

Technical Reports I Have Known . . . and probably written

By Dwight E. Gray

THE technical report is a specialized form of exposition that in recent years has advanced from a position of semiobscurity in the scientific information field to one of major importance. Today a sizable fraction of the new and significant results of US scientific research first sees the light of publication day in the 75 000 or so such documents that are issued annually in this country.

Ideally, the basic function of every technical report is to convey scientific information accurately, precisely, and unambiguously. In practice, the genus technical report can be divided into a number of species in terms of the degree to which each approximates this ideal and the particular characteristics that cause it to fall short. Identified and described briefly below are a few of the principal types that this author has encountered in a decade and a half of contact with this particular medium for the dissemination of scientific information. It should be noted with respect to the less desirable types that they do not constitute mutually exclusive groups. Each category has been named for its predominant attribute but ineffective reports as a whole are an unselfish lot and share their many bad habits freely.

The Suspense Type Report

IN this type of report the author seems almost deliberately to be trying to keep the reader in the dark just as long as possible regarding what is being reported and why. Occasionally the ultimate in suspense is achieved and the reader never gets the message. The mystery is heightened, of course, if the document carries a completely uninformative title like, for example, those of two reports I saw listed some time ago in a reports abstracting journal. One was called simply "Review of Work"; the other, "Progress Report No. XXIV".

This article is based on a paper ("The Technical and Scientific Report") presented at the Third Annual Institute in Technical and Industrial Communications, Colorado State University, July 11-15, 1960. The author is program director in the Office of Science Information Service of the National Science Foundation.

It is fairly common for suspense type reports to start with some such historical statement as "In 1927 Professor Q. Q. McGillicuddy, working at ABC University, found so and so." This kind of initial sentence is the technical report approximate equivalent of the "Once upon a time" with which so many of the stories of our childhood began, and it requires about the same degree of skill and intelligence to devise. It is, of course, an easy way for a report author to get started if he isn't quite sure just what he wants to say, is unduly impatient to begin putting words on paper, or is just plain lazy. For the reader, this kind of beginning introduces the element of suspense in the very first sentence. This type of initial statement may be followed by further historical meandering, and it by other background material, and so on—all presented in vacuo as far as the actual objective of the particular document is concerned. Thus, the reader may get well into this technical report "whodunit" without having the vaguest idea whether the evidence points toward the "butler"—or even whether there is a butler. Usually the reader is able eventually to discover what the writer is trying to tell him. Accomplishing this feat, however, is likely to require so high a degree of mental ingenuity and analytical agility that he is left too exhausted really to care.

The How's-That-Again Type Report

A NUMBER of very effective techniques are available to the author who really wishes to go in for how's-that-again report writing. To begin with, he obviously should shun the simple declarative sentence. This unassuming trio of subject, predicate, and object is much too direct and efficient a medium for the precise transmittal of information to be satisfactory here. Instead, the writer should, as far as possible, employ long, meandering, obscure sentences, crammed with prepositional phrases and interlocking subordinate clauses. Let me illustrate by quoting a brief bit of dialogue that occurred several years ago during the hearings of a Congressional appropriations committee. The witness, a representative of the Department of Defense, had been asked whether the Armed Forces planned to go in for underground construction; his answer was, in part,

We try to maintain a balance between the hard, as it is called colloquially, which means, in many instances, subterranean construction, and the effectiveness of our deterrent forces on the other hand which apparently, under present concepts, is regarded as the best instrumentality as opposed to a hidden defense posture.

To this a member of the committee replied,

You are wonderful. I haven't the faintest idea what you just said. You just spew out words. What in the world do you mean?

This sparkling exchange is a good example, not only of extremely effective how's-that-again writing, but also of the kind of consumer reaction such semantic mish-mash invariably engenders—whether at a Congressional hearing, in a technical report, or elsewhere.

Lest I leave the impression that the Government has a monopoly on this kind of jumbled exposition, I should like to present one non-Government (or privately sponsored) example. The following two-sentence quotation appeared under the subtitle "The Ascent and Descent of Air".

