History, Science, and Metaphor: Henry Adams and the Dynamo

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Henry Adams claimed that his discovery of the dynamo at the Paris Exposition in 1900 had broken his historical neck. The critical question that arises from this point is whether the dynamo was in fact a discontinuity so abrupt as to throw Adams into a new phase of thought, or whether in important ways it represented a restraining limit to Adams's scientific and literary thought, an adherence to tradition. By placing the dynamo in the personal context of Adams's own background and in the general context of certain contemporary writings which shared Adams's notion of the equivalence of social and physical energies, one can better understand the provenance and significance of Adams's dynamo as a historic and literary symbol.

I

It can be argued that Adams did not come to the dynamo completely unprepared. As a rationalist he was first concerned with unity, with running order through chaos; as a historian he was determined to plot the future by measuring the relative strength of forces. By the 1890's, Adams had tried and discarded several methods of doing so: first he had tried to plot history by the lives of great men; later he had seized upon economics as the greatest power in history, a juggernaut of forces which had run away with the "gold-bugs" (financiers) nominally in control. But during the 1890's Adams came to see the world economic system as a machine breaking down, and he became less and less happy with economic theory as a universal unit of measurement for all human movement. The alternative that presented itself was measuring history in terms of physical energy, on which all society could be said to be based.

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Adams probably started thinking in these terms as early as the 1870's, and he had definitely started on this tack by 1893, when the dynamos at the Columbian Exposition gave him so much food for thought;[1] by 1897 he was trying to ally economic and social forces with the kinetic theory of gasses:

> Do you know the kinetic theory of gasses? Of course you do, since Clerke Maxwell was an Oxford man, I suppose. Anyway, Germany is and always has been a remarkably apt illustration of Maxwell's conception of 'sorting demons.' By bumping against all its neighbors, and being bumped in turn it gets and gives at last a common motion, which is, and of necessity must be, a vortex or cycle. . . . We can now pretty well measure the possible x which is the ultimate quantity we want to eliminate. Another generation will have the figures, and the limit of ultimate concentration will then be calculable,—barring war, which may of course delay, or wholly defeat, further vortical movement. . . . With these two elements: the industrial and the capitalistic, I think I could fix approximately the elements of the human orbit, which is necessarily limited by the same conditions of mass, etc., which limit the orbit of the planet itself.[2]

Adams had not yet reached the dynamo, but he was already considering historical movement as being subject to the same mechanistic, Newtonian physical laws which govern natural energies.

Having decided to measure energy in order to chart historical movement, Adams needed reference points. He found the first in the Virgin of Chartres; for the second Adams needed a term which would be as redolent of power to twentieth-century man as the Virgin had been to the twelfth century: the dynamo seemed ready-made for the purpose precisely because it seemed different in kind from the mechanical energy represented by steam, air, and water power. As a rhetorical device, the dynamo was a bonanza.

But why the dynamo in particular? Why not radium or a

more mysterious source of energy as the symbol for the new phase in history? The answer lies both in Adams's practical needs as a "scientific historian" and in his general attitudes towards science and energy.

Behind Adams's view of the purpose of history lay the assumption that the movement of history was subject to rational analysis; that it was in fact orderly if viewed in the proper terms. Furthermore, historical process, like physical energy transfers, worked mechanically in accordance with universal physical laws. For example, Adams accepted the second law of thermodynamics as applicable directly to human society: as energy was used (that is, was changed from one form to another) to do work, the amount of *available* energy decreased, although the total energy remained constant.[3] Similarly, Adams applied a version of Gibbs's "rule of phase," which he took to mean that a substance moves directly from one phase to another without entering an indeterminate state between phases.[4] That is, H_2O, for instance, could exist as ice, water, or vapor, but not as something in between—although it was possible to have ice, vapor, and water present at one time. The point for Adams was that the change from one phase to another is radical and sudden. Adams postulated five phases for history: intuitive, mechanical, electrical, etherial, and hyper-thought, the realm of pure mathematics.[5] He linked this version of phase to the mechanistic idea that every substance is soluble in a thinner one: solids dissolve in liquids, liquids in vapors, vapors in electricity, electricity in ether.[6] This is why to Adams the dynamo pushed men into a "supersensual" mode of thought: if electrical energy needed a medium through which it could be transmitted (the so-called "universal ether"), so vital (social and moral) energy needed a similar medium through which it could be carried. Adams's scientific view was irrevocably Newtonian, not Einsteinian.

