PROF. SANJIB K. GHOSH
The Ohio State University
Columbus, Ohio 43210

Reading for Research

A researcher's mind should be carefully prepared because it is the most important element in the total process.

SCIENTIFIC RESEARCH is the search for and generation of new knowledge. Some research is of *basic nature* which opens up new hypotheses for further research, other researches contribute directly to the content of a *particular study* course, and still other research may be *mission-oriented* (e.g., improvement of a product or the quality of human environment).

In research, the most important *instrument* is the *mind* of *man*. Therefore the *preparation* of this instrument is very important—a training of the mind—must be largely self training. This, however, could be with the guidance of a scientist experienced in the handling of actual investigations.

ANOTHER feature of our age is the growing unity of the world. The intellectual wealth of all mankind is at the service of each one of us, if only we can overcome the language and some other barriers. Books and publications are the means by which we build bridges between cultures. Great publications are of use to us at a time when our critical values are confused. Many times a scientist suffers from contradictory impulses. Reading then comes to the rescue. Understanding and reading through other languages could be very enriching also.

ABSTRACT: *The mind of man being the most important tool in research, its preparation is important. Reading prepares the mind. Scientific and technological revolution and the growing unity of the world makes reading a basic requirement. Reading must be used as a stimulus to thinking so that originality and clarity (of thinking) is continued during research. Reading of general literature is also recommended. The start must be made with the text books. Thereafter, with proper literature search, firstly "skim" reading for general knowledge and, secondly, thorough reading for the specifics are suggested. The mind must always be receptive. The scientist's involvement in the progress of mankind must not be forgotten.*

One does not quite realize as to what extent our minds and thinking are moulded by our reading. There are several means by which one acquires knowledge, e.g., the T.V., radio, movie, newspaper, books, etc. Reading a book or a journal is different from mechanized instructions, but reading is the most ancient and the most effective of all of these means.

Research is also innovation. Innovation could be partly flash of genius, but it is primarily a chain of events that stretches from the idea to something tangible and socially valuable.

One of the chief features of our age is the scientific and technological revolution. In this regard we should (and must) read publications which give us a scientific temper and outlook.

The world's evils always came of ignorance. Even the best intentions, if lacking the required understanding, may do great harm to the human needs. Therefore, the proper understanding of the innovation process has to be one of the foremost objectives of the working scientist in general and the management behind him in particular.

In order to become successful in his endeavors the scientist must firstly maintain a *mastery* of a huge body of fast growing knowledge. Secondly, he must possess the *capcity to direct* his knowledge to real goals (into the future for newer uses). This requires an imaginative mind of the scientist. This mind, ideally, must have an extra element called *relevance*. But, then,

freedom of thinking and diversity are other elements that must be present in the same mind. In this respect the scientist has to work in a freely imaginative way like the poet, the artist or the musician. The key word here is *creativity*—that mysterious (but fortunately not very rare in the modern world) quality of the human mind.

THE HUMAN mind being of primary interest here, it can be said that science appeals especially to people who are individualists and thus their methods vary from one person to another. This fact will have to be considered for most of our discussions.

The mind being so important and its training being so necessary, study (or, call it reading) becomes the most significant preparatory step in this training. As a matter of fact a good researcher has to remain a student all his life. He has to, of necessity, keep abreast of the developments in the world. This, however, keeps on him a tremendous pressure. This is done mainly by reading current scientific journals. Knowing that there are so many journals, books and reports pertinent to one's interest coming out continuously, it is rather impossible to read more than a small fraction of the literature of interest. Thus, at best, he can skim through the available literature, with occasional thorough reading of only those of real interest to him.

It is, therefore, very usual for the researcher to study the publications dealing with his particular area of research. Surprisingly, however, some consider this practice as unwise. This, they say, conditions the researcher's mind to look at the problem through the eyes of the others and makes it difficult for him to find a new and significant approach to solve the problem. Some even discourage any excessive amount of reading in the general field of the science of the researcher's work. Many successful researchers were not trained in the branch of science in which they made their greatest contributions. Galvani and Pasteur are glaring examples of this.

