major scale [SEE Figure 2(b)]. And, Leonardo commented on that in a page of the *Codex Atlanticus*. There's a wonderful book by Rudolph Wittkower on the *Architectural Principles in The Age of Humanism*, which shows how the entire system of Renaissance architecture, applying Platonic principles, and this discovery, was developed, whether we're talking about Brunelleschi, or Alberti, or Michelozzi, or any of the great architects.

This is why perspective was such a cen-

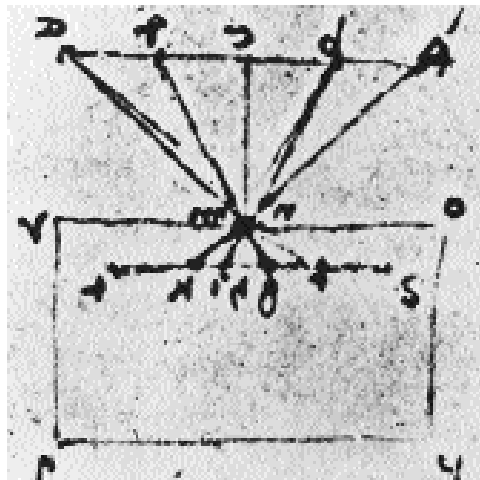


FIGURE 3. *Leonardo da Vinci, Notebooks, drawing of camera obscura, Manuscript D, fol. 8a.*

tral issue in the Renaissance: Because it showed very clearly, and very precisely, mathematically, that the Universe was harmonic, and ordered by harmonic principles. After all, before Brunelleschi, people *did* see things in depth, they didn't just bump into chairs, and go around like blind people. In fact, if you look at paintings by Giotto, or you look at antique art, and so on, there is an approximate perspective, which is called "natural perspective," based upon the similarity of angles. You can get a relatively visually satisfying image on a flat wall, by using these techniques. But it was not mathematical, it was not harmonic, and it was not demonstrable that it worked universally. Therefore, it could not be said to have the authority of law.

That was the situation when Leonardo appeared.

One more diagram: This was the perspective system supposedly used by Raphael in the "Marriage of the Virgin" [SEE Figure 2(c)], where, instead of using straight lines, he's using curved lines to create the intersection; that's how to interpret the funny way that this recedes. And of course, that represents a very significant development internally in the history of perspective.

Now, I'll just take a moment here to show you a one of Leonardo's scientific diagrams: it's a *camera obscura* [SEE Figure 3]. And if you look at this, and at his use of orthogonals, as in the drawings from the *Codex Huygens* I'm going to show you later, it's perfectly clear that Leonardo was thoroughly familiar with the previous history of perspective.

The Revolution in Perspective

Some of you may remember discussions of this that I made many years ago. This is a diagram that appears several times in Leonardo's Notebooks [SEE Figure 4], and it shows three equal spheres, or balls, and then it shows two intersections, and then a curvilinear intersection. What he shows is, that, according to linear perspective, the further an object is from the eye, the smaller it should appear, and the great advantage in linear perspective is, that it gives you a very

precise, mathematical system for establishing the ratios of distance to size and to height. But here, you can see that if this intersection is very close, the further two objects on the periphery, would project a broader, that is, a larger image, than the one in the center, which is closest to the eye—contrary to the presumption, and contrary to Nature. However, if the intersection is curved (line *gf*), then that distortion would disappear. What is debated very much is this line *ed* here, this intersection. The person who wrote the text I have here, claims that what this line is, is Leonardo re-projecting onto a linear surface, the new intersection, which would permit him to render a curvilinear or spherical perspective back onto a flat surface. It's the problem that John Mercator faced, in making a map of the globe. Well, it's not so clear, and also, it doesn't seem to work.

What is absolutely certain, however, is Leonardo's analysis that shows that there are devastating flaws in the way linear perspective was understood. Because, if you come very close, or you extend the angle of vision, and you approach the margins, you get phenomena, you get anomalies, which don't correspond to Nature. Now, since the principle of perspective, which was universally accepted by the leading thinkers of the Renaissance, is, that it is universal and true under all conditions, this left a gaping hole. And Leonardo, in his usual way, determined to solve the problem.

We see in one of the drawings that Leonardo made, that, in great measure, he was concerned with correcting this problem geometrically, with curved intersection. In fact, that became later on a great preoccupation of the school of Leonardo in the North of Italy. But, I think that Leonardo's primary solution went in another direction.

Let me, first, just read to you. Leonardo writes, in Manuscript E—I'm going to make a comment about the manuscripts in just a moment, after I finish this point—Manuscript E is dated 1513-14; he died in 1519. The earlier manuscripts are 1490-92, so this is a relatively late comment.

"The practice of perspective may be divided into"—and then he leaves blank how many parts; he hasn't decided—"of

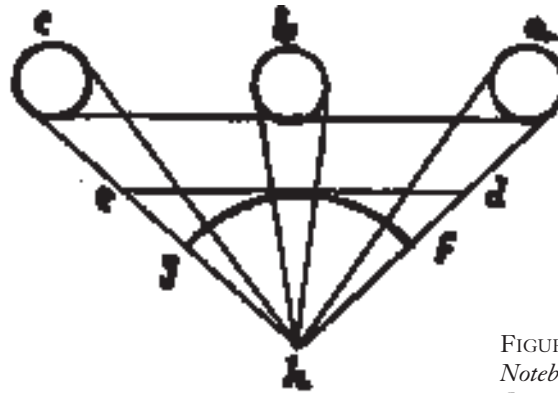


FIGURE 4. *Leonardo da Vinci, Notebooks, diagram showing flaws in linear perspective, redrawn from Manuscript E, fol. 16a.*

which the first treats of objects seen by the eye at any distance. And it shows all these objects just as the eye sees them diminished, without obliging the man to stand in one place rather than another, so long as the wall does not produce a second foreshortening." Well, that's a very obscure phrase, and I can't interpret it, so I'll just leave it. You know, he uses the term "*pariete*," which can mean a lot of things. "But the second practice is a combination of perspective, derived partly from art, and partly from Nature, and the work done by its rules, is in every portion of it, influenced by natural perspective, and artificial perspective." Now, that word "artificial" in the translation, is a modern word; I don't remember what appears in his Italian, but we can look it up. "By natural perspective, I mean that the plane intersection on which this perspective is represented as a flat surface, and this intersection, although it is parallel, both in length and height, is forced to diminish the remoter parts more than its nearer parts. And this is proved by the first of what had been said above, and its diminution is natural. But artificial perspective, that is, that which is derived by art, does the contrary."

And that's exactly the point we've just seen, in the three-sphere diagram: It operates *contrary* to natural vision. "For objects equal in size increase on the intersection, where they are foreshortened in proportion, as the eye is more natural and nearer to the intersection, and as the part of the intersection on which it is figured, is further from the eye."

Leonardo's Notebooks

I am now going to intrude upon this argument, a comment about the Notebooks. There are about 7,000 pages of notes by Leonardo. He probably made 20,000 in all, of which two-thirds are lost. So, you can see that the problem of dealing with Leonardo's thought is complicated by the fact, that we have only about a third of what he wrote down. I don't believe that this is devastating, as most writers do, because it seems to me, that he went over problems, he returned to them. The main issue is, for us, to establish the chronological sequence, so that we know where his thought finally arrived. Because it's very clear, from even my relatively simple and superficial consideration of these problems, that what Leonardo thought about perspective in 1492, he certainly did not think in 1513 or 1514, and so on. What is really interesting, is to try to sort out the progression of his thought. Because, in regard to perspective, he went from believing in the linear, geometric abstraction, to believing in the physical principles of the phenomena of light, as defining perspective, as we have just heard.