There is another, allied, reason why the dynamo was a likely symbol for Adams. He had always been involved with the question of continuous versus catastrophic development. When he first became acquainted with Darwinism in the sixties, Adams understood evolution to be a mechanism providing a continuous upward development from simplicity to complexity

under uniform conditions. But *Pteraspis*, a fish family unchanged since it first appeared, troubled Adams in that it seemed to deny that the evolutionary process was in fact a universal and uniform mechanism. Disturbed by the absence of mechanism in Darwinism that *Pteraspis* implied, Adams found himself supporting Louis Agassiz's views of cataclysmic geological change as well. When, at the same time, he found during his Harvard tenure that he was unable to determine orderly sequences in medieval history, he became increasingly receptive to the notion that history, like geology, underwent abrupt changes from one state to another. Given his insistence on mechanistic physics, the dynamo must again have seemed ready-made: it was a mechanism providing a catastrophic change. Powered by steam, it produced electricity, a new and overwhelming force.

The newness was necessary to the idea of abrupt change in historical phase and consequently to the historical model that had been building in Adams's mind ever since his discovery of the Virgin as energy or force. Since her force had been primarily feminine and intuitive, any symbol for a counter-force had to be masculine, materialistic, and mechanical. On this rhetorical ground as well, the dynamo fitted Adams's predetermined needs; it was the counter-force for the Virgin, and it was new. Dynamos are machines, derived from a rationalist view of the universe, operating by mechanistic physics—and they produce a force that seems to function only on the level of the "occult, supersensual, irrational." [7] They are at once mechanical yet mysterious. Furthermore, since Adams was always concerned with the practical application of theory to the practices of the immediate world about him, the dynamo illustrated that aspect of the new force which was *useful*, able to light real bulbs and turn real wheels. The dynamo's practicality thus made it a far better symbol for Adams's purposes than those other new signs of the supersensual universe, radium and x-rays, which could not be perceived to do work.

The dynamo, then, fitted a predisposition generated by Adams's beliefs about the nature of science and the nature of history for a certain type of symbol; once the symbol had been found, Adams could move swiftly ahead with his development

of the dynamic theory of history, in *Mont St. Michel and Chartres*, the *Education*, and "The Rule of Phase Applied to History." [8] But Adams's discovery of the dynamo was not merely a matter of predisposition; rather, it can be seen as the culmination of a search, only partly conscious, that is revealed in the letters Adams wrote during the 1890's.

By 1894, partly as a response to the panic of 1893, Adams was convinced that the economic system could no longer survive: "it has become so rotten and so bankrupt that I am quite curious to see what the next one [century] will do about it." [9] Further, he saw the failure in mechanistic terms: "Indeed, the money-making machinery has already a delightfully corroded and ruinous look, as though it were rotting like autumn leaves." [10]

Having recognized that economics were no longer an adequate way of describing history, Adams sought new bearings: "I read a volume or two every day, trying to find some sort of clue to where the devil I have got, in this astonishing chaos of a modern world." [11] Convinced that a major upheaval was coming, Adams thought that a war, originating in Germany, "might determine a new outburst of centralizing energy." [12] Here, we see that Adams had begun to transfer his thinking from economic force to the larger concept of social energy. Then, in November, 1897, he wrote the kinetic theory of gasses letter already cited, in which he spoke of human movement in terms of physical forces.