(1st sentence) While the lapse rate remains on the average less than the dry adiabatic, but slightly greater than the saturated adiabatic, we can readily conceive of any isolated mass of air which has become saturated and at a slightly higher temperature than its environment, being able to rise through its environment, since in the circumstances postulated its temperature would be at each successive level higher than that of its immediate environment.

(2nd sentence) The converse process of the descent of air, however, is not readily understandable.

In fairness to the well-known encyclopedia that was the source of this second quotation, I should say that this passage has been revised in recent editions.

To achieve the best results in how's-that-again writing, an author should try to maintain two ratios at a maximum. These are "average syllables per word" and "average words per sentence". For the former, a good rule to follow is "Never use a one-syllable word if a six- or seven-syllable substitute can be found." The effectiveness is appreciably increased if these words, in addition to being large, don't quite fit.

There are a number of ways of keeping the words-per-sentence index high. For example, "in view of the fact that" always is better than plain, old "because"; "of a confidential nature" is much to be preferred over just "confidential"; "of the order of magnitude of" is more effective than "about"; and so forth. Then one can begin as many sentences as possible with such widely beloved, but essentially meaningless, expressions as "It is noteworthy that", "It will be seen that", "It is interesting to observe that", and the like. These augment wordage without contributing substance and often have the further advantage of making the sentence as a whole so impersonal that no one really can be held responsible for what it says. The technical report author who conscientiously obeys these precepts and supplements them by writing mostly in the passive voice, by using professional jargon as extensively as possible, and by seasoning the whole stew with liberal sprinklings of dangling modifiers and pronouns of doubtful parentage can be reasonably confident he will turn out an acceptable job of how's-that-again writing.

The Find-the-Missing-Thought Type Report

TECHNICAL reports of this kind may be thought of as resembling postgraduate completion tests. Instead of filling in missing words, the reader must supply missing ideas—that is, essential bits of information and reasoning that the author neglected to include. In quite a real sense the reader is a contestant. If he guesses right, he wins at least a vague understanding of what the report is all about. If he fails to find answers, or comes up with erroneous ones, he either gets no message or is misled. Filling the gaps left by the author may be easy or it may prove very difficult. Sometimes, in trying to follow a step that the writer evidently considered obvious, the reader is in much the position of the members of a mathematics class I read about recently. The professor was engaged in putting a long derivation on the blackboard. At one point he uttered the familiar words, "From this we obviously obtain the following", after which he wrote a long and complex equation that bore no resemblance to anything that preceded it. Then he hesitated, looked puzzled, excused himself, and disappeared into his office. Thirty minutes later he reappeared and announced happily to the class, "I was right; it's obvious."

In this type of technical report the reader may be riding smoothly along with the writer's train of thought when he suddenly encounters the mental equivalent of a missing section of track or an unbridged canyon. The track may pick up again on the other side but the report provides no connecting span. This effect occurs largely because the author fails adequately to put himself in the place of the reader. The writer is reporting on something with which he is very familiar—usually on work he himself performed. When he reads over what he has written, he tends unconsciously to supply the missing sections of mental right-of-way, and fails to recognize that gaps exist. It probably is impossible for an individual reading his own report to separate completely in his mind the information he actually sees in the document from that which he possesses because of his close association with the research being reported. The solution is, of course, to have one or more colleagues read and criticize the document. Ideally, these critics should know enough about the field to be able to understand the report without having been so closely connected with the project that they will repeat the author's mistakes. Spotting serious gaps in the continuity of a report draft and seeing to it that the author fills them is one of the important functions a good laboratory editor can perform very effectively.

Masquerade and Nonsequitur Type Reports

THESE two types of technical report are considered together because they are similar in content, although they differ greatly in author intent. Both are characterized, however, by possessing some combination of the following features:

- (1) Data are not completely presented;

- (2) Conclusions are not based objectively upon the data in the report;
- (3) Recommendations do not stem clearly from the conclusions.

