waters of the equatorial Pacific reflects and emphasizes the general temperature trend during the Tertiary, which resulted in the ice age. The environmental uniformity of the oceanic depths and the thermic inertia of the oceanic mass reduce the possibility of short time, less important temperature variations being recorded and enhance the value of the paleotemperature measurements here presented as a basis for general discussion.

It is unfortunate that more paleotemperature data from the ocean bottom are not available, particularly from the Eocene, Upper Miocene, and Lower Pliocene. The type of material that is needed, however, makes rather remote the probability of securing additional, suitable samples in the near future.

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Contemporary Science and the Poets

J. Z. Fullmer

Metals Research Laboratory, Carnegie Institute of Technology, Pittsburgh

In recent years, the relationships between science and poetry have attracted a considerable quantity of literary criticism. "No poet today," say Levy and Spalding (*1*), ". . . can ignore science. The atmosphere of rational thought that has come with the new knowledge of the physical world, envelops him whether he is conscious of it or not. It is now part of his social heritage, and his poetry draws on it for sustenance." Douglas Bush (*2*, p. 151) makes this sweeping statement: "All modern poetry has been conditioned by science, even those areas that seem farthest removed from it." Dudley (*3*) points out that the science content of a poem may be adulterated but insists that there is a science content.

> No doubt the science in literature is often outdated, distorted or misapprehended, but so great a factor in the pattern of modern life must find imaginative as well as theoretical and technological expression.

Such statements are certainly ego-gratifying for the practicing scientist. Of course, his work has permeated to the heart of modern poetry. Why should not the new biochemical-genetical findings, for example, dominate any poetic myth-making concerned with the durability (or frailty) of man? Generalized theories of gravitation should naturally find their way into poetic metaphor. Is it possible to think about space, about time, without considering these new concepts? We know that the judicious application of certain of the findings of fundamental science has, in the last 50 years, gone far to reshape the way in which our lives are spent. The poets, a human kind of barometer, should be quick and sensitive to register the impact of each fresh discovery, each major theoretical advance. It remains only for the practicing scientist to read the modern poets to discern, mirrored back at him, all of his scientific progress; it should be there, now subtly, now obviously, but there nevertheless.

Another critical view exists, however, that sounds quite different. It is to be sure, a minority view and, one would gather, an unpopular one. J. Isaacs gives it expression (*4*, p. 75):

> I have gone through dozens of volumes and read and re-read hundreds of poems hoping to confirm the belief to which I have referred, that scientific imagery permeates modern poetry, that the poets have been forced by modern science to alter their modes of feeling and expression. Alas! it just isn't true.

So great a divergence of opinion between literary critics about a matter involving science makes it of interest to examine at least some of the poets cited by both groups to determine, if possible, just how the situation strikes a practicing scientist. It may be that modern poetry is influenced to a far-reaching extent by modern science. It may also be that there is no modern science in the works of modern poets, or perhaps the actual situation is somewhat between these two extremes.

At the outset, it might prove of value to state, from the point of view of a scientist, what is not meant by the modern science content of modern poetry. Pos-

sibly the problem of definition is the crux of the matter.

The 1904 revolution in physics caused an upheaval in more areas of intellectual endeavor than just physics. Fundamental philosophic thinking underwent new direction for the age-old problems, such as determinism and free will. The concept of the very nature of scientific truth had also to be placed in a new frame of reference. Since poetry is quite frequently concerned with philosophy, there is a chance that philosophic content will form the basis for judgment of the science content of modern poets. For a scientist such a juxtaposition is a curious one; the fact that it occurs as often as it does means that, in the mind of the nonscientist, it is a juxtaposition seductively easy to make.

What is not meant, then, by modern science content of modern poetry is philosophic content. What is not meant, too, is value judgment, particularly value judgment of "things" which of themselves can support no value judgment. There has been at least one poem (fortunately, a very bad poem) in which the phrase "vicious electron" appears. Since an electron can be no more vicious that it can be benign, or ludicrous, or poverty-stricken, a phrase of this kind is meaningless for a scientist. It represents an extreme and bizarre example of a chronic, hard-to-correct condition, the condition of imputing motives to inanimate systems. Such usage is neither philosophic nor scientific, and poems containing it cannot be considered.