We can see in his letters the elements that coalesced for Adams in Paris in 1900: a concept of social force, a dissatisfaction with economic machinery as a measure for history, a desire for a new tool with which to measure man, and a desperate but despairing urge to predict and control the future by rational analysis. All of these elements were present in Adams's mind through most of 1900, but they were disparate and remained so until late in the year; even during the Exposition in Paris, Adams still tended to think in terms of economics and of interests,[13] though his letters to his brother Brooks Adams suggest that he knew what he was looking for. The fair was at first a failure for Adams; he could see nothing new in it. But then, he realized he lacked a guide: there might

be something new in the fair, he wrote, "but I see no one to give me a general idea of the whole field." [14] Nonetheless, in September, 1900, he felt that electricity would provide what he was looking for:

> As far as I have guessed the results of this Exposition, the Germans alone show very marked development of energy. Their machinery seems to have impressed people much. . . . The limit of the great economics may be near or far. Since 1889, the great economy has evidently been electricity. Since 1840, electricity must have altogether altered economic conditions. Looking forward fifty years more, I should say that the superiority in electric energy was going to decide the next development of competition. That superiority depends, in turn on geography, geology, and race-energy. All these elements have somewhere exact numerical values, and the value of your theory depends on getting the values of these unknown quantities.[15]

Adams found his guide to the meaning of the fair in his friend Samuel Langley,[16] who, among other things, had greatly expanded knowledge of the invisible part of the electro-magnetic spectrum.

Then, in a letter to John Hay, written on November 7, 1900, Adams pulled all the elements together. The letter is lengthy, but as an encapsulation of Adams's fulfilling revelation it is remarkable:

> The Exposition is closing. To me it has been an education which I have failed to acquire for want of tutors, but it has been an immense amusement and only needed you to be a constant joy. It has brought me so near to the end that I hardly care to wait for the last scenes. There are things in it which run close to the day of judgment. It is a new century, and what we used to call electricity is its God. I can already see that the scientific theories and laws of our generation will, to the next, appear as antiquated as

> the Ptolemaic system, and that the fellow who gets to 1930 will wish he hadn't. The curious mustiness of decay is already over our youth, and all the period from 1840 to 1870. The period from 1870 to 1900 is closed. I see that much in the machine-gallery of the Champ de Mars. The period from 1900 to 1930 is in full swing, and, gee-whacky! how it is going! It will break its damned neck long before it gets through, if it tries to keep up the speed. You are free to deride my sentimentality if you like, but I assure you that I,—a good monk of St. Dominic, absorbed in the Beatitudes of the Virgin Mother—go down to the Champ de Mars and sit by the hour over the great dynamos, watching them run as noiselessly and as smoothly as the planets, and asking them—with infinite courtesy—where in Hell they are going. They are marvelous. The Gods are not in it. Chiefly the Germans! Steam no longer appears, although still behind the scenes; but one feels no certainty that another ten years may not abolish steam too. The charm of the show, to me, is that no one pretends to understand even in a remote degree, what these weird things are that they call electricity, Roentgen rays, and what not. The exhibitors are dead dumped into infinity on a fork.[17]

Adams had found the dynamo, and with it the Dynamic Theory of History, including the ideas of historical phase and accelerating change. But as we have seen, Adams was clearly expecting what he had found, and the dynamo did not break his historical neck by surprise. In what sense it *did* break his neck will become clearer after the question of an external context for the discovery has been explored.

II

If, then, the dynamo came to Adams more as the fortunate result of a long search than as a sudden and unforeseen revelation, the question arises as to whether the dynamo was for Adams a purely private discovery, or whether it had a prove-

nance in the larger scientific and cultural consciousness of the 1890's. To answer this question, I conducted a brief survey of wide-circulation magazines for 1893, the year of the Chicago Exposition, and for 1900, the year of the Paris fair. These dates were chosen because they mark the period from Adams's first discovery of the dynamo to his prostration before it in Paris, and they provide a sufficient span to discover if, to match Adams's own development, a corresponding change occurred in the public attitude, as expressed in writings about world's fairs, electricity, and the general idea of social energy as a form of physical energy.