If a mind full of information tries to tackle a problem, and if that collected information is adequate, a researcher is helped in obtaining a solution. But if the information is insufficient, then it is difficult for the mind to even think of original ideas, more so if the information is false or stagnant. This means that in subject areas where the knowledge is growing (as in photogrammetry) and where the particular problem is new, or is a new version of one already solved, the expert or the well-read has a distinct advantage. Against this, if the knowledge is no longer growing, if the field is old, well settled and worked out, then the world of that science requires a revolutionary new approach which is more likely to come from a newcomer—the so-called outsider.

THE BEST way, then, is to read and read publications very critically. Too much reading can be a handicap to a person with the wrong mental attitude. The reading, then, must be used as a stimulus to thinking so that originality and clarity of thinking is continued during the period of active research. This means that the reading scientist must neither believe nor disbelieve all he reads. In this respect, to quote Francis Bacon, "Read not to contradict and confute, nor to believe and take for granted . . . but to weigh and consider."[2]

On the other hand a good fundamental researcher should have diverse knowledge. Originality in research invariably comes from the scientist who has wide interests. Therefore, *variety* in the study would stimulate freshness of outlook as against dullness originating from constant studies in a narrow field. Therefore, unless the scientist wishes to be restricted to a very narrow field he should cultivate wide interest. In this respect some of the college teachers are considered lucky. The demands of teaching obliges him to be up to date with the developments in a field much wider than his narrow field of a particular research project.

FOR CREATIVE and mature thinking it is required that the scientist has a clear understanding of the broad scientific principles without loading his mind with a mass of technical details of *nuts and bolts*. The researcher should keep this in mind when he is engaged in reading. The details (nuts and bolts) will come automatically during the progress of the particular research. But the broad ideas must come from the readings or discussions. This means, considering that there is so much to read, the reading has to be somewhat superficial or *skim* reading over a wide field. The quality of this, in turn, depends on the reader's background of knowledge which enables him to assess quickly and grasp any significant idea. The mind of the scientist can build only as heavy a structure as the foundation (constructed within himself) can support.

In this respect (in terms of constructing the foundation), one should not forget the importance of the reading of general litera-

ture and the attention one must pay to the technique and art of writing papers or reports. It is realized that the general standard of the language used in scientific papers is seldom very high and very few are above criticism. The criticism is generally in terms of clarity and accuracy. The importance of the language is not merely for reporting the research well, but also for the thinking with the language. Thus the importance of language must never be undermined.

MANY BOOKS and papers are available on the writing of scientific papers, but the real knowledge of the language comes from reading of a different type. Literature has the supreme function of raising or lowering the quality of the mind of the reader. When we read great books, our minds become *dyed* to the author's thoughts. Great literatures foster the psychological health of the reader. They give moral contentment as well. The reading of literature (fiction or poetry) at least stimulates the scientist if not enriches him directly. Reading the biographies and works of some of the great men of science also enriches the scientific worker and his understanding is deepened. The study of the history of science has been drawing attention in the recent years. To the scientist it is expected to provide great stimulus, and would broaden the outlook. This type of study gives him an insight into the basic philosophy of science and the logic of scientific methods. This may be of little help in his research directly, but the indirect influence may be immensely rewarding in the end.

SOME books instruct, others entertain, still others elevate our nature. They are, however, the best interpreters of our past (our experience), and through reading we are in communion with the mind that wrote the book. We must read them if we are to become (even) conscious of our tradition. On the other hand, we do not maintain a tradition by simply repeating the words and acts. By doing so we destroy their significance. No tradition can be kept alive without the critical and creative change that our understanding can give. The individual's contribution depends on the pressure on him of the new problems of the age.

The question arises then, as to where should one start. Even to ascertain as to what investigations have been performed on a particular area of research, one must start somewhere. *Text books* such as the Manual of Photogrammetry (published by the American Society of Photogrammetry), however basic they may be, should be considered as the starting point. A text book can be considered as a coherent picture of facts and ideas thought as significant by the author. The authors of the text books often tend to ignore or to smooth out the gaps in the science. Thus the next step should involve the reading of the original papers that are expected to be appropriately referenced in the textbook.

It is, therefore, advisable to make a thorough study of the relevant literature in the early stages of the research investigation and this must be preceded by a thorough *literature search*. Trained librarians can be of tremendous help in this respect, as also the various published collection of abstracts (e.g., the ITC Bibliography cards, STAR, TAB catalogues, etc.).