Now, this is completely different from all the famous Renaissance characters that we know so well: Brunelleschi, Alberti, up to that beloved personality, Piero della Francesca. Piero della Francesca, for instance, was not interested in anomalies. He was interested in the immutable, unchanging laws of Nature. If there was a problem at the periphery of vision, or when you got close, or this or that, it didn't concern him. He wanted to represent, and to demonstrate, the immutable structure, given by geometry, of the Universe. As you know, Piero's most important work was devoted to the ordering of the five Platonic solids. He was the culmination, you might say, of a long tradition of research, going back to Leonardo Fibonacci, on this problem. And his work was taken over by Luca Pacioli, and Pacioli joined Leonardo in Milan, and elsewhere, to produce the *Divina Proporzione* (*Divine Proportion*), which is a special case, the Golden Section, based on the ratio of the side, to

the long diagonal of the pentagon.

However, Leonardo was not interested in the *immutable* laws of Nature. Leonardo was interested in the fact, that the immutable laws of Nature *appear to us in a mutable, transient* Nature. And therefore, we have to discover the relationship, using our senses, and using our experimental method, we have to *establish* the relationship, between the transient Nature, and the immutable laws. This became *physics*. This became the systematic study of physical phenomena which *reveal*—which cannot be assumed, but reveal—immutable laws. He was not about to throw out immutable laws and introduce a chaos theory, or something. But—just like God: God does not appear to us. He is *communicated* to us *through* the visible universe. And we *discover* God in the visible universe. And by so doing, we come, as Cusa and other people have studied, we come to know the nature of God *indirectly*.—*Vero, no?* We don't know Him—wake up in the morning, and there He is sitting at the end of the bed! We have to *discover* all of this.

And that is the character of Leonardo. He is going to examine the phenomena of Nature, to discover, in these transient forms, the true character of the Universe. And this, to my mind, is the birth of modern physics, and is one of the great changes in the history of culture. Certainly, the period of Brunelleschi to Piero is a great change, but the change from Leonardo to Raphael to eventually Kepler, and so on, is an even greater one, in my view. And this is the nature of it. And I will hope that we can all stay awake long enough, that we can get to Rembrandt, and see that Rembrandt is part of this process, that he is fundamental to this process.

The Role of Light

Now, as I said, one of the principal things that Leonardo came to recognize, which makes the difference between his view of 1492 and his later view, is the role of light. Let me quote:

Every body in light and shade fills the sur-

rounding air with infinite images of itself, and these, by infinite pyramids, infused in the air, represent this body, all in all, and all in each part. Each pyramid that is composed of a long converging course of rays, includes within itself, an infinite number of pyramids, and each has the same power as all, and all as each. The equidistant circle of converging rays of the pyramid gives to their object, angles of equal size. And, the eye will receive the thing from the object, as of equal size. The body of the air is full of infinite pyramids, composed of radiating straight lines, which are caused by the boundaries of the surfaces of the body, in light and shade, placed in the air. And the further they are from their cause, the more acute are the pyramids. And although in their concourse, they intersect and interweave, nevertheless, they never blend, but pass through all the surrounding air independently, converging, diverging, diffused. And they are all of equal power, all equal to each other, and each equal to all. By these images of bodies, are carried all in all, and all in each part, and each pyramid, by itself, receives, in each minutest part, the whole form of the body, which is the cause.

Now, this is really one of the most beautiful statements of physics that you can ever come across. You can see, that what he is saying is, that, it is as if this luminous air, which we occupy, has the *potential for all images*. Everything that we see, is potentially there in this luminous air, as a consequence of light and shade. Now, when you think about it, you can see that that's what we saw, in the difference between Verrocchio and Leonardo. In Verrocchio, as in all other artists of the Fifteenth century, the images are all closed and bounded, as if they were sealed into themselves. With Leonardo, none of these images are sealed or bounded. They are all interacting with the atmosphere. And that interaction, the active ingredient of that interaction, is light and shade.

Now, I'll show you a stunning drawing by Leonardo, which gives you the idea [SEE Figure 5]. He has drawn the light, so that it strikes this object. Just grasp the incredible precision of his eye and of his rendering. You see, he shows how the light on the surface turned to the light, how it gradually turns into shadow, and

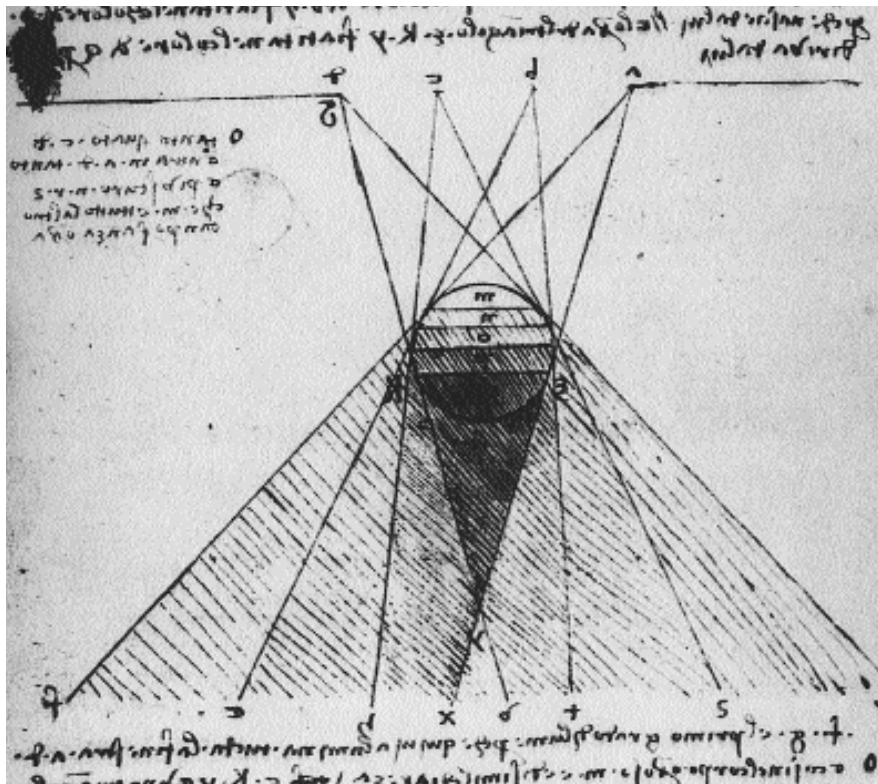


FIGURE 5. Leonardo da Vinci, *Notebooks*, drawing of gradation of light and shadow, Manuscript B.N. 2038, fol. 13v.

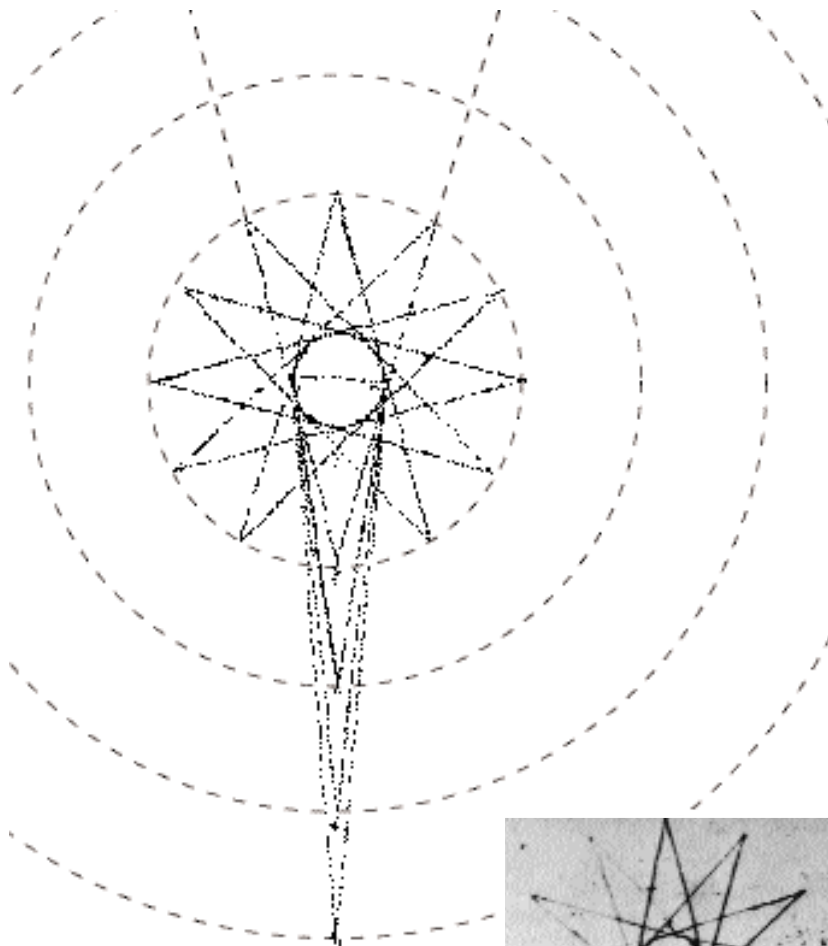


FIGURE 6. *Leonardo da Vinci, Notebooks, diagram of spherical radiation of light, redrawn from Manuscript A, fol. 86v.*

