## ANNUAL ACADEMY ADDRESS

# THE NOISE LEVEL OF SCIENCE

by

Paul Zinner

Assistant Director—Programs, U. S. Bureau of Mines

The invitation for me to speak before this distinguished group of scientists, engineers, and educators is indeed a high honor.

The building that we are dedicating during this meeting will be an important adjunct to the South Dakota School of Mines and Technology. Built to house the three academic departments of Geology and Geological Engineering, Mining Engineering, and Metallurgical Engineering, as well as the Engineering and Mining Experiment Station, it was planned with the needs of modern science and engineering in mind. Its laboratories have been designed to sparkle with the latest in scientific apparatus and they have been carefully arranged to make easier the integration of disciplines that have long been too rigorously kept apart.

In the years to come, we can expect many important achievements to emanate from the scientists and engineers—students, teachers and others—who will work in this new building. From within its walls still too young to be covered by a traditional mantle of ivy or scarred b yweather and the exuberances of student life, will emerge young men and women steeped in the principles of geology, geological engineering, mining engineering, and metallurgy. From its laboratories and conference halls, where the processes of education and research will be diligently carried out, will flow a gradually rising stream of papers, articles, theses, books, and other reports to proclaim and to record for posterity the results of these endeavors. Unfortunately, however, these written reports, like those flowing from other institutions of higher learning and like those added to the flood tide by Government, Foundation and Industry laboratories, will contain a substantial proportion of "scientific noise."

What is this scientific noise? Where does it come from? Is it a problem?

Perhaps I can best define my meaning by telling you where it is found. It hums and buzzes erratically through the passages of a poorly written paper. It rattles, clatters and sometimes shrieks through the pages of a manuscript that is longer than it needs to be. It whistles in mumbo-jumbo cadence in a report packed with mystical jargon. Above all, it rises to a deafening thunder in those

publications—far, far too many—that describe work which was never worth writing about in the first place or which has become out-dated before the paper goes to press.

This high level of scientific noise is a barrier to understanding. Like static, it disrupts communication, and because it is pervasive and non-discriminating, it drowns out both the worth and the non-essential messages with an impartial din.

Where does this vociferous noise come from? Regrettably, it comes from all of us. Each of us has contributed his share to the prevailing racket, and being human, we shall doubtless continue to do so.

It has become a way of life, especially with us who labor in the fields of engineering and science and who are so largely responsible for making the phrase "research and development" the glamorous password of the mid-Twentieth Century.

It is a problem because the level of scientific noise is rising so rapidly in some quarters that it threatens to drown out effective written communication altogether. The controls are now turned to peak volume because of several circumstances: First, because there are more engineers and scientists in the world today than ever before in all recorded history; second, the printed media and other outlets for publishing are greater in number than ever before, and third, because the proportion of the national expenditure devoted by the industrial nations of the world to research is greater than ever before.

The potential which these conditions creates for compounding literary misdemeanors is further enhanced by the competitive urge to appear in print, stimulated in large measure by research administrators, business managers, and financial sponsors of research.

This phenomenal outpouring of the written word has created a trauma in the man who feels he must read everything written in his field. It has been calculated, for example, that a scientist could spend a full year reading all the current literature in his specialty and at the end of that time find himself 10 years behind the literature that would have accumulated over the same period.

If one were to add to the totals of the published literature, all the unpublished papers that were presented to management and at the vast and continually increasing numbers of panels, forums, meetings, conferences, symposia, conventions, and other formal gatherings, the decibel count would strain an old-fashioned calculating machine.



At the present time more than 10 percent of our national budget, and considerable portions of our private expenditure, are being directed to the support of scientific and technical research and development.

In the United States alone, it has been estimated by the National Science Foundation, about 15 billion dollars are being spent annually on research and development. In the rest of the world, possibly another 15 billions are supporting such endeavors.

To the extent that publications are issued not primarily for the enlightenment of the scientific community knowledge, but to gratify a community of stewards, the ratio of the intensity of scientific noise to the sound level of meritorious papers is exponentially increased.

In other words, when starlings are put into the same cage with the canaries, the clamor is bound to drown out any song.

You and I and all our siblings are not only the victims of the various circumstances I've described; we are also fellow conspirators. This points up the third phase of our problem.

Don't we all contribute directly and indirectly to the scientific noise? Don't we tend to measure a person's professional stature by the length of his bibliography? Don't we tend to equate excellence with quantity and fail to separate the profound from the prolific?