The results of the survey reveal that while literally hundreds of articles on electricity appeared during the 1890's, the bulk of them showed little awareness of the dynamo as the symbol and agent of a new historical phase. A majority of the articles dealing with things electrical sounded a note of complacent optimism; electricity was for most men another example of "progress," and they boasted of how far we had come in ten years, of how electricity would soon be nature's best servant of man. The popular press had apotheosized steam, turner of the wheels of progress and profit, with the Corliss Engine at the Centennial Exhibition in 1876.[18] In 1893, although the panic brought so many values into question, the comforting familiarity of steam technology made it easy to see electricity as a new tool, rather than a new force, much less an ominous one. It was far easier to perceive electricity in terms of a widely accepted Newtonian model of the universe (a view which to some extent limited Adams as well) than to understand it in terms of a new, complex, and far less obvious model which predicted social disruption as an inevitable consequence of growth. *Harper's Weekly* provides a good example of prevailing attitudes.

Harper's Weekly combined a "journalistic" approach to the events of the times with some good fiction (Henry James serialized *The Awkward Age* in its pages) and lavish illustration. Its lead editorial for May 13, 1893, expresses a hope that the fair may promote economic reform in lowering trade barriers and by presenting a vision of international cooperation for peace, while in the same issue another article on the

fair's inaugural activities paints a vivid picture of the amount of force latent in the button, resting under President Cleveland's gloved finger, which would light the fair;[19] in the May 27th issue yet a third piece describes the power plant of the fair.[20] But none of these articles conveys the sense of a new phase or of the correlation between social and physical energies; the elements of Adams's discovery are there, but they have not been combined. Ironically, seven years later, the magazine could only maunder about international cultural gains and other such stuff.

But if the bulk of the public was not thinking along Adams's lines some men were, and their thought was readily available. Electricity was in fact beginning to make some inroads in the popular mind. *Scientific American*, for instance, is especially interesting because although it devotes much space to electricity at the Chicago Fair, it is utterly flat in tone. There is no speculation, no attempt to imply in any wider sphere than the immediate facts. One chance phrase from June 24, 1893, sticks out precisely because it is so blind to its implications: "But to the average electrical man the main interest in the exhibit of this company [Westinghouse] will be in the display of dynamos made in the power plant in the Palace of Mechanical Arts."[21] That there should *be* an average electrical man seems confirmation of Adams's suspicions about the new dominance of electricity.

Two periodicals, though, *Century Magazine* and *Popular Science*, contain articles of more obvious relevance to Adams's thought. In *Century* for June, 1900, is a piece by Nikola Tesla entitled, "The Problem of Increasing Human Energy."[22] Tesla was well qualified as a spokesman for the new science: he was, among other things, the man responsible for harnessing Niagara Falls to the dynamo, and he was among those who solved the problems of energy loss during long distance transmission of electricity. The article starts by measuring vital energy in terms of force and inertia: "All life-manifestation, then, even in its most intricate form, as exemplified in men, however involved and inscrutable, is only a movement, to which the same general laws of movement which govern throughout the physical universe must be applicable . . .

conceive then, man as a mass urged on by a force," [23] whose energy "can be measured, in accordance with well-known principles, by half the product of the mass with the square of a velocity we are not yet able to compute." [24] But, Tesla adds (like Adams in the *Letter to American Teachers*), our inability to get exact figures does not invalidate the theory. Our problem, Tesla says, is to increase the energy of the human mass. There are three ways to do it: increase the mass, reduce the inertia, or increase the impelling force. He considers each in turn.

If one seeks efficiently to increase the mass, one must not simply add more mass, but mass at a higher velocity: "if, for example, the children be of the same degree of enlightenment as the parents,—that is, mass of the 'same velocity,'—the energy will simply increase proportionately to the number added, : but: the most important result to be attained is the education, or the increase of the 'velocity' of the mass newly added." [25] Tesla goes on to argue that efficient and healthy lives increase mass and velocity and hence add to human energy.