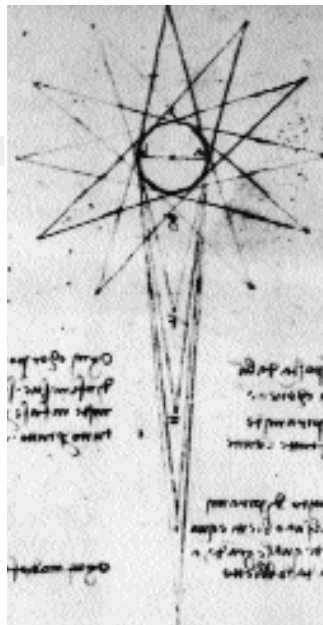


FIGURE 6(a). *Detail, Leonardo da Vinci, Manuscript A, fol. 86.v.*

therefore, the area where no light reaches, has become perfectly dark. Where there are all of these gradients, this is where there is a mixture of light and shade. In other words, contrary to what most people believe, light and shade are continuous in nature. They don't cut off. They don't have boundaries. Of course, this is the

basis for his famous rendering of drawings in the method of *sfumato*, "smokiness." And he shows you that all of this can be measured, by degrees, not numerically, but by degrees of shading.

So, you see, that where the lines in Alberti diagram were simply abstract, geometric lines, here, they represent the phenomena of light rays, which is a totally different idea.

I'm going to show you another remarkable drawing [SEE Figure 6]. You see here, his drawing of how these cones, these pyramids—and in the center, this is the object that is radiating, and these cones show you the directions of radiation, radiating out in all directions; and also, these are the concentric circles, in which, as the light diminishes, you can see by degree, and also, you can see that the angle becomes more acute. The inset corresponds more closely to the original Leonardo drawing [Figure 6(a)].

I'll now turn to some written material again. Remember, what I'm pointing out here, is the progression of Leonardo's thought about these matters.

The Treatise on Painting

We come now to Leonardo's preparation for what has come to be known as the *Treatise on Painting*. He prepared a treatise on painting that was not published—actually, he left the notes; what is known as the *Treatise on Painting* is a codex in the Vatican Library, which was prepared by his student Melzi, based upon Leonardo's notes, and presumably, his instructions—it was not published until 1561, and a modern edition only came out in 1894 by the grandfather, or the great-grandfather, of a scientist who collaborated with us, named Winterberg. So, like most of Leonardo's material, it did not see the light of publication in his lifetime. It was published in France in 1561, and the definitive edition was done by Winterberg in, I think, 1882, in Vienna, as part of a history of treatises, including, eventually, *The Divine Proportion*. In fact, Winterberg may have done the edition of *The Divine Proportion*, and

somebody else did the *Trattato (Treatise on Painting)*. I don't remember now; I may have confused them.

However, the fact is, that, in his preparation for the *Treatise on Painting*, he wrote these things:

There are three branches of perspective. The first deals with the diminution of objects as they recede from the eye, and is known as diminishing perspective.

That is, basically, linear perspective, or Albertian perspective, or some form of geometric perspective.

The second contains the way in which colors vary, as they recede from the eye.

The third and last, is concerned with the explanation of how the objects ought to be less-finished in proportion, as they are remote, and the names are: linear perspective, the perspective of color, and the perspective of disappearance.

You see, the further away, the objects become fuzzy. They lose whatever apparent definition they have. Let me read you something from a book I'm working on writing now: "Leonardo attributes the causes of these three perspectives, in the first instance, to the structure of the eye, and in the latter two, to the atmosphere which intervenes between the eye and object seen. The causes all concern physical effects. The role of the atmosphere in transforming boundaries and colors, or the structure of the eye, in seeing diminution. In this, Leonardo differs from all of his predecessors," etc.

So, this is where Leonardo arrives. He is concerned with the physical principles of perspective. He uses the language of geometry, of abstraction, indeed as Cusa does, as a language, but he does not believe that this geometric language renders the reality. For example, as you know, there is, as you approach the horizon, at long distances, there is a transformation in the color scale towards the blue or the ultraviolet. We all see that in a airplane or at long distances. We all see the diminution of clarity or precision in objects seen at a distance.



FIGURE 7. Piero della Francesca, "Montefeltro Altarpiece," 1469-74.

I want to just briefly show you Piero della Francesca, dearly beloved Piero della Francesca. This is his altarpiece in the Brera [SEE Figure 7]. You can see precisely what I am talking about here, in regard to the point that Piero della Francesca is not interested in anomalies. He's interested in the immutable character of visual reality, and he believes that it's on that basis that we encounter, or recognize, divinity. You can see, just as in his teacher Domenico Veneziano, a half-century earlier, all of the colors remain of the same intensity, wherever they're placed.

I'm going to show you another example



Alinari/Art Resource, NY

FIGURE 8. Piero della Francesca, "Birth of Christ" ("Adoration"), 1480.



Alinari/Art Resource, NY

FIGURE 8(a). Detail, "Birth of Christ."

of this from Piero, just because it's so much fun to see it [SEE Figure 8]. Here's something which adorns many of your walls, the "Adoration" in the National Gallery in London, and I'll just show you a detail [Figure 8(a)], which undoubtedly reminds you of Luca della Robbia's "Singing Cantoria," now in the Opera del Duomo of Florence. You can see that Piero has not changed his system at all over the fifty intervening years, and you can see the per-

spective maintains its clarity; so that one of the things that appeals to us, in Piero, is the purity and the assertiveness of the geometric forms, and the way they hold their clarity and precision throughout. That's exactly what Leonardo set out to overthrow! Not in a mean-spirited way, but in a developmental way.

The Last Supper

I want to introduce something else into the argument now. You all know this, all the world knows this, Leonardo's "Last Supper," in the refectory of the church of Santa Maria delle Grazie in Milan [SEE Figure 9]. I want to make a rather surprising comment: As you know, this painting is a failure. Leonardo tried to use a new technique, and by any account, in its limited sense, it was a failure. The picture is a ruin. It became a ruin almost immediately, and it caused Leonardo considerable embarrassment. But, on another scale, it is the greatest success in history, because it's the most famous painting in history, and it has had an enormous influence, and so on.

So, what's going on here?

First of all, was Leonardo so stupid that he just went ahead and did something, tried a new technique, for no reason at all? No, he *had* to do something. I don't know if you know what fresco is, but fresco is a method of applying paint on a wet, prepared surface, a plaster wall surface. That surface is called *intonaco*, and it's very unforgiving. You can only cover a certain area at a time, because, as the surface dries, the paint will not adhere. So, you have to paint very quickly, you usually have to prepare everything with, what in Italian are called *sinopie*, underdrawings, and then, you have to fill in the paint, the lines of the drawings on the wet wall. You can only do a certain amount each day, what is called, not surprisingly, *giornata*, a day's work. And one of the things we study in art history, is we can now discover all of the *giornate*, so we know exactly how a wall has been painted.