Of course, we have a ready excuse for this attitude—and it has some validity. Since a high level of scientific and technical achievement has become the symbol of prestige in an international competition between conflicting political ideologies, we feel compelled to resort to every device to make our superiority manifest.

We take pride in the fact that through our manifold programs of research and development we have contributed to our Nation's economic growth and to its military security. In doing so, we have added greatly to a better understanding of nature and have applied that knowledge to traditional and new uses. Yet, we lack the faith to let our achievements speak for themselves. We seek to build a tall monument to ourselves—a monument of published papers.

Thus, we encourage the production of literature for literature's sake—as a symbol of scientific achievement and a bid for scientific prestige—and if we sometimes are nagged by an inner voice that tells us we should be encouraging quality rather than bulk, we can quiet our consciences with the reminder that what

we are doing is no more than what others are doing and therefore pardonable.

We can see then that the fault lies mostly in ourselves. We have at the least implied our approval to the attitudes that have led to the present crisis in scientific communication.

If you do not believe this is a matter which directly concerns you, let me give you some statistics.

The General Electric Research Laboratory completed an analysis of 7,533 papers on physics, chemistry, metallurgy, and ceramics that were published in 1960 in 23 journals of research. When the publications were classified by the type of institution in which the work was done, it was found that about 28 percent of the articles originated in industrial organizations; 18 percent in Government laboratories; less than 4 percent in nonprofit organizations or from individuals; and nearly 50 percent in universities.

What do we do about all this, How do we segregate the static from the sound and how do we transform the sound into effective communication?

Obviously, there is not easy solution. Yet in a matter of such great concern to the world of science and technology, much effort, much money, and much thought is being given to finding answers to the problem.

A number of studies, financed in considerable measure by Federal funds ,have been, and are being, conducted to find out what published materials or data scientists need; what uses are made of such information; what are the best procedures or methods for analyzing, organizing, encoding, storing and searching subject matter; and what automated equipment would be satisfactory for reading, storing, searching, translating, and printing out scientific and technical information. (Incidentally, out of this has come a jargon of its own with such colorful nomenclature as "permuted title indexes" and "peek-a-boo.")

For those of you not too familiar with the thinking in this area, I hasten to point out that we are speaking here of two systems: Primarily one intended to retrieve information from published or otherwise recorded material; and secondarily, one designed to search out and retrieve the publication itself for someone who will then read it to obtain the needed information.

The Science Information Panel of the President's Science Advisory Committee, made the distinction quite clear in its report of last October when it pointed out that a document depository



or library is primarily a clearing house for documents; but retrieval of documents is not the same as retrieval of information.

The Science Information Panel then indicated the sort of information centers that would be most desirable—centers that make it their business to know everything published in a special field—(such as thermophysical properties of chemical compounds of titanium). From available documents, correspondence and personal contact and from their own observations, a competent staff of working scientists would select, analyze, distill, synthesize, correlate, compile, and compact critical reviews and report on what was of value to others working in the same segments of science and engineering.

Be that as it may, not all persons with a concern in this problem are approaching such suggestions with unbounded enthusiasm. While not deriding the usefulness that documentation and information centers would have, they are quick to point out limitations in both the established and proposed systems.

In the February 22 issue of SCIENCE-1963, an astute librarian from the University of Rochester, Phyllis A. Richmond, asks a disarmingly simple question: "What are we looking for?" In answer to her own question, she says, in part, we are looking not only to find out if, when or how something was done, but for new scientific knowledge of all kinds. We are looking for new ideas. We are looking for knowledge that is in advance of its time and may be obscured among the mass of current publications. An information retrieval system alone, by its very nature, she concludes, cannot be a really satisfactory means of keeping up with scientific research.

Everyone here, I am sure, has employed the simplest, most economical and usually the fastest information retrieval system of all—and that is person-ot-person contact.

All through the Nation and indeed through the world there are in existence invisible informal fraternities, in each of which a few to a hundred persons are apprised almost daily of new work and developments. They communicate by telephone and memoranda and, if necessary, do not hesitate to travel long distances for personal discussion. They ignore the bulk of the literature, turning only to that which they have reason to believe or suspect is significant. They facilitate the exchange not only of facts and data, but of discoveries, theory, methodology, and ideas. They reach into interdisciplinary fields by holding symposiums with workers in related fields, at which formal publication is usually purposely suppressed to prevent any hinderance to discussion of fresh news and unorthodox views.

