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EDITOR'S NOTE — The following article is a revision of the dedicatory address on May 11, 1974, when the aquatics laboratory at Bemidji (Minnesota) State University was opened formally and named in honor of Dr. Harold T. Peters, Professor Emeritus of Biology at that institution. Dr. Peters, a member of the Bemidji faculty since 1945, had previously served as chairman of the Division of Science and Mathematics there and also had been president of the Minnesota Academy of Science in 1957-1958.

'T. C. MITS' and the Utility of Science

ABSTRACT — The general public, as well as many leaders of our society tend to view science as descriptive and to value science mainly for "practical" applications. Although technological implications are important, science cannot legitimately be considered primarily descriptive. Science is a creative activity, involving human judgment, and can most fruitfully be thought of as metaphor or play. The practical value of science, of the liberal arts in general, and of academe is that they provide the playful approach to experience which is a necessary basis for successful planning and action, and which makes us human.

EVAN B. HAZARD*

When a college opens a new science building, it proudly invites T. C. Mits in for a look. I first learned of T. C. Mits as an acronym for The Common Man In The Street in Simon (1973). (I have since found that his liberated companion, T. C. Wits, prefers to retain her maiden name. She has, however, graciously assented to my use of masculine pronouns and acronyms in a generic sense.) Having T. C. Mits on campus to look at us provides me an excuse for a look at what we are doing in academe, using aquatic biology as a start, but going on to the natural sciences in general, and then to the other liberal arts. I will be selective, and will emphasize certain basic aspects of our calling which are generally neglected or belittled outside of academe, and which it has lately become fashionable to neglect within academe as well.

What might T. C. Mits see college faculty and students studying in aquatic biology and related environmental studies? Faculty and students are following the movements of walleyes with radio-tracking equipment, studying the growth rates of known year-classes of perch, developing new methods of determining the age of walleyes, analyzing well water to determine its usability, measuring the concentration of mercury and other heavy metals in game fishes, studying the effects on stream water quality of the fertilization of commercial wild rice paddies, evaluating the influence of snowmobiles on vegetation and wildlife, and so on.

These are important activities, deliberately described in terms that perhaps first come to the mind of T. C. Mits when he is thinking favorable thoughts about the sciences. Perhaps his feelings and those of many businessmen, legislators, and government officials, as well as of some academicians, can be summed up in the following widely quoted words:

"The most important problem does not lie in understanding the laws of the objective world and thus being able to explain it, but in applying the knowledge of these laws."

Some ways of applying knowledge are too obvious. As soon as the radio-tracking studies were publicized, we began to receive calls asking where the fish were. On a somewhat higher plane, knowledge that we gain in limnology, biochemistry, physiology, heavy metals research, and so on may be of real long term practical benefit. We may learn more about the movement of walleyes, and thus about the best ways in which to manage walleye populations for sustained yield harvesting. We may learn how to avoid eating excess methyl mercury in contaminated fish, or better still, how to reduce the contamination. And, in carrying out such studies, students acquire the facts and the skills to be of service to society in solving such problems elsewhere, and in teaching others the scientific approach to answering questions.

The practical application of science is important, and I wish in no way to belittle it. However, as I have described it, it is as much technology as it is basic science. Without being too analytical, perhaps we can consider technology as a collection of methods for getting jobs done, and science as a system of rules and behavior patterns for trying to explain observations within a certain rational context, for making rational sense out of the universe. The two are today often closely related, but this is not a logical necessity. If there were no deliberate attempt to do science, there would still be technology. Damascus steel was forged with no understanding of modern chemistry, medieval armies catapulted projectiles into walled cities with no knowledge of dynamics, Luther Burbank bred super vegetables without understanding genetics; and although we have known of Newton's law of gravitation for almost 300 years, we still make no use of it in predicting tides over 10 years in Coos Bay, Oregon.