But you can obviously see, from this

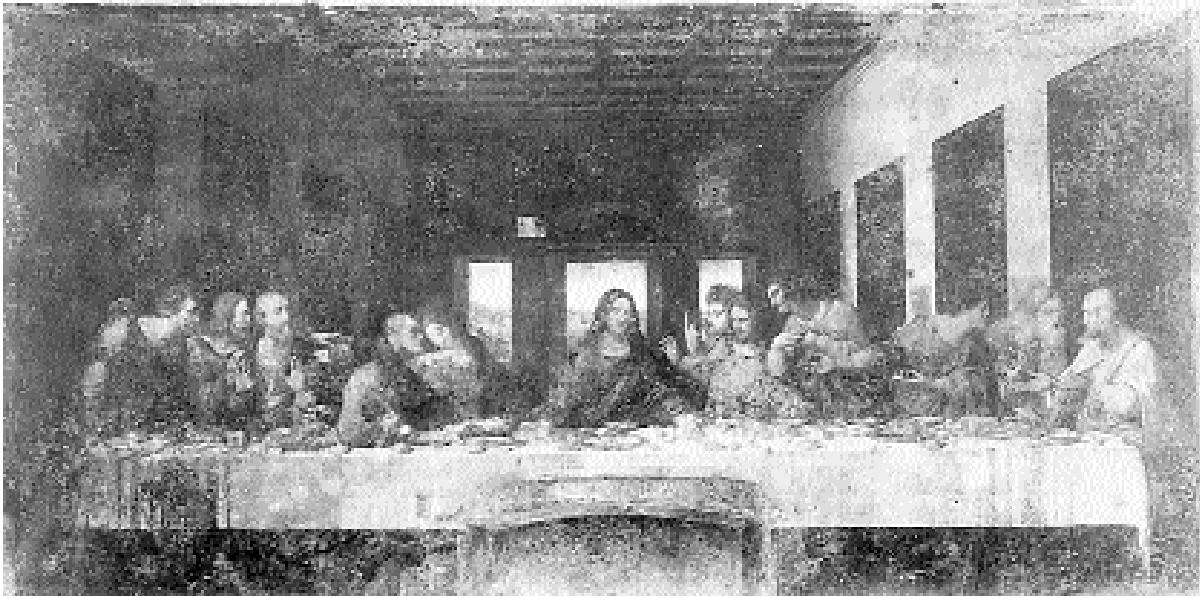


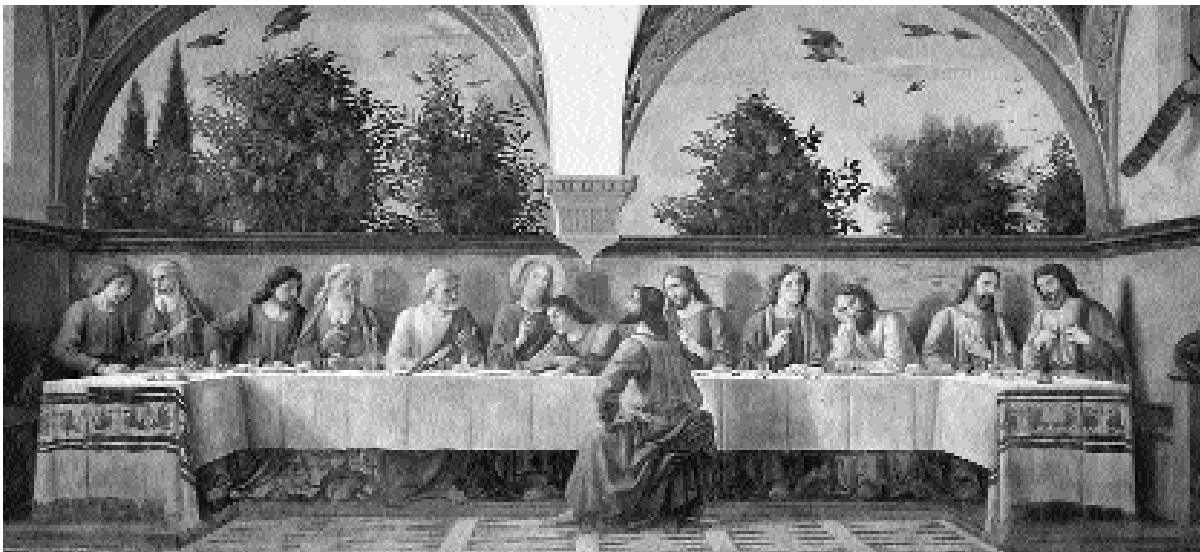
FIGURE 9. *Leonardo da Vinci, "Last Supper," 1495-98.*

method, that you have no opportunity to change your mind, or to do something instinctive, or intuitive, or to capture something fleeting. Everything is prepared in advance, and then you have to put it on, put it on, put it on. So, what was Leonardo attempting to do? He was attempting to free himself. He tried to develop a method by which you could paint directly into the wall, in a method similar to oil painting—but different from oil painting—so you could make changes, you could change things around, and you could enlarge upon what you were trying to do, if you changed your mind here and there.

What Leonardo was trying to do, was to make the whole thing *expressive*. He was trying to show what the response of the Apostles was when Jesus announced, "One of you will betray me." Which is indeed a thunderclap observation, and is worthy of being demonstrated.

Let me show you the traditional way this was presented, before Leonardo. This is a "Last Supper," painted by a contemporary, or near contemporary of Leonardo, a contemporary of his teacher Verrocchio, named Domenico Ghirlandaio, and a very great painter, indeed, a wonderful painter [SEE Figure 10]. But, he always has to play

FIGURE 10. *Domenico del Ghirlandaio, "Last Supper," 1480.*



the foil to Leonardo, because he makes such a good foil. This is Ghirlandaio's fresco, which exists in the refectory of the church, I believe it's the church of the Ognissanti, located exactly between the two luxury hotels, the Excelsior and the Grand, in Florence. There's the Piazza Ognissanti, and that's where this is. I could just as well show you Andrea Castagno, or any number of other people who painted a "Last Supper." But after Leonardo, no artist who wanted to be thought of in any way as modern, ever painted a "Last Supper" looking like these: static, without drama, without emotion, without movement, without change, and so on.

This is the problem which was, in part, enforced by the fresco technique. So, that's what Leonardo was trying to do. That's what caused his ruin. He was trying to introduce, into this, a means by which you could show the expressive content of the painting.

Now, what I am going to say here is this: There is a direct connection between considering the Universe from the standpoint of *physics*, and transforming the art of painting, into the art of *expression*. The change in the volatility of the work, the change in the expressive power of the work, is directly connected to Leonardo's conception of the world that we live in, as a physical universe, consisting of phe-

Leonardo's Unity of Thought

There is a book on Leonardo by Kenneth D. Keele, *Leonardo da Vinci's Elements of the Science of Man*,* which is a very honest book, I think, and which tries to reconstruct, more or less accurately, the material. How brilliant he is, or not, I leave to your judgment. But, at least you won't be dealing with someone who believes that Leonardo is an Aristotelian, or a member of the faculty of the University of Chicago, or something like that—which many people do.

The usual idea is: "Well, Leonardo's a botanist on Monday, and then on Tuesday, he takes up his brush, and then on Wednesday, he's working on mechanics; and on Thursday" As if he were forced to fit into the disciplines, as they are established. But, the great challenge, and the great puzzle of the Notebooks, as they have been left to us, is how to reconstruct the

unity of Leonardo's thought. Two-thirds of the Notebooks are lost. They have been corrupted. For example, the famous *Codex Atlanticus* was slapped together by a crude salesman, to sell it.

But, meticulously, over time, scholars have, to some extent, reconstructed what can be rediscovered of Leonardo's original notebooks. What people have not been able to discover, principally for a problem of cultural prejudice, is how these all go together as a unity of thought.