Tesla then explains how to reduce the inertia, or force retarding the human mass. That force is in part frictional, which he equates with ignorance, stupidity, and imbecility, and in part negative, under which he cites visionariness, religious sense, fanaticism, and insanity. His general proposal is to "turn all negative force in the right direction and reduce all frictional force." [26] He admits war as a negative force, but says we can use the energy it represents by transforming it into purely potential energy, like that of an electrical condenser. He predicts that this will be accomplished by automating war so that the energy is preserved but the human mass is not adversely affected; Tesla even goes so far as to suggest robot weapons to eliminate human participants from battle!

Tesla goes on to attack the third problem, how to increase the force accelerating the human mass. The trick is to harness more of the sun's energy; to work harder and more efficiently. He posits broadcast power and solar cells as ways to this end. The attractive forces, he explains, are always in the direction

of reason; man becomes increasingly rational by the effects of the accelerating forces. Tesla then states the crucial Newtonian assumption underlying the whole scheme: "But looking at all this busy world about us, on all this complex mass as it daily throbs and moves, what is it but an immense clockwork driven by a spring?" Tesla concludes that we find, then, "the three possible solutions of the great problem of increasing human energy are answered by the three words: food [healthy lives to increase the mass], peace [turning the negative and inertial forces to positive forces], work [to increase the rate of acceleration]." [27]

Tesla's article provides a remarkable group of comparisons with Adams's scientific views. First, consider what they share. Both start from a position of rational positivism, assuming that humanity can be measured, predicted, and controlled by mechanistic principles in accord with physical laws. Both are attempting to apply late nineteenth-century physics to this end. Both see the human mass as acting according to the formula for acceleration ($S = gt^2/2$),[28] and both see the direction of acceleration as toward increased reliance on machinery and reason. Both use much the same terminology, and even similar phrasing.

There are, however, two important areas of "scientific" difference between Tesla and Henry Adams that lead them to opposite conclusions. The first is that Tesla makes no attempt to apply the rule of phase to his system. The second is that while Tesla accounts for the second law of thermodynamics by saying we will harness a better percentage of the energy already in the system—which will not increase the total energy (which would be impossible under the second law)—Adams assumes that we are already using about as much as is available, and that we are facing maximum entropy—a dead chaos instead of a live one—in the immediate future. Adams was a "degradationist"; he believed that, as William Jordy explains in *Henry Adams: Scientific Historian*, "the steady decline in the amount of energy available for the future use of both biological evolution and history automatically implied a steady decline in the end products created by the depletion of the energy reservoir. As though each barrel drawn from

an ebbing oil well were necessarily inferior as fuel to those which had preceded it!" [29] These two differences produce the opposed conclusions in Tesla and Adams. Tesla feels the future is without any practical limit; Adams that the limit approaches ever faster. Tesla sees increasing rationality as the probable salvation of mankind; Adams feels that ultimately rationalism damns us, forcing us to increase the entropy as fast as we advance technologically, while it strips us of our human qualities. Both Tesla and Adams share the error of attempting to apply Newtonian physics to an increasingly relativistic, disunified society; but Adams and Tesla differ in their qualities of mind as well as in their conclusions.

Reference to two articles appearing in *Popular Science* will establish that difference more clearly. The first is a two-part article on "Electricity at the World's Fair," by Charles M. Lungren,[30] and the second is an excerpt from "A Hundred Years of Chemistry," by F. W. Clarke, who was the chief chemist for the U.S. Geological Survey.[31]

Part One of the Lungren article retails the wonders of the Chicago Fair's widespread use of electricity, and comments on its expansion since Philadelphia, especially in terms of the amount of power now generated. Lungren then describes the various devices in technical terms which affect even a modern reader with something akin to awe, though Lungren himself is not overpowered by what he sees. But in Part Two of this article, Lungren launches into a discussion of the economic factors affecting electrical development, and concludes that they are likely to restrict the amount of electricity used for heating houses to a very small figure. Two points of interest emerge from this article: first, Lungren is far more interested in the electrical devices themselves than in the power they produce, and although he is quite well aware of electricity's force and future, it simply does not disturb him. Secondly, he is aware of the interplay of economic and other forces just as Adams is, but he has no interest in expanding the concept into metaphysical and ethical areas. Lungren is interested in his subject, and at times is pleased and impressed with the powers of scientific man, but he is not awed. He is, in short, an "average electrical man."