Scientific understanding often makes technology develop faster, but in principle and often in practice, you can operate effectively without knowing what you are doing. And society primarily values science for its technological usefulness, not for its exploratory value. In fact, T. C. Mits would often

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rather **not** understand. I think we should keep this in mind when we think about society's support for science. Many people believe that American society supported basic science heavily in the 1960's. Actually, "the fact is that it never supported basic science on a large scale – as basic science" (Simon, 1973). Most nations support the sciences primarily in hopes of solving technical problems – in health, military capacity, space exploration, energy development, and so on. In the last few years, as budgets have gotten tighter, the emphasis on short-term, supposedly practical, results has increased. Purse-string holders have become more reluctant to realize that, in the long run, basic science done solely for its explanatory value will also produce information of potential practical benefit. Most of us could cite many examples to prove that this is true, but it would be pointless. As Edward Edelson, science editor for the New York Daily News, points out, "the very attempt is a mistake. You cannot justify science on practical grounds any more than you can justify music or art or literature. If you must start pleading practical benefits – that the symphony increases productivity or that painting is good interior decorating or that the novel uplifts morals – you have lost the argument before it begins" (Edelson, 1974). Therefore, despite the fact that the application of science is where the money comes from, let us dwell on the nature of basic science, partly because it is more fun, but also because it will take us full circle.

Alternative approaches

First, some ground rules. Scientists, insofar as they are effective scientists, are rational. They of course have no monopoly on reason, nor are they reasonable in all things. But they believe that, in order to understand their observations, they must reason. Linnaeus (1758) said "it is the exclusive property of man to contemplate and to reason on the great book of nature. She gradually unfolds herself to him who, with patience and perseverance, will search into her mysteries." (We will ignore any male supremacist implications at this time. Outside of his scientific endeavors, Linnaeus was as capable of unreason as the next person.) This ground rule is an article of faith. So is a second ground rule: "the universe is orderly." (Neither of these articles of faith rules out other sorts of faith among scientists.) There is no logical necessity that the universe be orderly. Even if it is, there is no assurance that people are capable of fully understanding the order that is there. But scientists think the universe is orderly, and in principle comprehensible, largely because this approach is so fruitful. The success of the scientific approach to the study of things has them pretty much convinced that the universe is all of a piece. Most of them find this exciting and awe-inspiring. The apparent orderliness of the universe in fact moved Einstein to observe that "the most incomprehensible fact is that nature is comprehensible" (Weisskopf, 1972). Many people, including most scientists, see the order in the universe and the potential ability of man to understand it as a good thing. Others do not see it that way at all.

In order to consider a few of the reasons why some people find basic science congenial and some people do not, we should look carefully at the nature of scientific understanding. T. C. Mits thinks science is basically a collection of information about nature, a description of the universe. Most college professors outside the sciences probably agree with him, and so do some scientists. These people see science as objective, which it is, and also as automatic, which it is not. They think that the scientist carefully collects measurable data, divides the sum by pi times the natural logarithm of Avogadro's number, and mechanically produces a description of that part of the universe from which the data were gathered. The more data, and the more precise the measurement, the better the description. It is understandable that some people, seeing scientists as cataloguers and calculators, find science unattractive. Wordsworth (1800), although he does not use the word science, is obviously talking about us when he writes:

"Physician art thou? one all eyes,
Philosopher! a fingering slave,
One that would peep and botanize
Upon his mother's grave?"

This view of science, as a description of nature, is unattractive because science then seems to be devoid of human judgment. But, as many of us see it, this mechanical view of science is false (Bronowski, 1965; Miller, 1970). I say this for two reasons. The first is that a completely mechanical description is as impossible (and would be as useless) in science as it is in painting or poetry. Cezanne and Wyeth both decide what to include in a painting and how to include it, and even Canaletto chooses his colors and his composition. Ansel Adams chooses his composition, perspective, lighting, and exposure. Are the known "facts" of science automatic descriptions? Hardly. Nobody has ever watched Mars do a full turn around the sun; all we have is a series of points on charts. Kepler's conclusion that the orbit of Mars is an ellipse is a human judgment. The points on the charts do not simply generate an ellipse – they can be made to fit other curves, and they do not fit an ellipse exactly. Johannes Kepler and his successors have had to make judgments about observational errors and the disturbing effects of other planets in order to conclude that Mars, and by inference all the other planets, travel in ellipses. Or, rather, that they would if the other bodies were not there. But they are there. Yet we, reasonably, still persist in saying that Mars travels in an ellipse about the sun.