For example, Leonardo did a book, or a treatise, on astronomy, that was meant to be part of a chapter of a super-treatise, which included a treatise on the eye, which has survived; we have the codex that deals with the subject of the eye. Well, no one in modern times would do that. But, in Leonardo's way of thinking, since it was the eye that received the astronomy, the heavens, they went perfectly together.

er. He was trying to have a totality of how the physical world functions: how we see, what we see, and so on. So, the super-treatise would have gone from astronomy, down to botany. There would have been a book, one of his books, on light. This is really something you can explore. You can get the various publications, Richter's edition of the Notebooks, which again, you see, distorts the situation, because it's organized by category—which is useful, in one sense, you know, "Perspective," and so on. But Leonardo never considered perspective isolated from astronomy. The problem is, that when you get these modern works, the categories that they establish are contrary to the systematizing that he did, which would have made it possible to follow his thought through. The challenge of anybody who wants to pursue this—and you don't have to be an expert to pursue it—is to establish Leonardo's continuity of thought.

—DSP
post-lecture discussion

* (New York: Academic Press, 1983).

nomena that could be represented. Because the principle here is the principle of, fundamentally, light and shade, then elaborated by gesture and pose, and so on, all of which are really extensions of the same notion, that Nature, the physical world, is not fixed and immutable, but changing and transient, and that if you have to render it, you have to be able to render its *changing* character, and not its fixed character. So that's what all of this is about. That's why, in his usual fashion of recognizing how *anomalies* give us insight, Leonardo said that the people you have to observe are deaf mutes. In fact, his student Melzi's son was a deaf mute! I didn't know that; I just read about it in preparing for this talk. He goes on, in his Notebooks, saying how, if you want to study gesture, you have to look at deaf mutes. The point is, that art, as the art of *expression*, and not of fixed verities, is another invention of Leonardo's. And it comes, as directly—I can't say it's an extension of, it's part and parcel of his view of how the physical universe functions. I'll read you some comments of his.

I'm reading from this book that I'm writing on, basically, the art of expression, or at least that's the first part of the book—just like Leonardo, I'm going to have a book on the art of expression, and this is part one of it, devoted to an artist named Annibale Carracci: "Fundamental to Leonardo's outlook, is that material phenomena, observed in the world, are not autonomous, but are, instead, the consequence of causes that arise through the action of universal laws of Nature." And that is the idea: that we are confronted with a world of phenomena, a changing world of phenomena, but which have a source in universal law. "Further, Leonardo believed that these laws could be known, and that it was the task of the artist to penetrate the surface of Nature, to reveal their actions. Since painting is, in fact, a science, in fact the greatest of all sciences, it not only represents the appearance of all things, but it reveals the causes

which create them, and reveals how they are formed. The scientist-painter not only portrays Nature, but its intentions. Leonardo expresses these views throughout his writings, and in his paintings, but they are most concisely expressed in the *Paragone*, the first part of the *Codex Urbanus*, preserved in the Vatican Library, entitled, *Libera di Pittura di Maestro Leonardo da Vinci, Pittore, Scultore Fiorentino*. That is, *Paragone*, which is a famous book in itself, is the introduction to the *Treatise on Painting*. "Leonardo writes:

If you despise painting, you will certainly be despising a subtle invention, that brings philosophy and subtle speculations to bear on the nature of all forms. Sea, land, plants, and animals, grasses and flowers, which are employed in shade and light. Truly, painting is a science, the true-born child of Nature. It is in the joining of painting, which extends to the surfaces, colors, and shapes of all things created by Nature, to Philosophy, which penetrates below the surface, in order to arrive at the inherent properties, which makes of the painter, he who apprehends the foremost truth of these bodies as the eye errs less.

"The purpose of so much of Leonardo's effort, indeed, the very purpose to write the *Trattato* [*Treatise*], is directed at training the painter's eye to see with the penetration of philosophy, so that painting, the most noble of all sciences, because it serves the eye, will realize its true purpose, to deal with the quality of things which constitutes the beauty of the works of Nature."

So, you see where this development, in its broadest form, has been articulated by Leonardo.

Now, here is more in my text, specifically on the expressive content. The woman who edited the *Paragone* wrote, for Leonardo, "the body was shaped by the spirit, and it is for the painter to reverse this process, and to create a body that give expression to the soul." One of Leonardo's followers, Lomazzo, wrote this story about Leonardo: "There is tale told that Leonardo once

wished to make a picture of some laughing peasants. He picked out certain men, whom he thought appropriate for his purpose, and sitting close to them, he proceeded to tell the maddest and most ridiculous tales imaginable, making them, who were unaware of his intentions, laugh uproariously. Whereupon, he observed all of their gestures very attentively, and impressed them on his mind, and there, made a perfect drawing, which moved those who looked at it to laughter, as if they had been moved by Leonardo's stories at the feast.

"Leonardo further comments: 'A good painter is to paint two main things, namely, the man, and the working of man's mind. The first is easy; the second, difficult, for it is to be represented through gestures and movement of the limbs, and these may be best learned from the mute, who make them more clearly than any other sort of man.'"

So, let's look at the "Last Supper" again. Now, the virtue of any lecture on art, is that you can *see*. You can *see* that the whole question . . . —just like these men laughing uproariously, the gestures are captured. Here is how Leonardo has proceeded: with numerous drawings, he has captured when someone hears something appalling or sur-

prising, just as the gestures of a deaf mute. And of course, only a trace of this is left today, but you can see that the whole environment is luminous, and the Christ, at the center of this luminosity, with the light behind him, is the key to the whole arrangement. But, this you can all see, so I'm not going to spend the time waxing poetic about what *I* see.

Instead, I want to show you this [SEE Figure 11]. Wonder of wonders! It's Rembrandt doing the "Last Supper." Now, Rembrandt never went to Italy, and yet he understood the "Last Supper" perfectly. He made four or five drawings, based upon prints that he saw of the "Last Supper." But he understood Leonardo. And he created this masterful drawing. Unfortunately, we can only get a glimmer of it here. He's transformed it, of course, but he's understood the idea of *emphases*, expressed in contrasts of heavy emphasis of shadow, and so on. And he has grasped the importance of every gesture, or the gestures. And, it's just a wonderful, lively, red-chalk drawing, which communicates much more of the essence of Leonardo, than very accurate copies.

So, we've now brought Rembrandt into the picture.

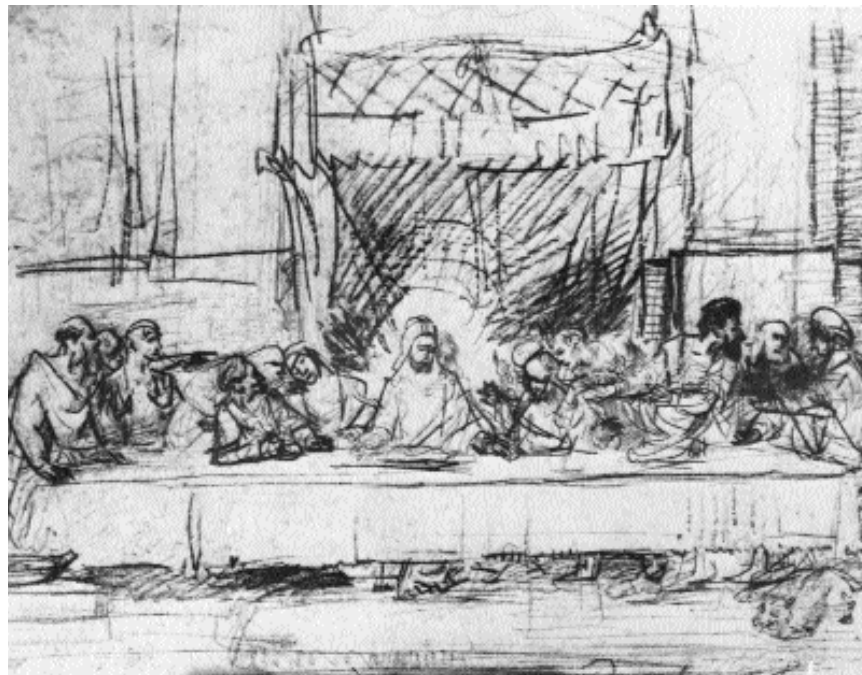


FIGURE 11. Rembrandt van Rijn, "Last Supper" (after Leonardo da Vinci), red chalk drawing, 1634-35.