In contrast to this down-to-earth view is this excerpt from Clarke's article on chemistry:

> From the curiously reversible chemical reactions of the secondary battery the automobile derives its power, and here again we find a field for invention so large that its limits are beyond our sight. From every peak that science can scale new ranges come into view. The solution of one problem always creates another, and this fact gives to scientific investigation its chief interest. We gain, only to see that more gain is possible; the opportunity for advance is infinite. Forever and ever thought can reach out into the unknown, and never need to weep because there are no more worlds to conquer. . . . For the material advancement of mankind the nineteenth century has done more than all the preceding ages combined, and science has been the chief instrument of progress.[32]

Clarke is well aware of the accelerating nature of change, but his awe for the scope of scientific thought is matched by a recognition that the benefit of science has been primarily for the material advancement of mankind. And while in its obvious intensity his praise of science seeks to lift it above the level of ordinary mental or material endeavor, his best metaphors are clichés. The scientific mind has its limits. It may be rationally and technologically advanced, like Tesla; It may be acute but narrow, like Lungren; or it may seek unsuccessfully to transcend itself, like Clarke, only to be pulled back by the essentially limited character of its thinking process.

Adams differs from these writers because his scientific writing refuses to restrict itself to the narrow boundaries inherent in the rationalistic, analytical thinking he insists on using to cope with the modern multiverse. Adams is *not* an electrical man, even while he discusses the nature of electricity with electrical vocabulary. His recognition of the dynamo and the dynamic theory of history is neither new nor successful as science; but treated as poetry, the case is rather different.

Some critics, notably J. C. Levenson,[33] have pointed out the

subjective, aesthetic, and sensual side of Henry Adams, but the question of how much weight both Adams and we assign it remains open. One can agree with the assertion that in his scholarly and scientific writing Adams felt obligated to emphasize analysis and argument at the expense of subjective response, but to this must be added that he was basically unsuccessful in the attempt. One sees the principle in action in Adams's letters, especially the letter to Hay of November, 1900, because in them Adams expressed his own feelings rather more freely than in the formal writings while still producing work of obvious artistic quality.

The first observation to be made is that while in this series of letters Adams was seeking an effective analytical tool, a machine by which to measure social forces, he constantly evaluated his machinery in non-mechanistic terms. The most obvious example is his use of the word "rotten" to describe the machinery of money, politics, and history. Living things decay and rot; machinery wears out, breaks down, or corrodes. In applying the one kind of term to the other, Adams shows that he evaluates his rational model by a non-analytical standard. The process in part establishes the unity he seeks between vital and physical energies; but it also tends to invalidate the rational, analytical mode as the form of thinking which matters most. In effect, by applying such living terms to non-living things, Adams is raising the analysis to the level of poetry. Thus, the machine terms themselves cease to be wholly scientific, semantically neutral, and take on poetic qualities. The language of science becomes the language of metaphor.

The letter to Hay quoted above shows this process clearly. The explicit sense of the letter is that man, moving at an accelerating rate, has entered a new historical phase, represented in the great dynamos, and that no one understands the new phase at all. But the terms in which this is said show a constant conflict with analytic rationalism. Adams's opening statement frames the emotional, subjective nature of his discovery: the exposition has been "an immense amusement." He then speaks religiously, saying that his vision is of the day of judgment, and that electricity is the God of the new phase.

Then for a sentence the analytic thinking is re-established with his estimate that current theories will swiftly be outmoded, but his feelings once again take over as he posits a mannikin who will wish he hadn't survived until 1930. Adams's observation about accelerating change is couched in slangy and metaphoric terms—the new period will break its damned neck.