In recent years, I and others in the organization with which I am associated have tended to rely more heavily on the personal contact mechanism than on the common literature search procedures to determine the current state of the art or what the people in any specialty are doing and thinking. If, for example, I need to know the latest developments or problems associated with some phase of an iron blast furnace practice, I first ask our Chief Metallurgist. I do not expect him necessarily to know the answer, but it is expected that he will produce the names of persons who know or are leads to still others who know. Thus, usually by means of a few phone calls, the essential information is obtained. This is about as simple and direct as the information transfer process can be.

Such short cuts are not offered as a panacea. They obviously will not work for everyone at every time nor on every subject. I merely point out that a phone call to a colleague can quite often be quicker and more effective in tracking down the really essential information than a call to a librarian or the operator of a digital computer in a specialized information center.

By no means do I intend to imply that documentation centers and information retrieval centers are without considerable value. If I tend to resort to simple means, it is largely because I am overwhelmed by the enormity of the task not to mention the staggering amounts of money that would be required to set up centers for the specialties in every scientificandtechnical discipline.

Although I have participated—constructively, I hope—in high-level discussions of the subject, I do not pretend to be an expert. However, I believe that the task of those who are expert, especially the task of those directly involved in the research, development and the establishment of retrieval centers, would be considerably lightened by several preliminary steps in which all of us can take part.

First, I would recommend that we eliminate a substantial percentage of the scientific noise by refusing to permit, or refusing to abet, the publication of papers, our own included, that are insignificant, inaccurate, repetitive, redundant, overlong, unreadable, or which are outdated and obsolete by the time they can reach their intended readers. To do this we must develope and apply a critical attitude toward each and every paper.

Before I go any further let me repeat: I am not trying to discourage the publication of papers of real merit. These are essential to the advancement of science and engineering. I am speaking soley of the suppression of scientific noise as I have defined it tonight believing that it comprises a large share of our



scientific literature and that its production consumes too much of the valuable time of a limited pool of scientific talent whose energies should be more profitably expended on other endeavors. To filter out the noise from what is worthwhile we must, therefore, start with ourselves; we must apply harsh analysis to our own endeavors.

Further, we must apply to the work of others the same strict criteria we would apply to our own. When asked to review a scientific paper we must give it a dispassionate and critical review in every sense of the word and not merely a check for technical accuracy. We must ask: Who is going to read it? Is it necessary? Is it timely? Does it make a significant and lasting contribution to the scientific literature? Suppression of useless or unneeded publication is not an act of subversion; on the contrary, I would consider it an act of patriotism and loyalty to the scientific community.

Next, we can refuse to be a party to the prevailing practice of equating value with quantity. As administrators and employers we must find some index of quality other than size and numbers of published reports. The scientific or technical paper as a unit of currency for measuring the merit of a faculty member or applicant has already been considerably devalued. Let's contribute to a further devaluation at every opportunity.

Finally, those who are concerned with the education of youth, can help lower the future level of scientific noise by teaching our students how to express themselves in our native language. I need not detali what already has been so widely exprssed, namely, the deplorable fact that so many American scientists and engineers can neither speak nor write effective English. I strongly urge that all the science and engineering departments of our colleges do what a few of them alreadv are doing in giving more courses in effective writing and by insisting that clear expression be a part of every course.

The pursuit of status has become an obsession with us. Colleges and Universities, no less than individuals, seek to enhance their reputation and their prestige by every possible means, not the least of which is an unwholesome pressure on their faculty to engage in research and to publish—with emphasis on the latter. At some institutions, the percentage of time devoted to teaching grows less and less as the pressure to publish grows greater. All of you know of professors who administer laboratories, raise funds, recruit personnel, supervise contracts, direct research, consult with industry and Government, and do a variety of other things—except teach.

As institutions go these days, this school is small in size. But size is of no significance. Athens, in its golden age, was a city a good deal smaller than Denver, but what other city that we know of produced in so short a time men of the stature of Socrates, Plato, Euripedes, Sophocles, and Pericles?

The addition of this new Mineral Industries Building to the campus creates a better opportunity for all who will teach here and will study here to achieve genuine stature in their professional careers and to contribute importantly to science and engineering. I hope they will also discover and perfect a new concept in scientific communication.