The Metropolitan Museum of Art



FIGURE 12. *Exhibition catalogue, "Rembrandt: Experimental Etcher," showing successive phases of plate, "Rembrandt Drawing at a Window," 1648.*

Rembrandt: Light and Shade

This is the cover of an exhibition catalog on Rembrandt as an engraver [SEE Figure 12]. What is wonderful about this, is that it shows you, all on one sheet, about fourteen or fifteen proofs of the same etching. First of all, it's very important that it's Rembrandt who's making the engraving, or making the drawing. That is, it is a man who is at work with his mind. And since Leonardo has pointed out, that the hard point is to represent the working of the mind, the movement of the mind, then we have a wonderful expression of that here. He has posed himself next to a light source, almost like a Leonardo experiment.

And, what he has changed in the successive proofs, what he has studied so meticulously—just like a Leonardo Notebook—is the penetration of greater and lesser light, the interaction of light and shade. In that interaction, the entire content, the expressiveness of the work is contained.

I can show you several other examples of how what concerns Rembrandt in each and every case, is the change in the proportion of the amount of light available, or the interaction of light and shadow. For example, we have this famous print of the Crucifixion [SEE Figure 13]. You'll see, that time after time, what concerns Rembrandt is almost the "quantity" of light, or shade, or darkness, or lightness that will appear.

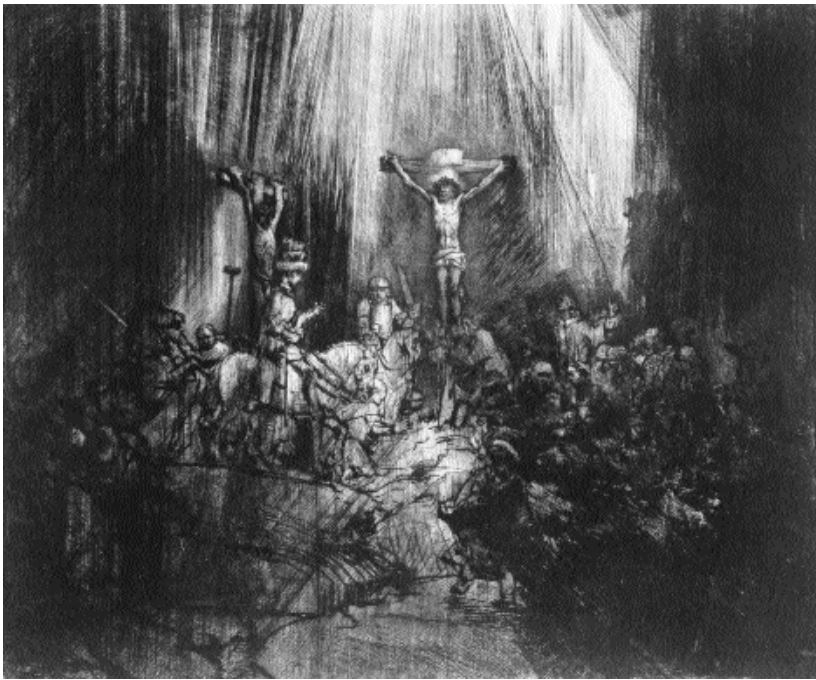
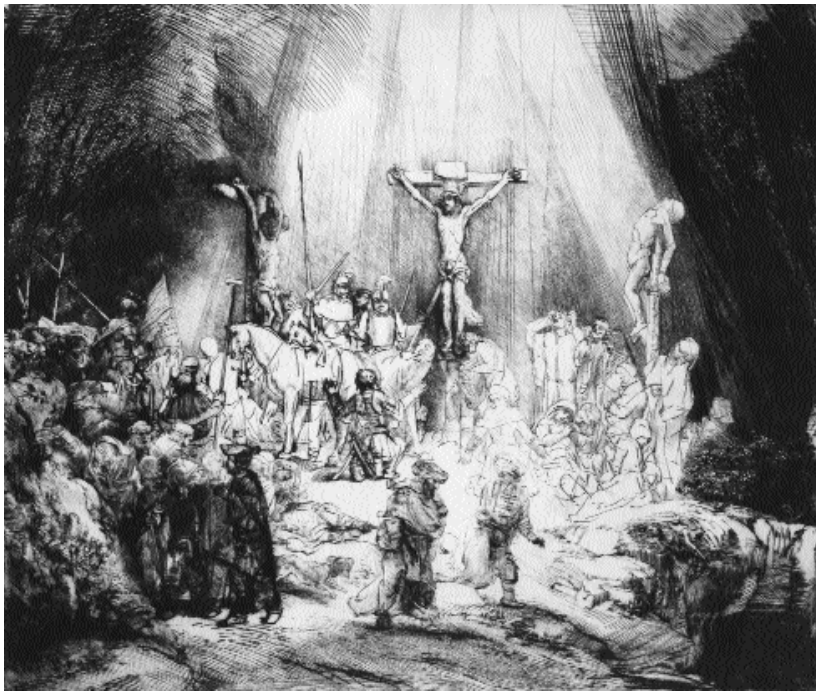


FIGURE 13. Rembrandt van Rijn, "The Three Crosses," phase I (top), phase IV (bottom), 1653.

Here is a painting at the Frick Collection in New York, by the early Rembrandt, painted in 1631 [SEE Figure 14]. You can see that the outline is fairly complete in this early painting, it is not broken and mottled, as in the later work. And you can see, that the shadow, the light, is almost like an object. You could say, he paints this shadow on the collar, and the shadow has a shape; and he paints the light here, on the face. So, light is objectified. It's something that can *fall into the painting*.

If we can turn to a very late work, and to his favorite subject, his self-portrait, you can see all of that is changed. Even in the reproduction, you get a sense of the *impasto* [SEE Figure 15, and inside front cover, this issue]. *Impasto* is an Italian word, from which pasta also comes, meaning doughy. It is a thick treatment of the paint on the surface. You see how the light and shadow—the shadow eats into the surface, and that everything is now rendered in an atmospheric fashion. So we have a transformation, very similar to that which took place in Leonardo's activity between 1492 and his thought of 1513.

I have many other wonderful Rembrandt paintings here, and I'm going to show you one, or maybe two more. This is a painting in the National Gallery here in Washington, which, if you come upon it in the right mood, and you are ready for it, you will burst into tears [SEE inside back cover, this issue]. No question about it—in fact, I'm in danger of doing that right now. It is the most moving painting; it represents the tragic woman Lucretia, who kills herself after she has been raped by Tarquin, and disgraced. Everything that we have seen of the way that the phenomena of the physical universe can be represented—the breaking of the light by the *impasto* surface, so that nothing is sharp or clear—it is all *morbido*, it is all in that fashion. The gestures. The study of the gestures. The way the light falls on the hand. The tilt of the head. All of these features, bring you to the point where you are so aware of the tragedy of this event, the disgrace and the redemption through her suicide, that you cannot help yourself but be

swept away by the clarity—not by just emotion—but by the *clarity*. Now, that’s the point I want to make: There is no distinction here, between the way the physical material is used, and the ability to render it expressive. It’s not like we’re studying, on the one hand, physics, or physical properties, and on the other, art and art expressiveness. They are absolutely unified. That is what Rembrandt gets from Leonardo.

I’ll just show you another treatment of this incredible subject [SEE Figure 16]. Here’s Lucretia again, mournful and bleeding, just, you know—all of this based upon the way the light and shade interacts here, just as in his engravings.