Adams admits that this thinking is sentimentalism which Hay is free to deride, but he insists (and means it) that it is as a good monk of St. Dominic absorbed in the Beatitudes of the Virgin that he asks the dynamos their destination. The point is that Adams, despite the flippant tone, is asking for a sentimental, humanistic, and religious answer to a question he insists on answering scientifically—a paradox, since the systematic, rationalistic, practical, machinery-producing Germans are in it, while the Gods are not. Indeed, says Adams, the charm of the show is that the new scientific phase is a religious mystery: the dead exhibitors are dumped into infinity on a pitchfork.

This letter does present all the ingredients of Adams's science of history, but those ingredients, despite the self-protecting banter, are expressed as much in emotional terms as in scientific ones. The letter is a continual vacillation between a twelfth-century sensibility and a nineteenth-century scientific rationalism. Adams, well aware of this dual viewpoint, uses it to establish a dialectic whose synthesis turns the dynamos into a "moral force" and pitches us into a supersensual universe. The dynamo, by the same process involved in calling a machine rotten, becomes a metaphor yielding a genuinely new insight: that the highest product of the mechanical phase is a new phase which cannot be understood by the rationalism which produced it, yet which must for practical reasons be approached in precisely those terms. The dynamo is a machine which converts rationally comprehensible mechanics into supersensually comprehensible electrical energy. The machine is visible, but the rays are not. Adams's nineteenth-century mind could seize upon the machine because it accorded with his concept of science, because it emerged from the logic of rationalism, because it fitted his scheme of

history, and because it worked rhetorically to establish a dialectic. But Adams's nineteenth-century mind could not grasp the energy the machine released for the same reasons. This is the sense in which Adams's historical neck was truly broken. The dynamo forced him to recognize that the very process by which he had arrived at the recognition was unable to handle its own results. But what other terms did he have?

At this point the value of the dynamo as metaphor appears. Metaphor appeals to imagination, to intuition, as well as to reason. Perhaps *scientific* metaphor, which united the modes of thought available to Adams, could point to a way of grasping the electrical phase. In the *Education,* Adams suggested that since early man was unable to perceive force as a unity, he had symbolized it and pursued it in philosophy and theology.[34] This is what Adams was doing in his use of scientific metaphor. And no place did he use it more strikingly than in his *Prayer to the Dynamo,* a separate poem included in *Prayer to the Virgin of Chartres,* written in 1901.[35]

Adams addresses the Dynamo as both "Gentle Friend," and "Despotic Master," and he prays to it even as he knows prayer to "Tireless Force" is useless:

> We know that prayer is thrown away,
> For you are only force and light;
> A shifting current; night and day;
> We know this well, and yet we pray,
> For prayer is infinite,
>
> Like you!

"Within the finite sphere," Adams continues, "that bounds the impotence of thought," we search continually for answers both to the Dynamo's identity and to our own. In this search for moral certainties Adams reveals his own incapacity to transcend the limits of rationalism and his inability in the light of scientific knowledge to return to intuitive truth. "Answer you shall—or die!" shouts Adams to a force which, when it attains maximum entropy, will most certainly die, whether man wills or no:

We are no beggars! What care we
For hopes or terrors, love or hate?
What for the universe? We see
Only our certain destiny
And the last word of Fate.

Seize, then, the Atom! rack his joints!
Tear out of him his secret spring!
Grind him to nothing!—though he points
To us, and his life-blood anoints
Me—the dead Atom-King!

But although he himself cannot escape the limitations that his knowledge has imposed upon him, Adams, knowingly or not, has provided an approach to twentieth-century multiplicity by the synthesis of poetic form and intuition with scientific knowledge and vocabulary. In *Prayer to the Dynamo* the attempt is overt; but it is the same technique, one feels, that is being used in the *Education* itself and in the later writings.