In the pure, or unadulterated, masquerade type report, the format and style are those of the true technical report but the objective is that of the huckster. The huckstering may be the conventional, direct or indirect promotion of something for ordinary sale, or it may involve the intellectual "selling" of some of the author's pet notions and ideas. A really high-class member of this report category usually can be recognized by its beautiful cover, probably with gold-leaf lettering; its very plush illustrations, generally in at least four colors and frequently with overlays; its slick, expensive paper and over-all impressiveness of appearance; and its high index of "nonsequiturness" for the data, conclusions, and recommendations.

However, a technical report can be nonsequitur in type without being in the masquerade category. In this case, the author usually either has failed to think his reporting problem through before plunging into the writing or he is so sure of, and enthusiastic about, his conclusions and recommendations that he simply fails to recognize the lack of logic in his presentation.

These types are, in my opinion, among the principal "bad guys" or "ineffective members" of the technical report population. This belief is expressed, of course, in the context of my earlier statement that the basic function of a technical report is to convey scientific information accurately, precisely, and unambiguously. Naturally, if the author's intent is to confuse the reader, to keep him from finding out too much, or to build into the report hurdles that will delay or prevent action, these can be very effective forms of technical writing. Now, let me turn to the kind of technical report I would classify as a "good guy". (In terms of the latter part of my title, I suspect that the probability factor is appreciably higher for what I have discussed up to now than it is for what follows.)

The Effective Type Report

IT is my belief that the really significant defining characteristics of any effective technical report are largely implicit in the answers to two fundamental questions that the author should ask himself, and answer carefully, before he starts to write; these are,

1. Just what is the purpose of this particular report?
2. Exactly for whom am I writing it?

Regarding the first, the author should recognize that the principal reason for existence of every technical report is to convey information. Other purposes—e.g., influencing someone, by means of recommendations, to take certain action—may be present but that of informing the reader is paramount. At least three significant characteristics are implied by this principal function. First, the report should be based on factual data and information; the technical report is not a legitimate

medium for an author to use for the dissemination of his own unsupported opinions or to promote his pet personal causes. Second, the writing should be clear, concise, precise and phrased in unambiguous, functional English. Third, the document should be organized logically and consistently according to a pattern that points up the emphasis the author wishes to achieve.

Perhaps two reasonably sound generalizations can be stated with regard to the second query. First, for any given report the principal user group (which sometimes is an individual) can be rather precisely defined before the report is written. For example, it may be the writer's immediate superior, his colleagues, the president of the company, the board of directors, the admiral or general who heads the military contracting agency, scientists or engineers in general, or others. Second, the specific "consumer public" for a particular report typically has a definite need for, and frequently the right to demand, the document's preparation. Important characteristics of the effective report which depend upon the answer to this second question include the technical level at which the document should be written, the extent and kind of background information that should be included, the points that should be emphasized, the types and quantity of illustrations that should be used, and the like.

Going beyond these general principles, one can infer certain attributes that the various parts of a technical report should possess if the document as a whole is to be effective. Presented below in outline form is this author's selection of the most important such characteristics.

Title

1. Ideally, should be brief, succinct, and sharply definitive of the report's contents
2. Practically, should represent the best possible compromise among these somewhat incompatible objectives

Title Page (plus, if necessary, a bibliographical control sheet)

1. Always should present at least (a) complete title, (b) name of the author and his position (thereby also indicating the issuing organization), (c) name of the person or organization to whom the report is being submitted, and (d) date of the report
2. In addition, should present whatever combination of the following items is appropriate for the particular report: (a) type of report (progress, final, etc.), (b) period covered, (c) security classification, (d) distribution limitations, (e) contract, project, and report numbers, (f) names of cooperating and sponsoring agencies