Okay, I have some things to read now. We’re coming to the conclusion of this discourse. I bring Rembrandt into my book, because I say that there is a relation between Annibale Carracci and Rembrandt. Later, as a coda to this, I’m going to show you a couple of things by Carracci. Here’s what I say:

“But the most striking feature that they shared in common, was the view that the creative act was defined by the autonomous will of the artist. That this view was held by Rembrandt, was demonstrated by the attitude attributed to him by Arnold Houbraken in his life of the artist. Houbraken wrote that Rembrandt made the remark, that a picture is completed when the master has achieved his intention by it.

Now, this is contrary to what you always hear, “Oh, it’s the patron who says . . . ,” and so on. Rembrandt maintains that you know when the picture is finished, when it satisfies your intention. That is to say, it is an expressive vehicle. “That means, that what guided Rembrandt, was his own intention. And it was exactly that elevation of the principal role played by the artist’s own creative power, that is celebrated in his self-portraits. With Annibale it’s not quite as explicit, but nevertheless, it’s there. As to their methods, they were both masters of the expression of the emotions through gestures.” The method of *affetti*, it’s called in Italian. “At one portrait, Houbraken comments, ‘The



Copyright The Frick Collection, New York

FIGURE 14. *Rembrandt van Rijn, “The Merchant Nicolaes Ruts,” 1631.*



Erich Lessing/Art Resource, NY

FIGURE 15. *Rembrandt van Rijn, “Self-Portrait,” 1669.*



FIGURE 16. Rembrandt van Rijn, "Lucretia," 1666.

Minneapolis Institute of Arts

head appeared to protrude from it, and address the beholders.' Another pupil, Samuel Hoogstraeten, adds his praise of Rembrandt's representation of emotions, when he wrote of the wonderful attention given to the depiction of people of all classes, who are listening to St. John preaching." This is St. John, and all the people are there, and what Hoogstraeten was prais-

Rembrandt and the Science of Light

One thing that is very interesting, is, to look at the relation of the physical character of Rembrandt's paintings, to the discussion of the wave theory of light, and the radiation of light, being done more or less contemporaneously.* Because, as you know, Rembrandt's paintings are done, especially the late paintings, with this attention to the thickness of the pigment, so there is actually, physically, a process taking place, of the light being refracted, its entrance and its reflection, which gives the experience, as if the light originates in the painting, as a feature of the physical properties of the paint. Rembrandt was very conscious of this. That's why he did it.

—DSP, post-lecture discussion

* The work of Huyghens, Fermat, and Leibniz; see page 54.—Ed.

ing, was the attention, the various expressions, on the faces of the various people listening to the speech.

"Many remarks of contemporaries attest to the widespread appreciation of Rembrandt's use of *chiaroscuro*, and his ability to render reflections, the study of which Leonardo had laid particular emphasis. Two features of Rembrandt's technique are singled out: his use of *impasto*, and his break-up of the color. And these are techniques which were used in Venetian painting, in particular, if you think of the late Titian, for example." And then the book gets into material which is interesting, but a little too off the track for us.

The North Italian Tradition

What I'm suggesting is, that this discovery, that the principal and primary—the *prima materia*—of this universe, is light, and its correlate, shade; and that everything that we see is a characteristic of that primary material, as we see it in the luminous atmosphere, and is the basis for rendering the emotions. And that this development corresponds to the development of Leonardo's emphasis on this at the end of the Fifteenth, and the early part of the Sixteenth centuries, and it is then communicated through a school of art in the North of Italy, which is very well represented, by the way, in the National Gallery in Washington: Bernardino Luini, and other artists of Leonardo's school, particularly Boltraffio is a great artist, and so on.

Let me just show you one by-product of that. This is something called the *Codex Huygens*, and it's now in the Morgan Library in New York. Curiously, the Huyghens family was very closely connected to Rembrandt. The elder Huyghens, who was the secretary to the Staatholder of Holland, wrote the first biography of Rembrandt, when Rembrandt was still a young man in Leiden, or just after he came to Amsterdam. He commissioned a series of the Passion, which is now in the Munich Alte Pinakothek, and his two sons, Christiaan and Constantijn, were the great scientists, or one of them was, anyway, who

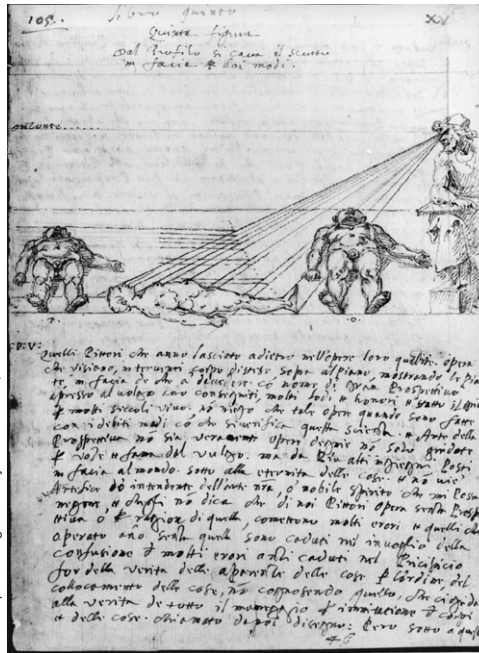
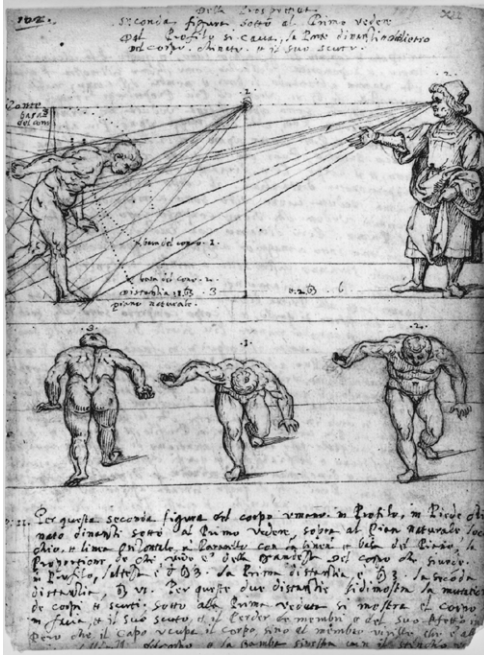


FIGURE 17. Carlo Urbino (after Leonardo da Vinci), *Codex Huygens*, fol. 102r (left), 105r (right).

worked in Paris. Both had been pupils of Rembrandt; both had learned drawing from him. We have a correspondence between the two brothers, in which one brother asks the other to examine some Carracci drawings, because they wanted to know whether the drawing by Carracci owned by Rembrandt was authentic, and the great collection of Carracci drawings was in Paris.

This latter Huyghens bought a codex, which was thought to be by Leonardo, but, in fact, it's by a pupil of Leonardo. Nonetheless, it gives a very good idea of the continuing study of the principles of movement and motion of the human body, which, of course, affected many people who came in touch with Leonardo, most notably, Dürer (although this is later than Dürer). There's a close connection between Dürer and the North of Italy.

Here are drawings from the *Codex Huygens*, which are all based upon the idea of the angle of vision in natural perspective [SEE Figure 17]. What he's interested in, is how you can regularize the rendering of figures seen from below, seen from straight on, seen from above. A very Leonardesque set of problems. Some of the drawings must come from the artist's copies of lost Leonardo drawings. And it's very interest-

ing, this idea of the rendering of the figure, seen, in forced perspective, feet first. If you remember, there's a wonderful painting by Mantegna, of the "Dead Christ," with similar perspective, and that goes on down in time, through Northern Italy.