The same process occurs in biology, and all the sciences. Gregor Mendel, in the second generation of his fifth experiment with garden peas, obtained 428 plants with green pods and 152 plants with yellow pods (Hardin, 1966). This is not a 3:1 ratio, but a 2.82:1 ratio. (Three significant figures is enough to make my point.) In Mendel's judgment, this and similar experiments, none of which gave exactly a 3:1 ratio, justified the statement that a certain set of conditions results in a 3:1 ratio. The 3:1 Mendelian ratio is not a description of nature, but a judgment about what is important in nature and what is not. It has meaning, whereas the mere data do not. And even the mere data themselves are a judgment, because Mendel decided that for a particular chosen purpose, it was best to ignore those plants that died, any insignificant differences in the greenness of green pods, the time of flowering, and what not. **Decided, chosen, purpose, best, insignificant** are not neutral, mechanical words. There are differences between the sciences and the arts, but absence of personal judgment is not one of them.

Science as metaphor

The second reason that science cannot legitimately be seen as mechanical description goes deeper. Klopfer (1974) argues that the objectives of the sciences, the arts, literature, philosophy, and theology are basically the same, "to find new ways of perceiving the universe." (Note: He did not say the methods were indistinguishable.) Let us now look at what some non-scientists think about their way of perception. John Ciardi, a poet, had this to say in 1964:

> "I do not deal in ideas but in experiences. I must make illusions for you. I must make something happen, and it must be **as if** it is happening to you. Every **as if** experience you try on is another way of seeing yourselves. I must lead you to feel as if you were a child, a lover, a murderer, a dancer, a coward. For only as you try on all your possibilities vicariously can you come to know yourself.
>
> "But you will not be able to try them on if I **only tell you about them** . . . . I must make you feel them **as if** they were happening to you. And to do that, I must play my games.
>
> "I am not even sure . . . . that I play my games for you at all. I think I would play them if I were the last man alive. If I am in any way your benefactor, the benefaction is an accident. I play the games that let me write poems because I find that writing the poem is a better way of living than not writing it. Because I am happiest when I find myself winning a hard game with myself" (Ciardi, 1954).

The poet uses metaphor to evoke images, to convey meaning. He plays with words. Theologians also are interested in finding meaning in experience. Some, like Frederick Buechner (1973) and David Miller (1970), find in play the route to greater understanding in theology. To Buechner the Lord's Supper is deeply meaningful, yet he says this of it: "It is make believe . . . . It is a game you play because he said to play it. 'Do this in remembrance of me.' Do **this**. Play that it makes a difference. Play that it makes sense. If it seems a childish thing to do, do it in remembrance that you are a child." Miller devotes his book **Gods and Games** to the development of a theology of metaphor, of "as if," of play. And he reminds us that this view of the Kingdom is not a new one: "Unless you receive the kingdom of God like a child, you cannot enter into it." (This is Miller's wording, and is presumably either Mark 10:15 or the comparable passage in Luke. It is not the wording of either KJ or RSV.)

But, one might ask, what has this to do with science? The answer is everything. The profound insights of science are metaphor – "as if" – let's pretend." Any abstraction is pretense, and the scientist must abstract in order to understand. The scientist is a model builder. The physicist does not consider his atom with its electron clouds as reality, but as a fruitful picture of reality. The uniform rectilinear motion of Newton cannot occur in the real world, but it is the basis for a theory that, within limits, successfully relates the motions of apples, moons, space probes, and even comet Kohoutek. (Comet Kohoutek may not have been as bright as we would like, but neither are we. But it followed precisely the predicted path, and it will be back. Just wait.) This theory, by the way, says objects behave "as if" there were an attractive force proportional to their masses and inversely proportional to the square of the distance between them, and which allows you to calculate "as if" the entire mass of a body were located at the center of the body, which of course it is not.