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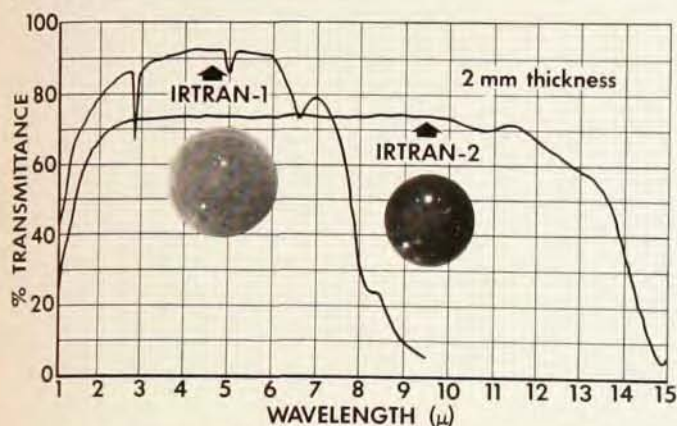
1. Should appear in any report of more than two or three pages
2. Usually can be taken from the final form of the author's working outline

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$$\frac{8.686\pi}{\lambda_0} \sqrt{K} \tan \delta$$

where K = dielectric constant
 λ_0 = wavelength in vacuum
 $\tan \delta$ = loss tangent
 δ is the complement of the vector angle whose cosine the power engineer calls "power factor."

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Another way the Irtran materials shine figuratively is their very low tendency to glow literally when hot and thus to blind themselves by swamping transmittance with emis-

sivity. They survive undamaged through the conventional torture tests of temperature-humidity cycling for 28 days, vacuum-steam pressure for 2,000 cycles in saline solution, sand and dust blast, acids, alkalis, organic solvents, plunges from hot to cold, etc.

Currently we can supply either of these polycrystalline Irtran materials as optical elements up to 6½" in diameter, among other forms. Let us have no jurisdictional disputes among optickers, micro-wavers, and infra-redders as to who sends for the supporting data from Eastman Kodak Company, Special Products Division, Rochester 4, N. Y.

Rapid-access photography

The silver halide crystal of suitable size and suitable dislocations, with a suitable organic compound or two clinging to it, makes the sweetest little old solid-state amplifier and transducer known to man. It is doing just fine, despite a few misconceptions that have arisen due to the following circumstances:

1) The idea was developed by artists before words like "solid-state physics," "amplifier," and "transducer" were coined and even before science was recognized as profitable.

2) The crystal is employed in very large numbers, dispersed in a dried-down broth from hides and bones. Superficially regarded, this seems archaic. By referring to the preparation as a "photographic emulsion," the notion is dispelled.

3) Memories from childhood suggest that after a photographic emulsion is exposed, one must wait until Dad brings the results home from downtown the week after next. This is no longer true.

Purpose of this message is to make it perfectly clear that today the delivery of photographic results within virtually any desired time interval after exposure is wholly feasible technologically. There are many ways of accomplishing quick delivery, some currently on the market and others on the way. The manufacturer wagers on what the public will buy. As far as goods for the general public are concerned, that's the way it has to be. But on goods for the professionally technical public—rational, organized, deliberate, articulate—must the betting be so blind?

We have had a flash of genius. Let's ask them first what they want! Then, as patterns appear in the answers, markets can be defined and gauged. If this works, rapid-access and simplified technical photography will encounter fewer custom problems to be solved at custom prices or else given up for less satisfactory alternatives.

Responsible organizations confronted with technical problems, major or minor, where rapidly or instantaneously available photographic images would be helpful, are invited to describe their wants to Eastman Kodak Company, Special Sensitized Products Division, Rochester 4, N. Y.

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Eastman Chemical Products, Inc. our subsidiary, sells the resin. Acme Backing Corporation, Canal and Ludlow Streets, Stamford, Conn., turns it to what others call film and we (for whom "film" has another meaning) call sheeting. Acme will gladly expatiate.

Kodak
TRADE MARK

*Formerly designated "Irtran AB-1."