So, we have a very definite school,

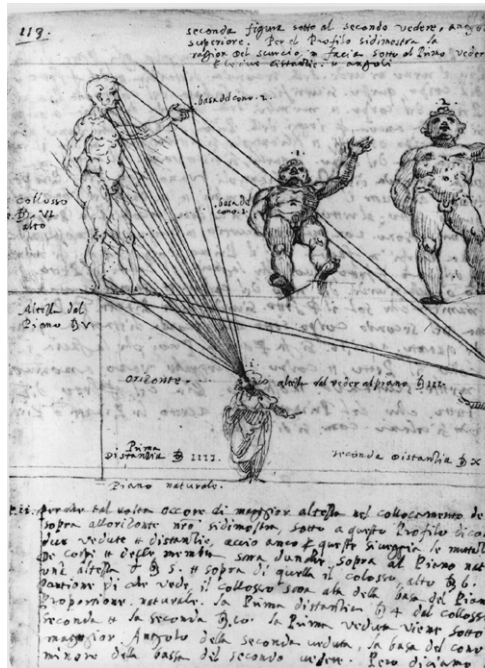


FIGURE 18. Carlo Urbino (after Leonardo da Vinci), *Codex Huygens*, fol. 113.



FIGURE 19. Annibale Carracci, "Bean Eater," (c. 1583).

shaped by Leonardo, but continuing past his death, where the study of the physical properties in the problems posed by perspective, and so on, are minutely studied. Bramantino, many treatises were done by artists in the North of Italy; and it's a very different tradition from what's taking place in Central Italy and Rome at the time, influenced by Michelangelo. That is to say, Central Italy and Rome is influenced by Michelangelo, and the North of Italy is influenced by Leonardo.

I'll just show you one more drawing, a colossal statue, gesturing and being seen from different angles, found in the *Codex Huygens* [SEE Figure 18]. This is another kind of problem, an architectural problem.

So, this gives you an idea of how the Leonardesque tradition survived. In my opinion, the greatest artist who took it up, was Annibale Carracci. I cannot really go into it very much, but I'll show you one or two things by him, which will, if not amaze you, at least amuse you. Let me show you this wonderful painting that he made of a man eating beans [SEE Figure 19]. Now, what this is, actually, is a kind of caricature. Annibale invented the caricature, which is completely in the Leonardesque tradition.

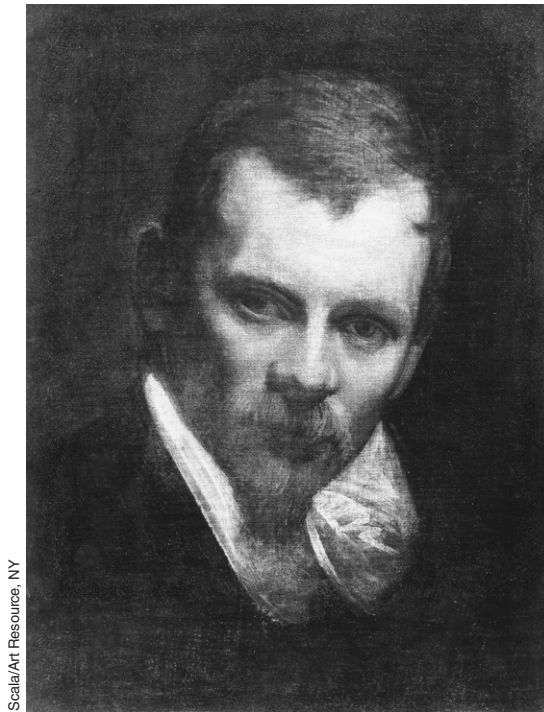
Leonardo made drawings of deformed people, but he did not make them as specific representations of people. That's what Annibale introduced. It fits into the whole idea of the anomalies of Nature, telling you more about Nature than the standard. You can't imagine Michelangelo making a drawing of a deformed face, or of a bean-eater! So, what happens is, that the chap is about to lose his spoonful, the gravy is falling down. The reason is, because some intruder has come into his den. This obviously was born of an observation, although this is a finished, worked-up painting to be sold. But Annibale obviously encountered this chap on the road between Parma and Bologna in Italy, where he travelled frequently, because the delectable dish shown here is called *erbasone*, which is a specialty of Reggio Emilia. Apparently, you can only get it in Reggio Emilia. Indeed, I have eaten it in Reggio Emilia. And I don't know exactly what it is; it's something like Brussels sprouts, or something like that, you know. I never ask. Otherwise you might not go forward with your courage!

This means, that Annibale saw this event take place in a sort of squalid tavern on the way between Parma and Bologna, indeed, exactly where you find Reggio Emilia. And then, he got home, and he made a painting of it. It's a very Leonardesque idea, the whole thing; it really represents gluttony. It doesn't represent gluttony in the way the Sixteenth century did, some kind of deformed, allegorical figure, who's called "Gluttony." It's someone in the act of gluttony, and that's what makes it funny and appealing.

Here is a portrait by Annibale [SEE Figure 20], long believed to be a self-portrait, but actually not, a portrait of another artist named Antonio Vassillacchi, and it's in the Uffizi. You see that it fits between Leonardo and Rembrandt, if we think of the *percorso* that I've been discussing: this North Italian tradition of representing, by the physical means, the interior of the individual, the existence of an animating soul, which becomes the burden of Rembrandt's

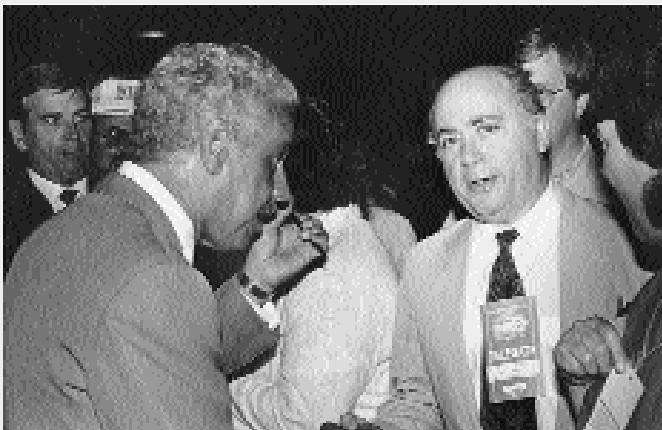
activity. We might call this whole development, from Leonardo through Annibale, through the North Italian school, Annibale to Rembrandt, the “History of Self-Consciousness.” The artist becoming aware of his own powers, as the intervening and determining power *vis-a-vis* Nature. Because Nature is no longer a fixed set of attributes. It’s a changing, transient process, and you see how Annibale conveys the idea, with a tilt of the head, the intensity of the eyes; very important. He’s putting the eyes into shadow, so that you have to look into the picture, and the course of looking into the picture, is a metaphor for you looking *into the person*, seeing that thing, the interior, not the surface, which is the difficult part of art. This is completely in the tradition of Leonardo to Rembrandt, the very quick and sketchy way he’s rendered the setting of the head in the collar, and so on, so as, on the one hand, to give the feeling of the transience, the spontaneity of the situation, while not distracting from the intensity and the focus on the head.

So: I think the best thing to do is to quit while I’m ahead, and I think I’ll leave it at that. If we can have the lights, we can take some questions, and have discussion.



Scala/Art Resource, NY

FIGURE 20. Annibale Carracci, “Self-Portrait” (“Portrait of Antonio Vassillacchi”), (c. 1590).



EIRNS/Suzanne Klebe

D. Stephen Pepper (right) greets Virginia Lt. Governor (later Governor) Douglas Wilder, at the state Democratic Party convention in 1989. A prominent LaRouche Democrat, Pepper was running for the post of Chairman of the Virginia Democratic Party.

D. Stephen Pepper

Art historian Dr. D. Stephen Pepper was a longtime associate of Lyndon LaRouche and the Schiller Institute. An expert on Renaissance art, he was the recognized world authority on the Italian painter Guido Reni, authoring the definitive *Guido Reni: A Complete Catalogue of His Works, with an Introductory Text* (New York: New York University Press, 1984), and was called upon to authenticate paintings in collections throughout Europe and the United States. He died suddenly in Italy in December 2000, at 63 years of age. “Leonardo da Vinci and the Perspective of Light” was the last lecture he delivered to members of the LaRouche political movement.