Science, Communication, and the Critical Mass

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In recent years, science has been confronted with a crisis in communication. To the average scientist this crisis has meant that the scientist to scientist transfer of information has bogged down. A number of programs to relieve this situation have been proposed and are, depending on the field, in various stages of implementation.

I suppose that those of you who have followed the efforts of biology to formulate a national system, and know of my activity in this area, have already concluded that a biologist is about to speak to you about biological communication.

Stand relieved—today I wish to talk about communication—but not that of scientist to scientist.

There is an equally urgent problem which if not resolved may have much more deleterious effects than that posed within the scientific community.

I refer to communication from the scientific community to the non-scientist. This problem is of equal importance to all fields of science—a fact which is easily demonstrable. A significant portion of the long range solution to this problem rests in large measure in the hands of that part of the scientific community concerned with education.

Previous to World War II, research in science was the activity of a dedicated few—a relatively smaller number of practitioners than is currently the case.

The public image of research was often revealed by caricatures in the popular press—in the case of biology often by a picture of an eccentric old man with collecting gear and butterfly net. Indeed, the remarks of some of my physical science peers led me to think that even they bought the image of a biologist, thus portrayed.

With World War II, the public image took a radical turn. In the post World War decade, the public image of science and the work of scientists developed directly from the efforts of the scientific community during World War II.

And what were these efforts? The more spectacular of them dealt with the harnessing of nuclear energy; the development of radar and sonar; the screening and selecting of chemotherapeutic agents such as sulfur drugs and metabolic by-products of fungi as antibiotics.

The mass media publicized the work under the label of scientific research. Yet it is a well known fact, at least among scientists, that the basic research behind these technological advances was a product of work carried out by the scientists of the 1930's and earlier. Further, we know that the success of the scientific community during World War II was not the result of *directed* research in the 1930's. The success remains as a clear example of how unfettered, undirected research can supply basic building stones on which directed development and technology can be constructed.

But these points were never really mentioned to the public and hence their image of science in the post war era was one that can be simply stated: given a specific problem, a relatively large amount of money, and an adequate concentration of investigators, the efforts of these scientists are direct and result in applicable solutions to the specific problem in a remarkably short period of time.

Acting on this image, the public stoutly supported the growth of what was labelled in governmental budgets—R and D—research and development.

It is difficult to pinpoint the blame for this erroneous image. Either few scientists spoke loud enough with corrective statements, or the mass media simply ignored, as non-newsworthy, disclaimers from the scientific community.

But the fact that this image of capability for immediate solution to all problems confronting society became firmly entrenched in the community at large can hardly be disputed.

With the advent of spectacular developments in space by the U.S.S.R., a second stimulus for public support of research and development was layed upon the first. I recall that academic salaries and departmental budgets increased dramatically—both attributable to the appearance in the stratosphere of a man-produced and man-projected satellite. At this point, the "D" of R and D began to grow at a rather disproportionate rate to its forerunner and counterpart—the "R".

The scientific community began to speak out loud and clear for its share of funds for basic research. Perhaps—for all the wrong reasons—the public began to think of R and D with some degree of insight provided by science.

Growth of R and D rose to a rate, in dollars spent, exceeding that of our gross national product. Federal expenditures in research and development rose over a 20 year period by about 25% each year. The need for scientific manpower drew national attention. From the first grade through the early years of college, the academic portion of the scientific community focused on those individuals whose potential predicted a career in science.

When one examined where we were going in the funding of research and development, even as early as 1958, a decade ago, the answer was apparent. A simply extrapolation of growth curves for R and D and the GNP led Jerome Wisner, Science Advisor to President Kennedy, to inject the thought that the bubble might burst. Instead of a 25% per year growth, leaders now talk about a 15% per year growth

—and 15% is still three times the rate of growth of the GNP. The problems of the growth of science and technology were apparent then a decade ago.

Congress, drawing its constituents from the public whose image of science was that of immediate applicability, began to examine the results of R and D spending. This examination was and still is in terms of the resolution today of the multitude of problems facing the nation in health, transportation, agriculture, education, and urbanization. No consideration was or is now being given to the results of governmental support in terms of basic accumulation of knowledge—those building stones on which development and technology rest.

The results of this intense scrutiny are familiar to you: the geologists have lost Mohole; funding for the 200 BEV accelerator at Weston is slow; the chemists are frankly pragmatic in stating that the development of chemistry as pictured in the Westheimer Report will probably not be implemented; the IBP is stranded for lack of funds; and even NIH in the biomedical domain has some problems. It is true that the scrutiny and the drastic cutbacks are made more intensive by our involvement in Vietnam, but I submit that the bubble was due to burst even without Vietnam.

And for those of you who are engaged in scholastic education, a reduction in the funding of science at the national level will be followed at the local level with little time lag. No one engaged in any facet of science in the United States will remain immune to the trend now begun.

Currently, not only research but also development shares the deceleration. Candidly, I think that if the Russians land the Presidium on the moon, we—the scientific community—may just avoid a further deceleration likely to become a decapitation.