It is also not meant in a consideration of the science content of contemporary poetry to examine those poems which equate the products of applied science with science itself. Present-day outlook confirms what has been known for a long time: science is an attitude, a method, a point of view related to the "particular go of things," to borrow Maxwell's happy phrase. Now, a machine, no matter how cleverly constructed, is not, by these terms, science; it is, rather, a product of science. There is considerable confusion because of such equating, not only among critics, but among the poets themselves. Hart Crane provides an example. In an essay about the function of modern poetry, he says (*5*):

> Analysis and discovery, the two basic concerns of science, become conscious objectives of both painter and poet. . . .
>
> The function of poetry in a Machine Age is identical to its function in any other age; and its capacities for presenting the most complete synthesis for human values remain essentially immune from any of the so-called inroads of science. . . . For unless poetry can absorb the machine, i.e., *acclimatize* it as naturally and casually as trees, cattle, galleons and all other human associations of the past, then poetry has failed of its full contemporary function.

Throughout the entire essay the words *science* and *machine* are used interchangeably, not because of any ambiguity in Crane's own mind about what he felt modern poetry should do, but probably because, to him, the words were completely synonymous. There are some scholars, it must be admitted, who regard this statement of Crane's with a feeling almost akin to embarrassment. In the hands of the less discerning, though, it is taken to show that Crane was an apologist for modern science.

These three, then, are what is not meant by the modern science content of modern poetry: philosophic content, ambiguous use of isolated terms, and equations involving products of science with science itself. What is meant is the appearance in poems of the newer theoretical concepts and broad points of view; what is meant, too, is the scientific spirit, the scientific attitude.

If there are present any of the unifying conceptual developments, it is to be anticipated that some of the terms of science will appear, used in a scientific way. For example, the phrase "atom of truth" might not qualify as a phrase showing the absorption of a scientific concept, but lines like (*6*)

> . . . the Sun's attractive force
> Builds energy in spirals that never cease.

might well be a reflection of one of the newer physical theories.

There is a risk in suggesting that what might be found in the modern poets is the scientific spirit or attitude. Perhaps some critics and some poets will say that should this spirit, this attitude, be present, it will be so at the expense of the "poetic spirit" or "attitude." Possibly this is a legitimate objection, but it would also seem that if the notion is accepted that modern poetry contains modern science, then we must face up to the fact that the scientific attitude will be there too, however antipoetic we might feel it to be.

II

Who are the poets that might be examined by a scientist for their science content? To have read all modern poets would be impossible, if not foolhardy. First examination should include the poets most often cited by critics as those who have been influenced by modern science, but so restricted a list automatically places limitations on the conclusions derived from the study.

If one examines three "major" poets and finds that there are significant references to modern science in all three, it is quite incorrect to state that "all modern poetry" is conditioned by modern science, because, for every three references to "modern" science, there might be three more (of comparable poetic significance) to Galen, Paracelsus, or Linnaeus. If, in the poets examined, there are no references to modern science, it would be just as wrong to state categorically that contemporary poetry contains no contemporary science.

As the practicing scientist well knows, the "method of exhaustion" as a method for formulating a generalization is always open to the limitation imposed by the problematical existence of one instance that is contrageneralization. At the very beginning, this means that *as a scientist* it is never possible to say

"all poets" or "all science" without doing some violence to conscience and scientific honesty.

The poets most often cited by the critics are T. S. Eliot, A. MacLeish, Edith Sitwell, W. H. Auden, Robert Frost, and Hart Crane, among others. It is with some of these that we shall first concern ourselves.