The entire science of population genetics is likewise based on a principle, the Hardy-Weinberg Law, which only holds true under conditions that never occur in nature. But this playing around allows us to predict the way real populations will behave with the passage of time. And these predictions come true, as anyone knows who has tried to kill flies with DDT in recent years. It turns out that the most informative way to express what happens in the genetics of populations is in terms of abstractions or metaphors, not raw facts. The population geneticist will thus happily state with a straight face that the **gene pool** of a **Mendelian population** of houseflies has deviated from a **Hardy-Weinberg equilibrium** because an alteration in the **ecosystem** has changed the **set-point**. The housefly, being less interested in abstractions, is happy if it can deviate from the path of a flyswatter.

I have said that the insights of science, like those of the arts and humanities, are basically metaphor, or model-building, and are thus in essence playful. In our work-oriented society, I fear most people would equate playful with "trivial." Quite the opposite – play is essential. As the psychologist Erik Erikson (1963) has put it, "child's play is the infantile form of the human ability to deal with experience by creating model situations and to master reality by experiment and planning." The playful, metaphorical approach to experience, then, is the creative, uniquely human approach, and it is basically the same in the poet's retreat, the artist's studio, and the chemist's laboratory. And this is what, to my old-fashioned way of thinking, a college, and the liberal arts, are all about. In the words of Miller (1970), "the university is where the action is not; it is where the imagination is – the imagination for all action. Or so we would hope! It is the playground of ideas of play. And such play is serious business! It is the basis for whatever and wherever the action is."

The utility of science

And it is David Miller, of course, who has brought us full circle. It is the impractical, seriously playful pursuit of the sciences, the arts, and the humanities for their own sake which can give us the understanding which can be the only sound basis for responsible action in the everyday world of T. C. Mits. And it is imperative that T. C. Mits understand that world if he is to survive in it and prosper in it. It is not enough that the scientist understand; T. C. Mits must understand, too. If he understands nature, he may love her. If he does not, he will use her and such use, of course, is mis-use. Misuse is rape, and can only lead to ruin, both of nature and of T. C. Mits. Speaking of the defense of nature, Sigurd Olson once said (in an address on our campus) "only if there is understanding can there be reverence, and only where there is deep emotional feeling is anyone willing to do battle." T. C. Mits will not defend what he does not comprehend.

One reason that T. C. Mits and his leaders often do not trust the arts and sciences, and are therefore suspicious of a liberal education, is that they do not want to understand. Understanding is heady stuff – it is risky and frightening. It often shows us that the usual way of doing things is short-sighted and even absurd. Because of this, T. C. Mits would often rather restrict the writer and musician to the production of TV commercials, and the scientist to the designing of better fish finders.

What we consider practical, in the end, depends on how we view man. If we think that all T. C. Mits needs is a full belly and a dry basement, the liberal arts are unnecessary and even dangerous. But these are not all he needs. To be fully human, he **needs** to participate in that playful, metaphorical understanding of himself and his world of which only humans are capable. This means he needs a liberal education in the sciences, the arts, and the humanities. Society must support the impractical liberal arts for the very practical reason that they serve uniquely human needs. Chairman Mao Tse-Tung was therefore being impractical in 1972 when he said:

> "Marxist philosophy holds that the most important problem does not lie in understanding the laws of the objective world and thus being able to explain it, but in applying the knowledge of these laws actively to change the world."

He, as well as others who adhere to any of the several existing rigid ideologies, might have added that a knowledge of the laws of the objective world might lead to the overthrow of the ideology itself, which is not the kind of change he had in mind.

Acknowledgment

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