If this is the case, Adams would have felt free to do just what in fact he did do: work with actual scientific theories to create a metaphoric structure which would express his unhappiness with pure reason and which would suggest the need for a new and unified mode of thought to grapple with the problems of history in the electrical phase, a mode of thought which would use both the processes of reason and imagination. In this attempt, Adams's *Letter to Teachers* and "The Rule of Phase" were failures, because the scientific qualities obscure the metaphors, and we simply react by assuming that Adams abused science to reach incorrect conclusions. But in the image of the dynamo, Adams attained at least partial success: as science it fits into an existing tradition; as metaphor it is an attempt to break *our* historical neck and make us react to twentieth-century multiplicity with a new and unifying mode of thought.

NOTES

1. See Louise Fant Fuller, "Henry Adams: Pilgrim to World's Fairs," *Tennessee Studies in Literature*, IX (1964), 1-10, esp. 2.

2. Henry Adams to Cecil Spring Rice, Nov. 11, 1897, in Worthington Chauncey Ford, ed., *Letters of Henry Adams*, II (Boston, 1938), 136. Hereafter cited as Ford, II, 136.

3. See Henry Adams, *A Letter to American Teachers of History*, privately printed in Washington, 1910, esp. 1-5, 18-21, 128.

4. Adams expounds his version of Gibbs's rule of phase in "The Rule of Phase Applied to History," in *The Degradation of the Democratic Dogma*, ed. Brooks Adams (New York: Macmillan, 1920), 267-311. For a decent explication see Henry Hirsch Wasser, *The Scientific Thought of Henry Adams* (Thessaloniki, 1956), 97-102.

5. Henry Adams, "The Rule of Phase," 307-308.

6. *Ibid.*, 275-276.

7. Henry Adams, *The Education of Henry Adams* (Boston: Riverside Sentry Edition, 1961), 383. Hereafter cited as *The Education*, 383.

8. Adams wrote that he was working on "The Rule of Phase" in 1908.

9. To Charles Milnes Gaskell, Sept. 27, 1894, in Ford, II, 55.

10. To Gaskell, Nov. 3, 1895, in *ibid.*, 89-90.

11. To Gaskell, July 24, 1896, in *ibid.*, 109.

12. To Brooks Adams, June 11, 1897, in *ibid.*, 129-130.

13. See Henry Adams to Brooks Adams, July 29, Oct. 7, 1900, in Harold D. Cater, ed., *Henry Adams and His Friends* (Boston, 1947), 497, 499.

14. To Brooks Adams, Oct. 7, 1900, in *ibid.*, 499.

15. *Ibid.*

16. *The Education*, 379-380.

17. In Ford, II, 301.

18. See, for instance, W. D. Howells, "A Sennight of the Centennial," *Atlantic Monthly*, XXXVIII (1876), 96. The best account of the machine's triumph in America is Leo Marx's *The Machine in the Garden* (New York, 1964).

19. Montgomery Breckinridge Pickett, "The Opening of the Great Fair," *Harper's Weekly*, XXXVII (1893), 442.

20. Julian Ralph, "A Recent View of the Great Fair," *ibid.*, 499.

21. *Scientific American*, LXVIII (1893), 387.

22. *Century Magazine*, LX (1900), 175-211.

23. *Ibid.*, 175.

24. *Ibid.*, 176.

25. *Ibid.*, 179.

26. *Ibid.*, 182.

27. *Ibid.*, 192.

28. *The Education*, 469.

29. William H. Jordy, *Henry Adams: Scientific Historian* (New Haven, 1952), 207.

30. Charles M. Lungren, "Electricity at the World's Fair," *Popular*

Science Monthly, XLIII (Oct., 1893) and XLIV (Nov., 1893), 721-740 and 39-54.

31. F. W. Clarke, "A Hundred Years of Chemistry" (part two), *ibid.*, LVII (May, 1900), 59-69.

32. *Ibid.*, 63, 68.

33. J. C. Levenson, *The Mind and Art of Henry Adams* (Boston, 1957).

34. *The Education*, 476.

35. The *Prayer to the Virgin of Chartres*, containing the *Prayer to the Dynamo*, was first published in Henry Adams's *Letters to a Niece and Prayer to the Virgin of Chartres, with a Niece's Memories* by Mabel LaFarge (Boston and New York, 1920), and is found on pp. 128-130.