Larrabee (*7*) about a year ago stated that "T. S. Eliot has encompassed more science than science has encompassed him." Unfortunately, the statement was left unsupported. Waggoner (*8*, pp. 74–5) states that Eliot's poetry contains a "complete condemnation of scientism, and on occasion, of science." He splits Eliot's condemnation of science into three separate kinds of condemnation. Two of them, the feeling that belief, that "faith, in scientific 'facts,' belief that 'rational knowledge of causes' will solve our problems, is a mean and pitiable delusion," and the feeling that science "has offered us a view of life that is unbelievable and intolerable," are really philosophic comments. The third, that "science has removed the mystery. When 'the bright color fades,' 'when the glow upon the world departs,' it is science that is at fault," is a comment somewhat less philosophic. Eliot suggests, of course, that the mystery, the "bright glow" may have been illusory to begin with, but be that as it may, the fading of the glow and the nostalgia for it is not an entirely new comment. Waggoner points out that Poe, in his time, made the same complaint against science. Keats took issue with Newton, because, since the rainbow had been unwound, it now lay "In the dull catalogue of common things."

In order to make these charges, Eliot does use scientific notions, but, for a practicing scientist, they do not seem to be the same ones that strike a literary critic. The critic (*8*, p. 88) seizes upon the symbols fashioned from nerves, from surgery, from rituals discovered by anthropologists, from taxonomic classifications made by geologists and biologists, from dreams of a Freudian nature. The scientist finds more striking lines like (*9*, p. 179):

> The endless cycle of ideas and action,
> Endless invention, endless experiment,
> Brings knowledge of motion, but not of stillness.

or (*9*, p. 109):

> Because I know that time is always time
> And place is always and only place
> And what is actual is actual only for one time
> And only for one place.

It is interesting, too, to a scientist, to read of the use to which Eliot puts the limitations of science—limitations, incidentally, which all scientists are the first to proclaim. Consider these lines (*10*):

> We understand the ordinary business of living,
> We know how to work the machine . . .
>
> But the circle of our understanding is a very restricted area.
> Except for a limited number
> Of strictly practical purposes
> We do not know what we are doing.

Waggoner (*8*, p. 76) feels that these lines form the basis for one of the indictments of science, which seems rather stretching a point. The indictment seems to be more of the "we" in the poem and concerned *on the surface* with the machine.

Bush (*2*, p. 162) comments on Eliot's symbols as a sign of his absorption of modern science. He says, for example, ". . . while airplanes . . . fly all through modern poetry as symbols of scientific slaughter and destruction, Mr. Eliot's use of the image is unique." The phrase "symbol of scientific slaughter" jars a scientist; to be sure, no one would disallow a poet the equating of killing with an airplane, should he so please. That a poet or anyone else would say it is a symbol of "scientific" slaughter is something else again, for this would mean killing in the spirit of free inquiry. It is doubtful that any poet ever meant *this*.

After reading Eliot's poetry, the scientist is likely to feel that Eliot is not uniquely aware of contemporary science, and what is usually called his science content is much more often his personal metaphysic. In the poems of Archibald MacLeish and Robert Frost, however, the scientific reference stands away from the philosophy and seems, too, to be more contemporary.

MacLeish writes many times with one eye on new physical theory. Consider, for example, part II of "Signature for Tempo" (*11*, p. 28). He writes:

> These live people,
> These more
> Than three dimensional
> By time protracted edgewise into heretofore
> People

The date of this poem is 1926. In 1929 appeared the very fine, long poem "Einstein." For the scientist, it is an interesting one, because it shows the awareness of the poet to the content of the early versions of the Einstein theories and the kinds of calculations that went into them. The poem reads, in part (*11*, p. 230):

> . . . he lies upon his bed
> Exerting on Arcturus and the moon
> Forces proportional inversely to
> The squares of their remoteness and conceives
> The universe.
>
> Atomic.
>
> He can count
> Oceans in atoms and weigh out air
> In multiples of one and subdivide
> Light to its numbers.