3. Major headings from this outline ordinarily suffice for short reports and usually for those of medium length; seldom are more than two echelons of heading necessary regardless of report length

Abstract

1. Should appear in any report longer than one or two pages
2. Should be complete in itself and, therefore, suitable for separate publication, should this prove desirable
3. Descriptive type (telling only what the report is about) is reasonably adequate for short reports; much less so for long ones
4. Informative type (summarizing principal findings) is distinctly preferable for all reports, particularly so for reports longer than a few pages

Introduction

1. In medium length and long reports, usually should be a labelled section; in short reports, may be simply the first one or two paragraphs
2. Always should (a) make clear the report's precise subject, (b) indicate the scope of its coverage of this subject, and (c) state the specific purpose of the report—usually in this sequence
3. Except for very short reports, usually also should indicate the plan of organization of the report
4. May also include other items of introductory information appropriate for the particular reporting situation

Main Body

1. Never appears as an actual section heading; term is used here to refer to the "meat" of the report—i.e., the information that provides the document's principal reason for existing
2. Includes fundamentally the statement and discussion of what was done and what was learned
3. Optimum selection of particular sections varies with the particular situation; typical section headings include: (a) *Historical Background* (sometimes incorporated under *Introduction*), (b) *Theory*, (c) *Experimental Procedure*, (d) *Data*, (e) *Results*

Tables, Graphs, and Illustrations

1. Ordinarily not separately labelled report sections
2. Should be carefully planned for optimum communication of the desired "message" to the readers of the particular report, remembering (a) that some, but not all, data are suitable for tabular or graphical presentation and (b) that an illustration may be, but is not necessarily, worth several hundred words

Conclusions

1. In any given case may not be appropriate; if included,
2. Should stem directly from the data presented earlier in the document and should not introduce new material

3. Should be consistent with the *Introduction* in fulfilling any "promises" made to the reader

Recommendations

1. In any given case may not be appropriate; if included
2. Should follow directly from the *Conclusions*
3. Should be compatible with what the *Introduction* has led the reader to expect

Final Summary

1. Not always appropriate to the particular report; if included
2. Should summarize the principal information in the report, but introduce no new material
3. Should differ from the *Abstract* in being an integral part of the report, rather than a digest that is complete in itself

Appendixes

1. May or may not be desirable in any given case
2. In general, are used to present supplementary information that may be helpful to the reader but is not essential to the report's principal thesis
3. Typical appendix-type items include: (a) derivations of unfamiliar formulas used in the main body, (b) calculations not part of the main argument but which the reader might wish to see, (c) complete tables where a tabular summary is preferable in the main body, (d) description of unsuccessful processes or lines of reasoning, (e) details of special instrumentation, and the like

List of References; Bibliography

1. Strictly, former comprises items actually referred to in report whereas latter is more in nature of supplementary or associated reading; this distinction is not always made
2. A standard form of citation should be employed consistently—certainly within a given report, preferably in all reports from a given organization

The sequence in which the major report sections were discussed above approximates that in which they appear in most completed reports. It must not be considered the only "right" one, however; the optimum order of arrangement necessarily varies somewhat with the particular reporting situation. Perhaps the principal significant variation is the growing trend (in my opinion, a healthy one) of summarizing the conclusions and recommendations at the very beginning—sometimes on the inside of the front cover. This permits the busy reader, if he wishes, to locate the "answers" immediately, and then study the data and the line of argument at a later time.

Thus far in this paper, the terms "effective" and "ineffective" have been used entirely within the framework of the technical report's own peculiar and somewhat specialized mission. There is, however, a broader interpretation of these adjectives which raises a ques-



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tion of considerable importance. This is just how effective even the "effective technical report" described above is in contributing to over-all progress in scientific research and development.

Technical Reports and the General Dissemination of Scientific Information

IN today's world, the welfare—perhaps the very life—of our nation depends importantly upon the state of its scientific and technical development. Essential to healthy scientific advancement, certainly, is the maintenance of prompt and effective availability to US scientists of the significant results of other scientists' research.

For decades, of course, the principal mechanism for the general dissemination of scientific research information has been the complicated system we call "publication". Research results typically appear first in primary journals. The contents of these publications are abstracted and indexed in secondary journals or services. Both primary and secondary sources carry volume and number designations, or their equivalent, and are indexed. These, plus annual, and frequently cumulative, indexes provide avenues for retrospective access to the published information. Books, bibliographies, conference proceedings, and the like—which are cataloged and indexed—also are important elements of this immense publication complex.