WE SEE then, that reading is necessary for the scientific investigator. However, such reading must be carefully planned and become very gradual, thorough and progressively flexible. It should be modest in the beginning, but will grow with the *passion* of the scientist. True science demands from a man all his life. On the other hand, merely having a passion for the science may not be enough unless it is mixed with *modesty*. An obstinate person many times refuses good and friendly help and may lose the essence in the long run. Similarly an obstinate scientist may lose the guidance or ideas he could obtain from publications he may throw away as trash without going through them. Thus *reception* is the essence. The scientific researcher must be receptive with modesty even for his reading. A scientific attitude requires one to be open-minded with respect to different facts and values, with respect to different ways and means, languages, and cultures, even persons.

The scientist-engineer may often be *carried away* in his work. It can not be denied that technology is one of the foundations of the spiritual and cultural development of the people. Man, however, must not be dominated by technology; that would be a direct defeat. It is not only the science (say photogrammetry) with which we are concerned, but also the progress of mankind in general is involved. This must not be forgotten.

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1. Allison, David, *The R & D Game;* MIT Press, 1969.
2. Bacon, Francis, *The Advancement of Learning;* 1605.
3. Beveridge, W. I., *The Art of Scientific Investigation;* Vintage, 1957.
4. Cannon, W. B., *The Way of an Investigator;* W. W. Norton Co., 1945.
5. Radhakrishnan, S., *The Present Crisis of Faith;* Orient Paperback by Hind Pocket Books, India, 1954.
6. Russell, Bertrand, *Human Knowledge, Its Scope and Limits;* G. Allen & Unwin Ltd., 1948.

Errata

Lunar Photos Inverted

Dear Editor;

. . . The lunar picture on the front cover of the January is upside down. The flight line was north of Aristarchus and the crater is at the south end of the phanoramic photo. The only natural appearance is obtained with the eye near the perspective center. This means turning the magazine upside down.

On page 70, Figure 10 is also upside down. In this instance the flight path was south of Hadley Rill, i.e., above the picture as printed. Here the feature was very near the middle of the sweep so the perspective angle is not critical. But if the picture is reversed, it has the added advantage of putting North at the top of the page and presenting a much more natural appearance to those (like me) who have had reason for extensive study of the Hadley Rill site.

For the same reason I prefer the two pictures on page 75 to be rotated 90° counterclockwise. This would conform to their orientation on the lunar surface to the way the stereomodels were formed and to the orientation of the final map as printed on page 79.

Frederick J. Doyle

Dear Mr. Doyle:

You are entirely correct about the front cover photo; I didn't catch it. But I wish to express disagreement concerning the others. To the earth-mapping photogrammetrists, shadows are very important because of their extreme contrast in lunar photos and the lack of recognizable orientation features. I consider that the page 70 photo is correct and those on page 75 to be misoriented 180° , not 90° (but here the specific instructions of the author were followed). Wherever it is not inappropriate, I intentionally turn earth photos upside down so that the shadows fall toward the observer. However, in these lunar photos I neglected to include an explanatory note in the captions. Thanks for writing.–Editor.

Errata

The Stereorthophoto Pair

The following References were inadvertently omitted from the article by Prof. Collins published in the December 1972 issue of this Journal, page 1195:

1. "Proceedings of the International Symposium on Photo Maps and Orthophoto Maps" held Sept. 18-22, 1967, published in *The Canadian Surveyor,* 22:1, March 1968.
2. George R. Loelkes, R., "Orthophotography and Optimum Data Base", *Proceedings* of the ASP-ACSM Convention, Portland, Ore., Sept. 23-26, 1969.
3. Collins, S. H., "Stereoscopic Orthophoto Maps", *Proceedings,* Reference 1, Reference 1 (above), pp. 167-176.
4. Cossins, S. H., "The Accuracy of Optically Projected Orthophotos and Stereorthophotos", *The Canadian Surveyor,* 23:5, Dec. 1969.
5. Collins, S. H., "The Ideal Mechanical Parallas for Stereorthophotos", *The Canadian Surveyor,* 24:5, Dec. 1970.
6. Blachut, T. J., and Van Wijk, M. "3-D Information from Orthophotos", *Photogrammetric Engineering,* 36:4, April 1970.