A scientist is struck, too, by the acute awareness of MacLeish to the time-space relationship. In "You, Andrew Marvell" (*11*, p. 50), starting from the lines of a poet of the 17th century (*12*):

> But at my back I alwaies hear
> Times winged Charriot hurrying near

he expresses an inexorable flow of time, as well befits a man of this day, in space units. The point has been made both by Waggoner (*8*, p. 144) and Pearson (*13*, p. 159).

Robert Frost writes with some of the same aware-

ness of theoretical physical science—the difference lies, of course, in the use to which he puts his awareness. A comment on a cosmology, for instance, is found in "It Bids Pretty Fair" (*14*, p. 44):

> The play seems out for an almost infinite run.
> Don't mind a little thing like the actors fighting.
> The only thing I worry about is the sun.
> We'll be all right if nothing goes wrong with the lighting.

These lines are interesting in conjunction with the poem "Epistle To Be Left in the Earth," by MacLeish (*11*, p. 61). Apparently in the latter case, the same subject matter is under consideration, for the poem, a statement of all the knowledge of man to be handed to future generations or future inhabitants of the world, begins with the line ". . . it is colder now," and ends with "It is very cold/ there are strange stars near Arcturus."

The second law of thermodynamics appears in Frost's "West Running Brook," (*15*)

> Our life runs down in sending up the clock . . .
> The sun runs down in sending up the brook.

Frost's short poem, "Innate Helium" (*14*, p. 29) depends almost entirely for its interpretation on a knowledge of the properties of the rare gas.

Of special interest (aside from their charm, wit, and lucidity) to the scientist are two poems of Marianne Moore. In "Four Quartz Crystal Clocks" (*16*, pp. 116, 173), there appears a restatement of a leaflet reporting work at the Bell Telephone Laboratories (1939):

> There are four vibrators, the world's exactest clocks;
> and these quartz time-pieces that tell
> time intervals to other clocks,
> these workless clocks work well;
> independently the same, kept in
> the 41° Bell
> Laboratory time
> vault.

Later on, in the poem,

> We know . . .
> that a quartz prism
> when the temperature changes, feels
> the change and that the then
> electrified alternate edges
> oppositely charged, threaten
> careful timing, so that
>
> this water-clear crystal as the Greeks used to say,
> this 'clear ice' must be kept at the
> same coolness. Repetition, with
> the scientist, should be
> synonymous with accuracy.

The poem "Icosasphere" (*16*, pp. 142, 175) relies for part of its idiom on the work of J. O. Jackson of the Mellon Institute, described in a report by Kaempffert in the *New York Times* of Feb. 5, 1950. In this poem, the heart of the report is paraphrased in a disciplined metrical line so that the line "fits" the idea being conveyed. Critics of the science content in poetry seem to have overlooked these two poems.

On the other hand, the comment is made repeatedly that Auden demonstrates a high content of science. This may be true, but as in the case of Eliot, the philosophy obscures the content, overlays it, and makes the evaluation extremely difficult. Because Auden writes primarily of urban society and urbanization, the critics are inclined to take references to machines, again, to products of applied science (for example, use of antibiotics) as evidence of science content. Isaacs (*4*, p. 77) feels that the science content of Auden (and of L. MacNeice) is predominantly that of social science; he points out, though, that the "New York Letter" (*17*) contains in its notes references to Spemann's ***Embryonic Development and Induction.***

III

Discussion of the science content of contemporary poetry leaves untouched the fact that the practice of science insists on an attitude and insists on the use of a generally understood, but hazily defined, methodical approach. To what extent has this insistence permeated modern poetry? To give an answer here is of far greater difficulty than to answer the question: Is there science content in poetry? Methods of accomplishment are rarely reflected in the accomplishment itself, except to the extent that the method places a limit on the nature of the accomplishment. An attitude or spirit is even less tangible; the only index to attitude can come from the total impression after the work has become a discernible entity. Even then discovery of attitude is made complicated by the fact that two attitudes are involved, the attitude of the creator and the complex of attitudes of the discoverer. So interwoven are all these factors that any evidence will be secondary or even tertiary. It should be evaluated as such.