Prior to World War II, our gross national product of research information and the capacity of the total publication system to make it widely available were substantially in equilibrium. However, the explosive expansion of the total research effort during and since that conflict badly upset this approximately steady state. For a variety of reasons involved with this enormous growth in research, the mechanics of its administration, its relation to the military, and so forth, the period since the war has seen the technical report become, as mentioned earlier, a major medium of initial scientific publication.

Certainly the technical report has important functions. It is ideal for the rapid reporting of research to those who need the answers promptly. It provides an effective tool for a contractor to use in accounting to the contracting agency for his stewardship of research and development funds. A series of progress reports capped by a final comprehensive report makes a tidy information package keyed to a specific project or program. The technical report has great flexibility in that it can handle any degree of detail or comprehensiveness the author, the laboratory, or the contracting agency desires. It ordinarily is not greatly affected by complications stemming from page limitations, printing costs, requirements of editors and referees, publication schedules, society rules and regulations, backlogs of unpublished manuscripts, and so forth. Unquestionably, many of the technical report's particular functions could not be served as well by conventional journal papers subject to the usual ground rules of regular scientific publications.

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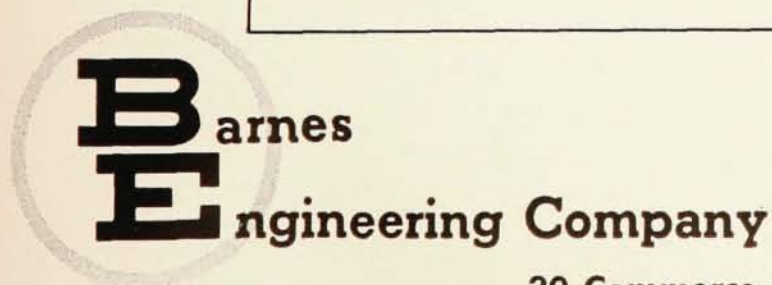
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On the other hand, the technical report's peculiar characteristics can scarcely be said to make it an ideal medium for the prompt dissemination and insured continuing availability of important research information to the scientific community as a whole. Reports are a heterogeneous lot, by no means subject to the degree of bibliographic control that maintains for conventional scientific publications. They issue from hundreds of different sources, in widely varying print runs, and are distributed and stored on all sorts of bases. With the exception of certain intralaboratory series, they follow no pattern of identification analogous to the volume-and-number system. In general, they are not widely covered by the major abstracting and indexing services, and for good reasons. Such a service has great difficulty both in defining its scope of report coverage and in assuring its readers of access to the reports it abstracts. Each agency establishes its own rules for the preparation of reports; they are subject to little standardization of style and format; extent of review for technical quality varies from zero to a degree comparable with that of good professional journals. In fact, US technical reports have as almost their only common features that they are printed in English and come out as pamphlets of rectangular cross section.

As far as the technical report's principal mission is concerned, perhaps one need not greatly deplore this situation—although there are areas where some reasonable degree of standardization undoubtedly would benefit everyone concerned. From the standpoint of the over-all advancement of US science, however, I believe there is real reason to view the present technical report picture with considerable alarm. There is evidence to indicate: First, that the bulk of unclassified technical reports contains appreciable quantities of scientifically worthwhile information; second, that a considerable fraction of such material appears no place else for at least several years; and third, that a significant portion of it never is published in other than report form. I should like to close, therefore, with the following urgent, three-pronged plea to the scientists and engineers who write technical reports, to the laboratories that issue them, and to the contracting agencies and other organizations for which they are written; it is that all three of these groups recognize the following principles and take steps to implement this recognition:

First—that they as individuals and organizations have a responsibility to the total scientific community and to the nation to make generally available the significant unclassified information in technical reports,

Second—that the technical report itself, which is written for a specific purpose and to serve a specialized audience, does not adequately fulfill this responsibility, and

Third—that, therefore, this scientifically worthwhile information must *also* find its way into conventional, bibliographically controlled channels of dissemination if it is to be of maximum benefit to science and to the nation.