What is needed? Certainly it is not a return to the 25% per year increase in spending; the nation cannot afford it under present or projected economic conditions. The first need is a planned steady growth of research and development more in line with, and probably hinged to, the 5 or 6% annual rate of growth of the GNP. Secondly, a more equitable distribution of these funds between research and development must be attained, if the generally accepted cliche "what is science today is technology tomorrow" is at all correct.

Are we likely to achieve these two needs when the war is over? And my answer is no, not unless we effectively communicate to a critical mass in the 200 million people who constitute our population.

This communication can occur at two points—one clearly a function of the educators present; the other, a function of this academy and other institutions of organized science.

The two points are fairly obvious: initially, during the period of basic education; secondly, as an input in the continuing education which every adult in the electronic age must carry out if he or she is to adjust to the rapid advances of society in this age.

The mere suggestion that we look at science education conveys the impression that there is something amiss. What is it? The facts of science education as a major vehicle of communication for the past two decades seem to fit the following pattern.

In the face of the most affluent period that science has witnessed in any civilization since its inception, in the face of a demand for scientific and technical personnel—we began in the elemetary school to single out and encourage those individuals whose talents seemed bent toward service of mother science.

We instituted science fairs at the expense of the more general hobby fair—and we achieved positive results, plus some negative ones. How many students whose talents were bent in another direction were rebuffed by the emphasis on science?

We put our best teachers into advanced chemistry, advanced physics, advanced biology and advanced mathematics in our high schools. We created an elite of advanced students—and we achieved positive results, plus some negative ones. How many students whose bent was in the direction of humanities received advanced courses in those fields? And how many of these same students were instructed in basic science using examples relevant to their future role as adult decision-makers in an age where progress in technology is common place—but dependent on the progress in science?

We put our best teachers into major courses in institutions of higher learning and neglected the courses for liberal arts and business students; and we achieved positive results, plus some negative ones. How many students joined C. P. Snow's "other culture" with no understanding of science and even a complete disdain for it?

I submit that for the past two decades we have communicated in science education to a very select group. The total number of this group, although in our eyes large, simply does not represent the critical mass, in our population, under our system of government, necessary to insure support of science at a sound fiscal level. Sound in terms of the total national prosperity and sound in terms of permitting the type of planned organization and growth which characterizes science itself.

In 20 years then, characterized by unprecedented emphasis in science education, we have produced one generation and begun another who possess a very basic misunderstanding of what science is and what it can do. The youth of this age—and here I speak of our current high school and college populations—are convinced that science does not have all the answers. I believe this is youthful wisdom. Not all of our problems—certainly not all of the socio-economic behavioral complex of urbanization—are susceptible to resolution by application of science. But I fear this glimpse of wisdom carries with it youthful immaturity. Immaturity that will lead—should I say is leading?—to the abandonment of science. How else do you explain the national trend of decreased enrollments in science?

I call then for a very serious reconsideration of our entire approach to science communication in terms of basic education. I do not seek to materially reduce the concentration on a selected few, but I ask for balance and certainly more attention to the education of the non-scientist, particularly to his understanding of science and technology. This understanding should be developed in terms relevant to his role as an adult in an age where science can and does permeate every aspect of life.

The second point of communication with the non-scientist is with the adult and I suggest this as a function of this academy, its sister institutions and other organized elements in science.

Our aims on a long term basis would be to reinforce public understanding for the sake of science and its support and to provide a continual updating of scientific background as a basis for decision making in public policy and personal problems.

In an address to the 1966 Academy Conference of the AAAS, E. G. Sherburne, Jr., Director of Science Service, outlined a program for the academies—a program of communication to the non-scientist. I endorse his proposal as timely and efficient. Sherburne noted that two-tenths of one percent of the population in any state or city are the leaders. For them he suggested:

1. that the Academy establish a science advisor to the governor and an advisory committee in frank imitation to the presidential science advisor and his committee.
2. that the Academy conduct science seminars on relevant problems for members of the state legislature or even county boards.
3. that the Academy appoint ad hoc committees to study problems relevant to science at the state level and to communicate the findings and recommendations to the decision makers.

Through its committee on Science and Society, the Academy has moved to implement some of these ideas. The Committee's activity should be strongly endorsed by effort on the part of each member to implement the program.

At the same Academy Conference, I addressed the representatives on the role of academies of science in the field of scientific publications. In my talk I reviewed the publication practices of some 48 academies of science. Only 2 of the 48 publish newsletters directed solely to the general public. Yet these two by their action recognize an important role of the scientist and his organizations—namely the communication to the attentive public of studied opinions on those matters affecting science, and those problems facing the state for which there is an answer in science.

In conclusion, may I point out that regardless of your role as a scientist, you have a stake in development of a critical mass. For each of you in your day to day activities are communicators of science. Your decisions in communicating science produce both positive and negative effects. Science, today, cannot afford negativism. If you agree with me, will you begin today to meet the challenge?