It is secondary information that has thus far been uncovered. It derives from the prose writing of Ezra Pound. The qualifications for citing it stem directly from Pound's unique position in modern poetry as the "Father" of many modern poets, or, perhaps by now, the "Grandfather." Pound strove to remove from poetry the imprecision in language usage that characterized the late Victorians. The number of poets who acknowledge their indebtedness to him is astonishing. One is rather sure that his influence is even greater than any printed list of names would indicate. For a scientist, his statements on precise language are very reminiscent of the writings of Lavoisier and the papers of the Royal Society that deal with almost the same subject. Pearson (*13*) has also noted this.

In *The A B C of Reading* (*18*) Pound's advice to poets is that they should "look to the biologists." In another place, he tells them to "look to the scientists." The reason for looking to these people is that in them one finds ways in which abstractions are developed and, in particular, ways in which they are to be used. Pound's own poems seem to have been written with an awareness of this power. Of course, it cannot be said that he learned how to make abstractions from a study

of scientific methods, or whether he cited the biologists as a clear and obvious example of another group of workers who also deal in abstractions. What can be said is that the thought processes that are successful in transforming scientific techniques are, in some measure, similar to those operating to transform poetic techniques. The transformation is possible because the subject matter of science, abstractions, also occupies a dominant role in poetry. The difference is one of degree only, for the essential nature of the abstracting process is the same, whether it be used to extract the properties of a collection of selenium atoms or the characteristics of man's philosophic dilemma.

Pearson (*13*, p. 160) concludes:

> Science has performed an inestimable service to modern poets in forcing them by a redefinition of physical reality to search out a revitalized manner of expression. . . . Science gave in her new terms a fresh beginning to poets. They served as challenges to poetical clichés.

The statement is a little one-sided. Poetic usage of science, of the scientific attitudes and spirit, performs an "inestimable service" for scientists, too. Poets as such will probably never suggest the direction of future scientific inquiries, but they will always provide a fairly reliable index of the extent of popularization of major scientific advances. Poetry is a reliable index because it is unself-conscious; it is only fairly so because of the necessary time lag between the publication of a scientific concept and republication of the poetic distillation of that concept. Possibly no other index of this quality exists, being, as it is, almost an artifact of the poetic energy, not the *raison d'etre* for poetic expression. Scientific content seems to be used only as one of the ways for creating and heightening the expression, itself extrascientific.

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A Treasurer Retires: W. E. Wrather

Howard A. Meyerhoff

Scientific Manpower Commission, Washington, D.C.

IN March 1940, a score of scientists met in Dallas to make preliminary plans for the first annual meeting of the American Association for the Advancement of Science ever to be held in Texas. At Washington headquarters, there was some trepidation about holding a convention at a point so distant from the northern and eastern centers of learning, where scientists are concentrated in largest numbers, but the warmth and sincerity of the invitation from Texas had been persuasive.

Foremost among the decisions to be made was the selection of a general chairman for the meeting. By tradition, born of experience, the general chairman must be an eminent scientist who not only commands the respect of his fellow-scientists but also enjoys the confidence of the entire community. He must be a leader, a man who can get things done and with whom everyone will cheerfully cooperate. Of the several men proposed, only one had all these exacting qualifications. By unanimous consent, the group chose William Embry Wrather, an oil geologist whose successful consulting practice and wide scientific contacts had made him not simply an eminent local businessman but a prominent citizen of Texas and a scientist with a nation-wide reputation as well.

Dr. Wrather had been a member of the AAAS since 1917 and a Fellow since 1925, but this was his first major role in Association affairs. The success of the Dallas meeting, handicapped as it was by the tension and confusion that followed upon the attack on Pearl Harbor only 3 weeks before, was an achievement for which William E. Wrather must be given generous credit. It was, however, just the beginning of a long and valuable period of service.

Not long after Pearl Harbor and the Dallas meeting, Dr. Wrather was called to Washington to func-